`

HYDRO 2023 INTERNATIONAL
NIT WARANGAL, INDIA
राष्ट्रीय प्रौद्योगिकी संस्थान वारंगल, भारत

28th International Conference on Hydraulics,Water Resources, River and Coastal Engineering
21-23 December 2023

LIST OF SPONSORS

MEGHA ENGINEERING & INFRASTRUCTURES LTD

INDOMER Coastal Hydraulics [P] Ltd.

SAMARTH committed competence

Springer

जल शक्ति मंत्रालय
MINISTRY OF JAL SHAKTI

SERB INDIA

Engineering Growth Connection
K.C. ENGINEERS (P) LTD.

JWMM

IAHR AIRH
International Association for Hydro-Environment Engineering and Research

DHI
The expert in WATER ENVIRONMENTS

Chief Guest's Message

Prof. Philippe Gourbesville, IAHR President

Under the pressure of multiple challenges, transformation is rapidly reshaping the world we live in today. In the water sector, this is being driven by vulnerability to climate uncertainty; increase in water demand caused by population growth and the rise of modern urban environments; degradation of environmental quality of rivers and lakes receiving domestic and industrial effluents; competition among uses; economic and geo-political conflicts but also by disruptive advances in technology such as digital solutions. Countries are responding to their water challenges by accelerating efforts to build global resilience by adapting and mitigating climate change, protecting and restoring the environment, transforming energy dependencies, securing food, harmonizing uses and digitalizing water management.

Water engineering underpins and impacts almost every aspect of our lives. It gives rise to options and solutions for improved policy settings, economic growth, as well as physical, social, and environmental well-being. As countries accelerate the implementation of the Sustainable Development Goals (SDG), the most critical and the costliest solutions all involve water infrastructures, technologies, and innovations. It is estimated that water infrastructures alone will require most countries to invest 1-2% of national GDP over the period 2015-2030.

In addressing today's challenges, water engineering is a truly holistic endeavor. The complex interlinkages between different activities and sectors necessitate a system wide understanding from the harnessing of the sources in the mountains to the development and resilience of our coasts. The Indian Society of Hydraulics (ISF) focused on innovation and engineering across all sectors of the entire water cycle. Its expert communities unify and expand its collective knowledge, as well as the influence and capacity of the sector to achieve holistic water outcomes. The successful HYDRO 2023 was the opportunity for the ISF community to meet, discuss and share strategies, results, and good practices for addressing most of the urgent water issues in India. The current abstract book synthetizes the various contributions and will contribute significantly to enriching the global expertise of the water community.

Guest of Honour's Message

Dr. R. S. Kankara, Director CWPRS & President ISH

Water is essential for sustenance of life. Water resources of the country are required to be harnessed judiciously to meet the growing requirement of our developing economy. Therefore, development, conservation and management of water resources are crucial. Unplanned development leads to over exploitation of the surface and ground water resources. The challenge is even more pressing as the world confronts the multiple threats of climate change, rising food and energy costs, and the global economic crisis. Sea level rise, Flesh flooding, Changing River morphology, Reservoir sedimentation, disaster management, Dam safety etc are debatable topics for the academicians, researchers, scientists, engineers, and practitioners.

I am delighted that National Institute of Technology (NIT), Warangal under the aegis of Indian Society for Hydraulics (ISH) is organizing an International Conference on Hydraulics, water resources, River and Coastal Engineering "HYDRO-2023" during 21-23 December 2023 at Warangal. I extend my warmest greetings to the participants and contributors of the 28" HYDRO 2023.

The conference signifies a significant milestone in our commitment to fostering dialogue and knowledge exchange in the fields of hydraulics, hydrology, water resources, river, dam and coastal engineering. The dedication and scholarly contributions of academicians, scientists, researchers, practitioners, and consultants have laid the foundation for a comprehensive exploration of the latest advancements in our domains. ISH encourages the researchers to publish their research in ISH journal and by recognizing through various awards. As President of ISH, it is truly gratifying to witness the evolution of our annual national conference, HYDRO, into this collaborative and enriching endeavor.

I commend the organizing committee for their dedication to ensuring the successful execution of this conference. The decision to publish all papers in the conference proceedings is a testament to our collective commitment to disseminating valuable insights and fostering the growth of our community.

As we embark on these three days of collaboration and learning, I encourage each participant to engage actively in discussions, share experiences, and cultivate connections that will undoubtedly contribute to the advancement of hydraulics, hydrology, and water resources.

Wishing you all a fruitful and intellectually stimulating experience at HYDRO 2023.

NATIONAL INSTITUTE OF TECHNOLOGY
WARANGAL – 506 004 (T.S.) INDIA
राष्ट्रीय प्रौद्योगिकी संस्थान
वारंगल - 506 004 (टी.एस.) भारत

Ministry of Education

Prof. Bidyadhar Subudhi
Ph.D (Sheffield), FNAE
Director

प्रो. विद्याधर सुबुद्धि
निदेशक

With great pleasure and enthusiasm, I extend my warmest greetings to all the delegates. It is certainly great opportunity to host the 28th International Conference on Hydraulics, Water Resources, Environmental, and Coastal Engineering—HYDRO 2023, from the 21st to 23rd of December 2023.

On behalf of NIT Warangal and on my own behalf, I extend my heartfelt gratitude to the Indian Society of Hydraulics for considering it to organize this prestigious conference. It is both an honour and a solemn privilege to pay tribute to the visionaries, the architects of our community – the founding members Late Prof. R.J.Garde, Late Dr. P.P. Vaidyaraman and others who laid the foundation for this esteemed organization.

We are truly humbled and immensely grateful for the overwhelming response to the HYDRO Conference. The enthusiastic participation, insightful contributions, and collaborative spirit displayed by all attendees have exceeded our expectations. We have received more than 750 abstracts and based on the initial peer review, invited 550 abstracts to submit full length papers and finally approximately 450 papers are accepted for presentation

On behalf of the entire community and participants, I extend my warmest congratulations to the outstanding team behind the HYDRO Conference. I am sure that these three days deliberations of researchers in the advanced research challenges on river engineering and fluvial hydraulics, hydraulic structure and hydropower projects, hydroclimatic extremes and impacts, surface and ground water hydrology, climate change, environmental hydraulics, and coastal engineering etc. will bring new directions.

DIRECTOR

Phone: (+91)-870-2459216, 2462000 (O), 2468000 (R), Mobile: (+91) 7008118559, WhatsApp: (+91) 9439031620
Fax: (+91)-870-2459119, E-mail: director@nitw.ac.in, bidyadhar@iitgoa.ac.in, Website: www.nitw.ac.in

Chairman's Message

Prof. T D Gunneswara Rao, Head, Department of Civil Engineering, NITW

It brings me great pleasure to announce that the Department of Civil Engineering at NIT Warangal will host the 28th International Conference on Hydraulics, Water Resources, Environmental, and Coastal Engineering from December 21st to 23rd, 2023. The conference welcomes submissions on diverse themes, including Geospatial Technologies in Water Resources Engineering, Soft Computing Techniques in Water Resources Engineering, Flood Forecasting and Mitigation Measures, Coastal and Ocean Engineering, Fluvial Hydraulics, and the Impact of Climate Change on Water Resources.

In light of the escalating concern over depleting water levels globally, the imperative to conserve water has taken center stage. Discussions and debates on various platforms revolve around exploring ways to preserve this invaluable resource. The conference aims to serve as a platform for researchers, academicians, practitioners, and industrialists worldwide to contribute their valuable experiences and knowledge related to emerging techniques.

I am confident that the conference and the subsequent publication of proceedings will provide academicians, corporate delegates, research scholars, and students with a unique opportunity to present their original concepts, recent discoveries, and technical expertise across diverse research fields. On behalf of NIT Warangal, I extend a warm welcome to keynote speakers, distinguished academicians, corporate delegations, and all attendees of HYDRO 2023. I wish the conference resounding success.

Coordinator's Message

Prof. N. V. Umamahesh, Faculty of Department of Civil Engineering, NITW

National Institute of Technology Warangal stands as a distinguished institution renowned for excellence in academics and cutting-edge research in engineering and technology. Hosting the 28th International Conference, HYDRO 2023, is a significant stride in the ongoing pursuit of advancing knowledge and fostering innovation.

The response has been overwhelming, with more than 750 abstracts received, drawing participants from prestigious institutions such as IITs, NITs, and renowned establishments worldwide. This diverse participation contributes to the conference's true international character, providing a platform for fruitful discussions and knowledge exchange. Engaging with eminent researchers from around the globe has been a rewarding experience, amplifying the impact and significance of the conference. Despite the demanding nature of the endeavour, I am delighted to report the positive outcomes achieved.

I extend my best wishes to the Organizing Team, Advisory Committee, administrative functionaries, and the Students Committee, trusting that their collective efforts will yield rich dividends in terms of the conference's technical contributions. May the success of HYDRO 2023 further enhance NIT Warangal's standing as a hub for academic and research excellence.

Coordinator's Message

Prof.M C Deo, IIT Bombay

It is my pleasure and privilege to forward this volume of abstracts of the papers slated for presentation in HYDRO 2023 INTERNATIONAL, the 28th International Conference on Hydraulics, Water Resources and River Engineering being held at N I T Warangal on December 21-23, 2023.

At the outset I congratulate N. I. T. Warangal for taking initiative to organize this annual series of Hydro conferences. Since their inception, the Hydro conferences have provided a much-needed platform for upcoming as well as established researchers and innovators in India to showcase their latest technological contributions.

It is heartening to know that initially more than 750 abstracts were received for this conference and after rounds of peer reviews a total of 415 papers were accepted for presentation.

The readers of this abstract volume will notice that the studies reported are spread across a wide range of topics in hydraulics, water resources, coastal and environmental engineering including watershed management, hydropower projects, climate change and hydroclimatic extremes, among others. They also include computing applications such as computational fluid mechanics, hydro-informatics and alternative data-driven methods.

Authors of the papers presented would be happy to know that selected papers out of those presented would get published subsequently in reputed Journals.

I am sure for years to come the conference proceedings and associated Journal publications will remain as an extremely useful reference material for present and future researchers.

Organizing Secretary's Message

Dr Manish Pandey, Faculty of Department of Civil engineering, IIT Kharagpur

Dear Esteemed Participants, Distinguished Guests, and Respected Colleagues, on behalf of the organizing committee, it is with great pleasure that I extend a warm welcome to all of you to the 28th International Conference on Hydraulics, Water Resources, and River Engineering - HYDRO 2023, hosted by NIT Warangal. This conference is a testament to our collective commitment to advancing knowledge and fostering collaboration in the crucial fields of hydraulics, hydrology, and water resources.

The overwhelming response to HYDRO 2023 has been truly heartening, with over 750 abstracts initially submitted. Following rigorous peer reviews, we are proud to announce that 415 high-quality papers have been accepted for presentation. This diverse collection of contributions represents the cutting-edge research and innovative solutions from academicians, scientists, researchers, practitioners, and consultants worldwide.

We are honoured to have the support of more than 10 sponsors and partners, whose involvement underscores the significance of this conference in the global scientific community. Their commitment reflects the shared goal of advancing our understanding and addressing the challenges in hydraulics and water-related disciplines.

In a momentous collaboration, the International Association for Hydro-Environment Engineering and Research (IAHR) and the Indian Society for Hydraulics (ISH) are coming together to sign a Memorandum of Understanding (MOU) during HYDRO 2023. This partnership marks a significant milestone in fostering international cooperation and knowledge exchange.

Over the course of the conference from December 21st to 23rd, 2023, we look forward to engaging discussions, insightful presentations, and networking opportunities that will undoubtedly contribute to the growth of our collective expertise. Let us seize this occasion to build bridges, share experiences, and chart the course for future advancements in the fields that bind us together.

Once again, a warm welcome to HYDRO 2023. May this conference be a source of inspiration and collaboration that propels our collective efforts towards a sustainable and resilient future.

Organizing Secretary's Message

Shri Amit Kulhare, Scientist 'C', CWPRS & Secretary ISH

The Indian Society for Hydraulics (ISH) was established in 1992 as a Technical and non-profit voluntarily National organization to encourage and foster understanding amongst engineers and scientists in the field of Hydraulics and Water Resources Engineering. One of the major activities of the ISH is to organize International Conference 'HYDRO' every year for dissemination of recent contributions by the scientists, academicians and engineers in their chosen research area. The "Hydro-2023" conference represents a link in the chain of such "HYDRO" conferences organized annually in India over a period of last three decades under the auspices of the Indian Society for Hydraulics.

I am delighted that the Department of Civil Engineering, National Institute of Technology, Warangal in collaboration with The Indian Society for Hydraulics (ISH) is hosting an International Conference "HYDRO 2023 International" on Hydraulics, Water Resources, River and Coastal Engineering from 21-23 December 2023 at the renowned NIT campus, a leading institution of higher education.

I am glad to see that many quality papers have been submitted for the Conference. I hope that the conference will facilitate technical exchange and knowledge sharing and provide a great opportunity for the beginners in the field.

I would like to take this opportunity to affirm that The Indian Society for Hydraulics (ISH) encourages the Engineers and Scientists for the Research and Development in Hydraulics by organizing Conferences, publishing Research journal and by recognizing them through various awards. I appeal to all the Researchers and Engineers working in Hydraulics and allied fields to join the Society for the betterment of hydraulics and mankind.

I express my sincere appreciation to the conference organizers and look forward to its grand success.

Co-Organizing Secretary's Message

Prof. Manali Pal, Faculty of Department of Civil Engineering, NITW

It is with great pleasure and anticipation that I extend a warm welcome to each of you on behalf of **NIT Warangal** to the **28^{th} International Conference, HYDRO 2023**. As we gather for this significant event, we embark on a shared journey to address the pressing challenges and opportunities that surround the vital resource that sustains life—water.

In an era marked by unprecedented environmental changes and global water crisis, the importance of responsible water management cannot be overstated. The **28^{th} International Conference, HYDRO 2023** serves as a confluence of experts, scholars, policymakers, and practitioners from around the world for a collaborative effort to transcend boundaries and cultivate a holistic understanding of the complex water issues that will contribute to the development of comprehensive solutions that address the multifaceted challenges of water scarcity, pollution, and equitable access.

Throughout the conference, we will have the privilege of hearing from esteemed plenary and keynote speakers, participating in interactive panel discussions, and exploring groundbreaking research through paper presentations. Additionally, ample networking opportunities will facilitate the exchange of knowledge and best practices through productive collaborations and partnerships.

I extend my heartfelt gratitude to the Indian Society of Hydraulics (ISH) for the untiring commitment to advancing knowledge and expertise in the field of water resources and hydraulics that has played a key role in successfully addressing the recent water related issues. I extend my deepest gratitude to the organizing committee, sponsors, and each participant for their invaluable contributions to making this conference a grand success. As we embark on this intellectual and collaborative journey, let us be mindful of the profound impact our collective efforts can have on the future of water sustainability. Together, we have the power to shape policies, influence practices, and inspire the next generation of water stewards to safeguarding one of our planet's most precious resources.

Wishing you a rewarding and inspiring experience at the **28^{th} International Conference, HYDRO 2023**.

Co-Organizing Secretary's Message

Prof. Anant Kumar Rai, Faculty of Department of Mechanical Engineering, NITW

I extend a warm welcome to all as the Co-Organizing Secretary of the HYDRO 2023 at the National Institute of Technology Warangal. I am honoured to be part of an event that brings together brilliant minds from diverse corners of India and abroad as we embark on this exciting journey of knowledge exchange and collaboration. The annual conference HYDRO 2023 serves as a catalyst for intellectual growth and collaboration in the field of hydraulics and water resources. In addition to the presentations and discussions, I encourage you to take full advantage of the networking opportunities at HYDRO 2023. It is possible to open doors to new possibilities by building connections with fellow researchers, academics, and professionals.

I extend my sincere appreciation to all the contributors, from keynote speakers to session presenters and attendees. It is your commitment to advancing knowledge and pushing the boundaries of your respective fields that makes HYDRO 2023 one of the best intellectual gatherings in the world. I would like to extend my sincere gratitude to the organizing committee, volunteers, and sponsors who have dedicated their time and resources to this conference. Your hard work and commitment have laid the foundation for a successful and impactful event. I would also like to recognize the guidance and support of the director and management of NIT Warangal.

As we delve into the diverse array of presentations, workshops, and discussions, I wish each of you a fulfilling and enriching experience at HYDRO 2023. I hope that this conference will provide inspiration, collaboration, and new insights that will resonate long after its conclusion. Thank you for being part of this exciting journey. I look forward to the vibrant exchange of ideas and the friendships that will undoubtedly be forged during the HYDRO 2023.

PREFACE

About the Conference

Civil Engineering Department of the National Institute of Technology Warangal, under the aegis of the Indian Society for Hydraulics (ISH) will hold HYDRO 2023 INTERNATIONAL, 28th International Conference on Hydraulics, Water Resources, River and Coastal Engineering from December 21 to 23, 2023 at Warangal, India. The conference aims at providing a forum for dissemination of recent contributions from academicians, scientists, researchers, practitioners and consultants in the fields of hydraulics, hydrology and water resources.

About NIT Warangal

National Institute of Technology, Warangal, formerly known as Regional Engineering College, was established in 1959. Pundit Jawaharlal Nehru laid the foundation stone for this institute on October 10, 1959 and this was the first in the chain of 17 RECs in the country. By the act of Parliament, the NITs are considered as Institutes of National Importance. The NIT Warangal is fully centrally funded Institute of National Importance, established under Parliament Act. It has been recognized as a premier technological institute in the country with state-of-the-art infrastructure, dedicated faculty and staff. The institute is in the process of incorporating rapid changes to be on par with IITs. It offers 8 B. Tech Programmes, 37 PG Programmes (M.Tech., M.Sc., M.C.A. and M.B.A.) and Research programmes (PhDs) in all disciplines of engineering, sciences, humanities and physical education. The institution is well-known for its R&D activities, industrial consultancy, continuing education and training programmes for teachers and industrial personnel.

About ISH Pune

The Indian Society for Hydraulics (ISH), a technical, educational and notfor-profit national organization, was established in 1992 to serve as a common platform for engineers, scientists and technical personnel working in hydraulics and other allied fields. ISH helps technical personnel stay abreast with the latest development in hydraulics and water resources by organizing regular meets, symposiums, gatherings and seminars. The body also periodically recognizes and awards outstanding achievers in the field

CONFERENCE THEMES

Papers on the following themes are invited from academicians, scientists, Practicing Engineers, Researchers, Consultants, and other associared with Hydraulics, Water Resources, Environment, and Coastal Engineering:

1. **Hydraulics**
2. **River Engineering and Fluvial Hydraulics**
3. **Surface Hydrology and Watershed Management**
4. **Environmental Hydraulics**
5. **Groundwater Hydrology**
6. **Hydraulic Strucutre and Hydropower Project**
7. **Water Resources**
8. **Coastal Engineering**
9. **Climate change**
10. **Hydro-Informatics**
11. **Hydroclimatic Extremes and Impacts**

ORGANISING COMMITTEE

PATRONS

Prof. Bidyadhar Subudhi
Director, NIT Warangal

Dr. R. S. Kankara
President, ISH Pune

CHAIRMAN

Prof. T D Gunneswara Rao
Head, CED, NITW

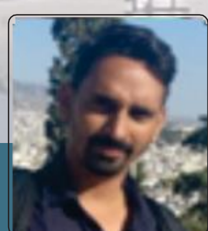
COORDINATORS

Prof. N. V. Umamahesh
NITW

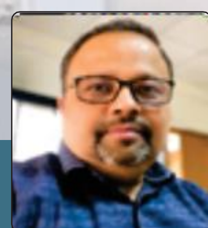
Prof.M C Deo
IIT BOMBAY

ORGANISING SECRETARIES

Dr Manish Pandey
IIT Kharagpur



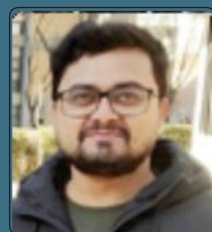
Dr Jew Das
NITW



Shri Amit Kulhare
CWRPS, Pune

CO-ORGANISING SECRETARIES

Prof. Manali Pal
NITW



Prof. Anant Kumar Rai
NITW

CONTENTS

Discharge Characteristics of Lateral Square Intakes in Open Channel Flow

B. Das[1*], Z. Ahamd[2] & P.K. Sharma[3]
[1,2,3]Indian Institute of Technology Roorkee, Roorkee, India
*bdas@ce.iitr.ac.in

Abstract

A lateral intake is a flow diversion structure provided in a side wall of a channel to divert water from the main channel. It is frequently employed in hydropower engineering for discharge withdrawal. The coefficient of discharge plays a crucial role in determining the actual water flow rate through the hydraulic intake system. Most past research focused on figuring out the discharge coefficient in open channels for various orifice shapes and circular intakes. A thorough literature assessment reveals that few studies are available to compute discharge coefficients for square intakes. This paper deals with the experimental investigation of discharge characteristics of square intakes in open channels under a uniform approach flow. A 9.47m long, 0.5m wide, and 0.6m deep concrete flume was used for the experimentations. An intake pipe of size equal to 0.04m×0.04m was provided at a distance of 6.0 m from upstream of the channel for studying its discharge characteristics. The analysis of data reveals that the coefficient of discharge (Cd) for the square intakes is highly dependent on the approach Froude number (Fr), intake Froude number (Fri), and intake Reynolds number (Rei). It is found that the Cd decreases with increases in Fr, Fri, and Rei when other parameters like discharge in the main channel, the width of the channel, and bottom clearance are kept constant.

Keywords: Coefficient of Discharge; Square Intakes; Open Channel Flow.

Numerical Estimation of Flow Field around Bridge Piers Using Turbulence Models

Ritika Kashyap[1*], Manoj Langhi[2] & Himanshu Sharma[2]
[1]Research Scholar, Institute of Infrastructure Technology Research and Management, Ahmedabad, India
[2]Assistant Professor, Institute of Infrastructure Technology Research and Management, Ahmedabad, India
*ritika.kashyap.22pc@iitram.ac.in

Abstract

In this paper, the three-dimensional flow field around a single bridge pier in an open channel flow is estimated using Ansys Fluent software. A multiphase modelling approach is used to track the free surface of the water. Computations are performed using the two-equation turbulence model, namely the standard k-ε and k-ε RNG model. The models are mainly used to study the characteristics of horseshoe and wake vortices around the pier. Horseshoe and wake vortices are observed in the k-ε RNG model, whereas only wake vortices are observed in the standard k-ε model. On the downstream side of the pier, a wake region is created due to the pressure difference between the upstream and downstream sides of the pier. In this region, generations of wake vortices are clearly seen. The results are compared and validated with the experimental data. Despite the shortcomings of the k-ε model, it performed well, indicating the close agreement of the horizontal velocity component with experimental data. However, the distribution of bed shear stress exhibited a discrepancy between the simulated results and the experimental data. Sensitivity analyses are also carried out for both models to improve the simulated results. The present approach to the estimation of the turbulent characteristics indicates the way forward for the estimation of scouring around the bridge piers in future studies.

Keywords: Ansys fluent, Horseshoe vortices, Wake vortices, Multiphase modeling, Open channel flow, Turbulence model.

Experimental Investigation of Submergence and Velocity on Flow Fields around Circular Cylinder in a Plane of Symmetry

Aravind Jagilinki[1*], T. I. Eldho[1]
[1]Department of Civil Engineering, Indian Institute of Technology Bombay, Mumbai, Maharashtra, 400076, India
*arvindjagilinki9@yahoo.com

Abstract

Submerged flow conditions are frequently encountered in fields like coastal structures, offshore structures, bridge constructions and caisson foundations. These submerged levels along with the varying velocities largely affect the mean velocities (U), Reynold's stresses, turbulence intensities and streamline patterns. This study aims to analyse such effects around submerged circular cylinders representing piers. In order to achieve this, a series of experiments are performed in a 15 m long, 0.50m wide recirculated rectangular fiberglass open channel. A circular cylinder of diameter 0.04 m is mounted on the plane bed at the channel centre and is located 10.5 m from the channel inlet. The submergence ratio (S), calculated as the ratio of water level above the cylinder to the total flow depth, is used to indicate the submergence level. The experiments are conducted using three values of submergence ratio S = 0.76, 0.52, and 0.28, each at three mean velocities, U = 0.35 m/s, 0.28 m/s, and 0.22 m/s. The entire flow field of instantaneous velocity vectors is collected along the plane of symmetry using the Particle Image Velocimetry (PIV), which is an advanced instrument to measure two dimensional instantaneous velocities. The results highlighted the changes in the velocity fields and the generation, expansion, and concentration of the vortex. The velocities are observed to accelerate at the top surface of the cylinder due to the shear friction between the cylinder surface and the fluid layer. The upstream region is not greatly affected in case high submergence ratio due to the less blockage area. With an increase in submergence ratio, the negative velocity region is observed to shift towards the channel bed. From the calculations, it is evident that the bed shear stress reduces with an increasing distance from the rear end of the cylinder and higher magnitude values are observed at the immediate cylinder downstream end. Thus, this study provides an insight into the effects of submergence ratio of piers and its impacts on hydrodynamics.

Keywords: Streamline, Submergence ratio, Particle Image Velocimetry (PIV), Submerged structures.

Comparison of Hydrodynamic Parameters of Raceway Pond Using K-ε Turbulence Model for Two Different Paddle-Wheel Positions

Rozy Kumari[1*], B. S. Das[2], Shashank Shekhar Sandilaya[3], Anurag Sharma[4] & K. K. Khatua[5]
1M. Tech Research Scholar, Department of Civil Engineering, National Institute of Technology Patna, Patna, India– 800005
2Assistant Professor, Department of Civil Engineering, National Institute of Technology Patna, Patna, India – 800005
3Ph.D. Research Scholar, Department of Civil Engineering, National Institute of Technology Patna, Patna, India– 800005
4Assistant Professor, Department of Civil Engineering, National Institute of Technology Rourkela, Rourkela, India – 769008
5Professor, Department of Civil Engineering, National Institute of Technology Rourkela, Rourkela, India – 769008
* rozynitp@gmail.com

Abstract

Large-scale microalgae farming takes place in a raceway pond, which is a long, shallow, closed-loop recirculation channel. The improper design of the raceway pond will result in the creation of a dead zone with very low velocity. Additionally, it results in uneven velocity across the entire pond, which has a negative effect on the development of algae. This study looked at the impact of five different aspect ratios (length/width) on raceway ponds such as 5, 10, 15, 20 and 25 with a constant depth of 0.4 m and inlet velocity of 0.3 m/s. Two distinct paddle wheel positions were used to reduce the dead zone. ANSYS -Fluent software is used for the simulation of the raceway pond in which k-ε turbulence closure equation is used to carry out the simulation. It examined the hydrodynamic performance of the raceway pond based on factors of velocity uniformity and eddy viscosity. The simulated results show higher velocity homogeneity for aspect ratios greater than 15 that indicating better geometry to be used for an efficient raceway pond. The study also found that the efficiency of the raceway pond is better when the paddle wheel is placed in the middle of the total length of the raceway pond.

Keywords: Raceway Pond, ANSYS (fluent), k-ε turbulence model, Paddle-wheel.

Advancements in Turbulence Modeling for Hydraulic Applications: A Comprehensive Review

Suniti Kumari[1*], Ankur Sharma [2], H. L. Tiwari [3], & Rutuja Chavan[4]
1,2,3,4Department of Civil Engineering, MANIT Bhopal-462003, INDIA
*213111005@stu.manit.ac.in

Abstract

This review paper mainly focused on the turbulence models that are in practice to simulate and analyse hydraulic structures. Turbulence is the fundamental concept in fluid mechanics. Most flows in hydraulics are turbulent, characterised by high irregularity, fluctuation, and constant 3-dimensional eddying motion. The turbulence exerts a significant influence on velocity, the development of flow, temperature, losses, heat transfer, sediment motion, and other factors, as it considerably contributes to the momentum, heat, and mass transport in hydraulic flow. In recent years, there has been a great interest in understanding the role of turbulence in hydraulics. An overview of the important role of turbulence in hydraulics and the models for calculating hydraulic flow effects are discussed briefly. RANS (Reynolds averaged- Navier stokes), DNS (Direct Numerical Simulation), and LES (Large Eddy Simulation) are the three numerical models. These are most frequently addressed with certain assumptions because simulating extensive and intricate geometries requires significant computational power. As a result, hybrid models combining RANS and DNS have been developed to facilitate research (Hami, 2020). Multiple investigations on turbulence modelling provide insights for both theoretical and practical research directions in the future.

Keywords: Turbulence, Turbulence models, DNS, RANS, LES.

Mathematical Model Studies for Hydraulic Transient Analysis of Lift Irrigation Schemes

Venkata Ramana Murthy Gumma[1*] & Vishal Telgote[2]
[1]Scientist 'C', Central Water and Power Research Station, Pune - 411024, India
[2]Assistant Research Officer, Central Water and Power Research Station, Pune - 411024, India
*gummamurthy1971@gmail.com

Abstract

Hydraulic transients in water distribution systems are abnormal pressure situations caused by abrupt changes in flow rates. These are caused by events like power failure, main breaks, pump start-up and shut-down operations, sudden valve closure, check-valve slam, etc. Transient generating events are capable of producing both positive and negative pressure waves which travel at approximately the speed of sound in water. Due to the devastating effects that a hydraulic transient can cause, its analysis is very important in determining the values of transient pressures that can result from flow control operations and to establish the design criteria for system equipment and devices so as to provide an acceptable level of protection against system failure due to pipe collapse or bursting. To assess the transient pressures in the water conducting system, employing a model using computer program (WH-2.7), which uses explicit finite difference method to simulate hydraulic transients in the pipeline of irrigation system and investigating many scenarios and alternatives to study this phenomenon was presented in this paper. The hydraulic model is formulated and solved by the method of characteristics using the differential equations of momentum and continuity combined which are developed for solving transient problem. This paper mainly focuses on the mathematical model studies conducted by CWPRS for transient analysis of Hanbarwadi Lift Irrigation Scheme. The primary objectives of surge analysis are to determine the transient pressures and to suggest surge control devices for an acceptable level of protection against hydraulic transients. During the mathematical modelling analysis, the large positive and negative pressures indicated need for providing anti-surge devices. Subsequently, studies were carried out with ten (10) air valves at different locations in the rising main and a provision of an additional anti-surge device in the form of air vessel was found to be necessary to avoid unacceptable maximum and minimum transient pressure conditions in the rising main. Finally, an air vessel of 45 m^3 capacity along with ten (10) air valves were recommended for the rising main to bring acceptable pressure conditions in rising main.

Keywords: Hydraulic transients, Finite difference, Surge analysis, Anti surge devices.

A Comparative Study of Velocity Profile for Unsteady Open Channel Flow on Both Simple and Compound Sections

Pratyush Kumar Dora[1*], Suchismita Sahoo[2], Kishanjit Kumar Khatua[3]
[1]M. Tech, Research Scholar, Department of Civil Engineering National institute of technology Rourkela, 769008
[2]PhD Scholar, Department of Civil engineering National institute of technology Rourkela, 769008
[3]Professor Department of Civil engineering National institute of technology Rourkela, 769008
*pratyushdora1998@gmail.com

Abstract

The velocity profiles of unsteady flow in simple channel are different as compared to steady flow condition. The cross-section of a flooded river is usually composed of a deep main channel and adjacent shallow flood plains called “compound sections”. Unsteady flow often occurs in a compound channel making the flow process more complicated due to the large variations of 3-dimensional velocity. The velocity profile changes highly in a compound channel as compared to simple channel cases. Because of the difficulties in measurement of flow variables of open channel flow during unsteady flow, studies on open channel flow in such conditions are very rare. An attempt has been now made to investigate the behaviour of velocity profiles of a channel under unsteady flow conditions. Extensively literature study on unsteady flow in both the simple and compound cross sectional channel has been carried out. The comparable study of velocity profiles is done. In unsteady flow compound channel flow case, the velocity profile trend lines are found to be much different as compared to the falling limb cases. This is because, the effect of the lateral momentum transfer in a compound section is affected in the unsteady flow as compared to steady flow cases. The recommendation to improve the existing equation of steady flow to be applicable for unsteady flow can be done from the analysis.

Keywords: Unsteady Flow, Simple Channel, Compound Channel, Velocity Profile.

Numerical Studies on Flow through Box Culvert

P.P. Gaigole[1*], A.D. Ghare [1], P.P. Sadan [1] & A.D. Lade[1]
[1]Visvesvaraya national institute of technology, Nagpur, India
*prasadsadan97@gmail.com

Abstract

Culverts are one of the important components of drainage work that allows the water to flow under roadways, railways, and other traffic embankments. A culvert should be designed in such a way that it can effectively drain water during excess rainfall periods. Understanding the flow characteristics through a culvert is crucial for designing, analyzing, and maintaining these structures. The purpose of present study is to evaluate the performance of Box Culvert for outlet control flow conditions. Flow Profiles for submerged as well as unsubmerged inlet corresponding to free flow outlet are analytically examined for different headwater conditions described in the available literature. The hydraulic analysis of flow through Box Culvert is performed using FLOW-3D® software which numerically simulates the flow of water. Flow Profiles obtained from numerical modelling resembled the standard Flow Profile. Discharge values calculated analytically for different headwater conditions have been compared with those obtained using numerical modelling. The results in terms of critical depth and headwater obtained from the numerical modelling are found to be in good agreement with those obtained analytically.

Keywords: Box Culvert, Numerical modelling, Outlet control flow.

An Estimation of the Hydroelectric Potential of Pumped Hydro Storage Systems using Seawater for Renewable Energy Production in a Small Island Developing State

Prashant Birbal[1*], Hazi Azamathulla[1], Kailas Banerjee[1]
[1]University of the West Indies, St. Augustine Campus, Trinidad
*prashant.birbal@sta.uwi.edu

Abstract

The majority of energy produced in Small Island Developing States (SIDS) are from fossil fuels. Therefore, in order for the SIDS to reduce their carbon footprint, there becomes an increasing need for the adoption of renewable energy. Hence most of the SIDS nations are now focusing on variable renewable energy sources. However, these variable renewable energy sources such as wind and solar are unpredictable and bring instabilities in the electric power system if not buffered by a reliable storage system. The proposed system will be a low head pumped hydro storage system using seawater as the medium. Given the fact that most SIDS are isolated and surrounded by large bodies of water, this paper will examine the potential use of the sea as a lower reservoir to generate sufficient energy from a relatively low head. This research will focus on detecting potential locations for the pumped hydro storage system sites on the island of Trinidad and Tobago (one of the SIDS nations) using the ArcGIS.Pro program. These sites were classified based on various criteria and the average potential power that could be generated from each site classification was determined.

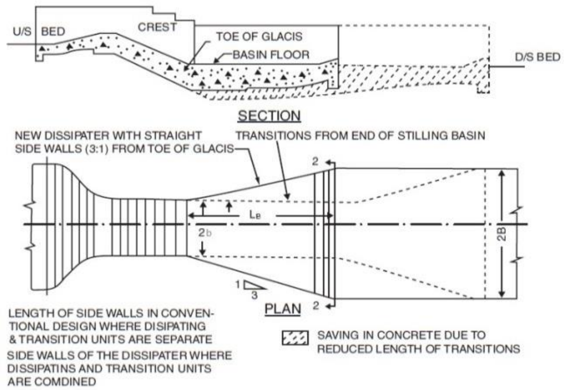
Keywords: Hydroelectric, Pumped Hydro Storage, Seawater, ArcGIS Pro, SIDS.

Development of Stilling Basin with Diverging Side Walls Having Lateral Offsets at Entry

S.K. Mazumder[1*]
[1]Former AICTE Emeritus Professor in Civil Engineering, Delhi Technological University
*somendrak64@gmail.com

Abstract

Water flowing over spillways acquires high velocity at the toe of dams /canal drops and regulators. Stilling basin must be provided at the foot of the spillway to convert supercritical flow to sub-critical one by means of hydraulic jump with a view to avoid scour/erosion/flow instability downstream. Bradley (1957), Peterka (1958), Bradley and Peterka (1957), USBR (1968) Haeger (1992), Mazumder (1987, 2020), Mazumder and Sharma (1983) developed different types of basins depending upon inflow Froude's number (F_1) and velocity of flow (V_1). Basin lengths (L_B), conjugate depth(d_2) and appurtenances to stabilize the jump can be found from the equations /curves developed analytically/experimentally. In all these classical basins, side walls are kept parallel to the basin axis up to the end of the jump. In case the incoming flow is contracted, diverging transitions are to be provided to connect the basin width (2b) to normal flow width (2B) of flow (as indicated in Fig.1), resulting in very high cost of the basin. Mazumder (1994) developed an innovative and economic stilling basin for a flumed Spillway where the side walls are diverged right from the toe of spillway as indicated in Fig.1.1.



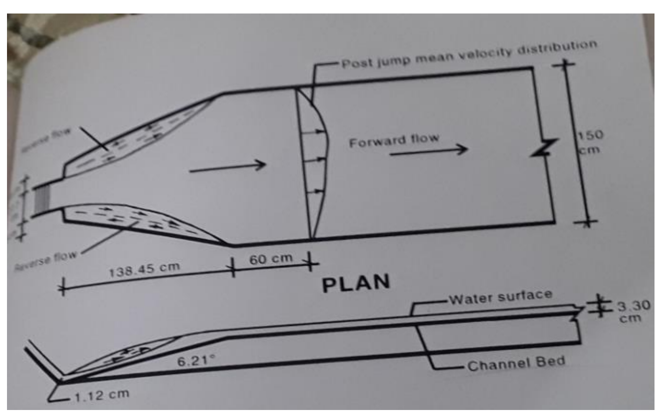


Fig. 1.1 Plan and section of Stilling Basin with Diverging Side Walls (Firm line) and Classical Basin (Dotted line), Fig.1.2 Showing Stilling Basin with Sudden Lateral Offsets at Entry

The author and his co-workers achieved further economy by developing a new basin, almost similar to the earlier one (Fig.1.1) by providing sudden offsets at the entry to the basin as shown in Fig.1.2. In this paper, an ogee type model spillway was provided with different lateral offsets at entry to the basin and their performances were measured and compared with that without any offset. Adverse slope required to the basin floor to stabilize the lateral eddies (Fig.1.2) were computed by equations derived from momentum principles such that the forces in forward direction from offsets and side walls equal the bed reaction in the opposite direction. Performance of the basin in terms of efficiency, flow stability and distribution of velocity at exit of the basin were measured for three different flows with and without off-sets. Although highest performance was obtained without offset at entry, a limited offset at entry give almost similar performance thereby further curtailing the basin cost.

Physical modelling for the restoration of damaged breakwater – A case study at Kalpeni Island, Lakshadweep

B R Tayade*, Praveen K M, Deepak Sharma & S P Jagtap
Central Water and Power Research Station, Pune, INDIA
* tayade.br @cwprs.gov.in

Abstract

Kalpeni is one the islands in the Lakshadweep archipelago. A 165 m long breakwater was constructed at Kalpeni Island to achieve the berthing conditions at the wharf used for the passenger as well as fishing vessels for all seasons. During the 'Ockhi' cyclone in Dec 2017, the wave height was about 7 m to 7.5 m which severely damaged the breakwater leaving behind only the berthing wharf. The restoration of breakwater was completed in two phases. Initially, a temporary restoration work was carried out by replenishing scattered debris / boulders. Finally, the desk and wave flume studies were carried out to design a permanent restoration work for the damaged breakwater. The design to restore this damaged breakwater required tetrapods weighing 25-30 tonnes in the armour layer and bottom width exceeding 60m. Moreover, it is difficult to cast and handle the tetrapods of this larger size due to limited space and with available heavy machinery and cranes. Based on the site conditions and hindcasting studies, the breakwater was designed against the wave action for a return period of 25-30 years. The wave flume studies were carried out to check the hydraulic stability of the breakwater under regular and random wave action. The wave flume studies indicated that the crest of the breakwater is sensitive to the overtopping waves. Various tests were carried out using different sizes of concrete cubes (CC) blocks and parapet wall placed at the crest to check its hydraulic stability. After various modifications, a hydraulically stable block against significant wave height was selected. This study provides an insight into the possible challenges that can be encountered while restoring a damaged breakwater.

Keywords: Physical modelling, Breakwater, Tetrapods, Crest wall, Concrete cube blocks.

Hydraulic Model Studies of Upper and Lower Reservoir for Kundah Pumped Storage Hydro Electric Project (4 x 125MW)

P.M. Abdul Rahiman[1], M.S.R. Naidu[1] and A. Jyothi Prakash[1*]
[1]Central Water and Power Research Station, Department of Water Resources, River Development & Ganga Rejuvenation, Ministry of Jal Shakti, Khadakwasla, Pune, India
* jp.cwprs@gmail.com

Abstract

Intakes are inlet structures where fluid is accelerated to a certain flow velocity to provide required amount of water into a hydraulic system. Intake size and geometry affect the formation of flow patterns, which can be influential for hydraulic performance of the whole system. Swirl in the power intake system can cause a significant change in the operating conditions for a pump, and can change the flow capacity, power generation and efficiency. The intake structure should be designed to allow all turbines to achieve their optimum hydraulic performance for all operating conditions. Hydraulic model is essential to verify the adequacy of hydraulic design of intake system to have vortex/swirl free flow. Based on the hydraulic model studies anti swirl vortex/swirl devices are installed at optimised locations in the intake structure to mitigate reduction in flow capacity, power generation and efficiency. CW&PRS has been engaged in addressing the issues of voter/swirl in intake systems for both pump and power intakes by using physical model studies. Kundah pumped storage hydro electric project (4 X 125MW) consists of two reservoirs, one upstream and other downstream. The two reservoirs are proposed to be connected by a tunnel through the reversible pump turbine of 4 X 125 MW capacity. The tunnel of 8.5 m diameter from upper reservoir draws water during generation mode through approach channel leading water into intake tunnel. The intake invert level is at EL. 2190.75 m and its soffit is at EL. 2208 m. The intake further leads water into a 7 m (w) x 8.5 m (h) rectangular tunnel that further leads water in to the circular tunnel of 8.5 m diameter to the turbines for power generation. Similarly, the water from lower reservoir is drawn during pumping mode through the approach channel, rectangular intake with invert level at EL. 1943.0 m and soffit level at EL. 1959.50 m. The rectangular intake further leads water to the pumps through circular tunnel of size 8.5 m diameter. The FRL and MDDL of upper reservoir are fixed at EL. 2220.46 m ASL and EL. 2207.55 m ASL respectively while the lower reservoir has FRL and MDDL at EL. 1985.77 m ASL and El.1957.98m ASL respectively. The design discharge of 4x125 MW turbines is 248m^3/s (under generation mode) and design discharge for pumping mode is 186 m^3/s. The project envisages generation of power with a design discharge of 62 m^3/s for single turbine operation to 248 m3/s for

all the 4 turbine operation at full load during upper reservoir level varying between FRL to MDDL and lower reservoir level varying between FRL to MDDL. Similarly, pumping mode envisages pumping of design discharge of 46.5 m^3/s by single pump to 186 m^3/s by four units for both (lower & upper) reservoir levels varying between FRL to MDDL. Model tests were conducted on geometrically similar 1:25 scale model constructed partly with Perspex and partly with steel and other materials. Model discharge of 79.36 LPS for upper intake and 59.52 LPS for lower intake which correspond the maximum discharge of 248 m^3/s and 186 m^3/s respectively were simulated for both FRL and MDDL reservoir levels. The adequacy of designed flow passing through trash rack, bell mouth, rectangular tunnel, intake structure, transition and downstream were verified and corrective measures incorporated for both upper intake & lower Intake are presented in this paper.

Keywords: Intake structure, Anti-swell Device, Tranquil condition.

Transient analysis of Rising Main of Wagholi Village using Bentley's Hammer

Mr. Pankaj Sajjan Garad[1*], Dr. D.G. Regulwar[2]
[1]MTech. Water Resource Engineering, Government College of Engineering Aurangabad-4135005, India
[2]Professor and Head, Civil Engineering Department, Government College of Engineering Aurangabad-4135005, India
*garadpankaj99@gmail.com

Abstract

Transient analysis is a critical aspect of hydraulic system analysis that focuses on understanding the dynamic behaviour of water distribution networks under changing operating conditions. This study aims to investigate the application of transient analysis in assessing the impact of pump shutdown on the rising main, particularly regarding the occurrence of negative pressure and cavitation for Wagholi village. Wagholi has experienced an upsurge in population and expansion, leading to a higher demand for water. As a result, water is being supplied to the village from a well located approximately 2 km away. To ensure uninterrupted supply, an electric motor is employed to transport the water to the village's water supply tank. It is essential to safeguard the rising main pipe to maintain a smooth water supply. This involves conducting various tests, such as assessing its capacity during sudden power failures and valve closures. In this study, the transient analysis of the rising main is performed using Bentley's Hammer software, which offers a user-friendly interface for the design process. The background for the analysis utilizes the AutoCAD DXF file of Wagholi, enabling more precise design and reducing the designer's effort in laying out the rising main within Hammer. Through transient analysis performed under shutdown conditions using Hammer, the study concludes that an HDPE pipe with a class rating of PN6 and two air valves is sufficient to supply water to the elevated service reservoir.

Keywords: Transient Analysis, Bentley's Hammer, Rural water supply, Rising Main, Water Distribution Network, HDPE Pipe.

Shear Stress Estimation in Compound Channel Using M5 Tree and XGBoost Soft Computing Techniques

Neil Tripathi[1], Shashank Shekhar Sandilya [2], Bhabani Shankar Das[3], Kamalini Devi[4], Jnana Ranjan Khuntia[4]

[1]B.Tech. Student, Department of Civil Engineering, National Institute of Technology Patna, Patna, India– 800005

[2]Ph.D. Research Scholar, Department of Civil Engineering, National Institute of Technology Patna, Patna, India– 800005

[3]Assistant Professor, Department of Civil Engineering, National Institute of Technology Patna, Patna, India –800005

[4]Assistant Professor, Department of Civil Engineering, Chaitanya Bharathi Institute of Technology, Hyderabad, India

*neiltripathi1862002@gmail.com

Abstract

Natural rivers have a typical cross-section of compound channels having a main channel and one or two flood plains. Prismatic compound channels maintain uniform water levels, while non-prismatic compound channel exhibits non-uniform and complex flow pattern. Shear stress is generated at the interface of the main channel and flood plain due to momentum transfer. The boundary shear stress distribution cannot be determined easily as they depend upon the velocity field, the shape of the cross-section, and the boundary roughness. This study attempts to develop a model to predict the shear stress in the non-prismatic compound channel using two machine learning (ML) techniques (1) M5 tree and (2) extreme gradient boosting (XGBoost) by considering the impact of several geometric, flow, and roughness parameters such as width ratio, relative flow depth, flow aspect ratio, and bed slope. M5 tree provides significant benefit by presenting transparent formulas that yield a deeper understanding of the derived equations. XGBoost are powerful gradient-boosting algorithms known for their ability to handle structured data. The models are constructed based on several correlated physical channel characteristic variables to predict the shear stress. Predicted shear stress of both M5 tree and XGBoost models has been found satisfactorily with the coefficient of determination (R2) value greater than 0.85 and mean absolute percentage error (MAPE) less than 12 % for training and testing datasets. However, XGBoost model prediction accuracy is better compared to the M5 tree model in predicting shear stress at different sections of non-prismatic compound channels.

Keywords: Prismatic compound channels, non-prismatic compound channel, Main channel, Flood plain, M5 tree, XGBoost

Hydrodynamic Analysis of Raceway Pond using LES Turbulence model

Sweety Rajput[1], B. S. Das[2], Anil Kumar Sharma[2], Jnana Ranjan Kuntia[3], Kamalini Devi[3]
[1]Ph.D. Scholar, Department of Civil Engineering, National Institute of Technology, Patna, Bihar, .800005, India
[2] Assistant Professor, Department of Civil Engineering, National Institute of Technology, Patna, Bihar,800005, India
[3]Assistant Professor, Dept. of Civil Engineering, Chaitanya Bharathi Institute of Technology, Hyderabad-500075, India
[3]Assistant Professor, Dept. of Civil Engineering, Chaitanya Bharathi Institute of Technology, Hyderabad-500075, India
*sweetyrajput113@gmail.com

Abstract

The open-closed looped raceway pond is one of the best energy-saving options that can meet several requirements like; energy and nutritional reclamation, wastewater treatment, and biomass cultivation for biofuel production. At present raceway pond (RP) is widely used for producing biofuel using microalgae as feedstock. The wide use of this technique is because of its low maintenance and construction cost, and its simplicity in operation. Therefore, the hydrodynamic study of RP can be helpful to increase the productivity of the pond. In past decades computational fluid dynamics (CFD) has gained attention in expressing a wide range of parameters even in multiphase flow with a high degree of accuracy in raceway ponds. Various numerical simulations using ANSYS Fluent have been suggested by many authors in existing RP hydrodynamics. Modelling of RP is a cost-effective way to determine its performance under various environmental and physical conditions. The present study aims to use the large eddy simulation (LES) turbulence model to understand the hydrodynamic behaviour of raceway ponds using ANSYS-FLUENT software. The study is performed by taking three different aspect ratios (10, 15, and 20) with constant inlet velocity of flow to understand the performance of the raceway pond. The LES turbulence model is used to determine the effect of velocity and pressure on the performance of RP by varying the geometry of RP. The paddlewheel is used for the mixing mechanism in the raceway pond. Hence the modelling also understands the hydrodynamic behaviour of the raceway pond by varying its position with constant rotation speed.

Keywords: Raceway Pond, ANSYS Fluent, Hydrodynamic, LES, CFD.

Numerical Simulation of Flow in Sump for Multiple Pump

Ravikant Kumar[1*] & Ruchi Khare[2]
[1]Maulana Azad National Institute of Technology, Bhopal, India
[2]Maulana Azad National Institute of Technology, Bhopal, India
*9774ravisingh@gmail.com

Abstract

The Design of pump intake are widely used for providing water to the reservoir from river level to the higher reservoir level. As of the mass construction in pump intake it is always a cost-effective terminology that any error in design components leads to extreme losses. Thus, special attention is provided while design calculations. Thus, for the improvement in efficiency, design of pump intake has several design aspects to study and has great scope in the research area. The efficiency and performance of the pump intake can be obtained experimentally as well as with the help of advanced numerical methods known as computational fluid dynamics.

The Present work to investigates the ability of a commercial computational fluid dynamic (CFD) software to predict the performance of multiple pump intake. The two different inlet geometries of the multiple intake sump are designed as per the standard code for providing sufficiently uniform and swirl free flow. Complete pump intake geometry including suction pipes and bell mouth is designed for the study of swirling flow simulation. Analysis of both the rectangular and circular inlet intake is carried out in Ansys ICEM CFD. Swirling flow simulation has been carried out at a constant static pressure of 1.5 atmospheric at inlet of sump and a discharge of 100.28 kg/s at the inlet of each pump suction. Results obtained from the numerical flow simulations are discussed with the help of tables and graphs of various aspects of swirling angles, velocities etc. with respect to location of swirls.

Keywords: Sump, Computational Fluid Dynamics (CFD), Swirl, Vorticity.

Flow Patterns and Velocity Distribution in Channel with Dense Flexible Vegetation

Hariom Gautam[1*], Zulfequar Ahmad[1], Pramod Kumar Sharma[1]
[1]Department of Civil Engineering, Indian Institute of Technology Roorkee,
Roorkee 247667, India
*h_gautam@ce.iitr.ac.in

Abstract

The vegetation on the river floodplains has a significant impact on how the water flow in a river. When there is vegetation in the water, the way it flows gets more complicated because of how the water interacts with the vegetation. It depends on how big the vegetation is, their shape, how they're spread out, and how deep the water is. In this laboratory study, we aim to understand how water velocity is distributed in an open channel that contains dense and flexible vegetation. To simulate natural vegetation, we used artificial plants with uneven shapes and varying widths. We conducted experiments for different flow depths. Based on the vegetation's characteristics and the water's depth, we observed two distinct flow patterns: one in the lower layer with vegetation and another in the upper layer without vegetation. We used an ADV (Acoustic Doppler Velocimeter) to measure velocities in three directions. We analyzed and compared the distribution of vertical and transverse velocities at various positions along the straight channel flume. The stable velocity profile along the stream shows a significant change in velocity at the upper part of the vegetation layer. The vertical velocity profiles differ between the non-vegetated and vegetated layers, with the upper free water layer following a logarithmic law. Moreover, the transverse velocity distribution in the vegetated flow is noticeably distinct from the non-vegetated flow.

Keywords: Flexible vegetation, Stream-wise velocity distribution, Transverse Velocity Distribution, Open channel flow, ADV.

Quantification of Suspended Sediment Load in Mahanadi in Chhattisgarh State

Syed Khateeb Ahmad[1], Zulfequar Ahmad[2] & Pramod Kumar Sharma[3]
[1]Research Scholar; [2]Professor & [3]Associate Professor
Department of Civil Engineering, Indian Institute of Technology Roorkee
*sk_ahmad@ce.iitr.ac.in

Abstract

Mahanadi in Chhattisgarh state stretches from Changori (21°41'7.61" N, 83°22'25.56" E) to Dudhawa (20° 18' 37.61" N, 81° 43' 47.7" E) having length and catchment area of 352 km and 69,000 km^2 respectively. The major left joining tributaries of Mahanadi are Seonath, Hasdeo, Kelo and Mand river whereas Jonk, Pairi and Sukha river joins Mahanadi from the right bank. The knowledge of suspended sediment loads are important for understanding the geochemical, ecological and morphodynamic conditions of the rivers. Many practical problems in planning and design of water resource projects requires an estimate of sediment load carried by the rivers. The present study deals with the quantification of monthly and yearly sediment load at all the 13 gauging sites of CWC in Mahanadi basin of Chhattisgarh state from the year 2015 to 2019. The monthly average sediment load data shows that the gauging sites of Andhiyarkore, Bamnidhi, Baronda , Basantpur, Ghatora, Kotni, Manendragarh, Rajim, Rampur and Seorinarayan, have highest sediment load in the month of August of order 0.59, 0.05, 0.12, 1.54 , 0.06, 0.23, 0.01, 0.1, 0.08 and 0.61 Million tons (Mt) respectively. Jondhara and Simga gauging sites on Seonath river have the highest sediment load in the month of September of order 0.50 and 0.16 Mt respectively. Whereas Kurubhata gauging sites on Mand river have the highest sediment load of 0.75 Mt in the month of July. The annual sediment load at the gauging sites of Rajim, Seorinarayan and Basantpur on Mahanadi; Andhiyarkore on Hamp river; Bamnidih and Manendragarh on Hasdeo river; Ghatora on Arpa river; Jondhara and Simga on Seonath river; and Rampur on Jonk river indicates an increase in sediment load from the year 2015 to the year 2019. Whereas, at the gauging site of Kotni on Seonath river and Kurubhata on Mand river, the suspended sediment load decreases in the same duration.

Keywords: Suspended Sediment Load, Mahanadi Basin, CWC Gauging sites.

Two-Dimensional Depth Averaged Boundary Fitted Numerical Model for Open ChannelFlow Simulation

A. Goswami[1*], H.M. Kalita[1]
[1]National Institute of Technology Meghalaya, Shillong, India
*p21ce006@nitm.ac.in

Abstract

This paper presents a two dimensional (2D) numerical model for flow simulation in open channels. For this purpose, the governing shallow water equations are first transformed to a boundary fitted coordinate system, to make the model applicable in real rivers. The transformed governing equations are then solved using a simple explicit based Finite Difference Method. The Finite Difference Method based scheme used here is Lax–Friedrichs scheme. This scheme is first order accurate in time and second order accurate in space. The main advantage of this single step numerical technique is its simplicity, less computational time requirement and ease in programming. The inherent dissipation error of this technique is minimized here using a weighting coefficient. The numerical model is then applied to replicate three classical test cases of known experimental solutions. The results obtained are found to be approximately mimicking the available experimental results, with less computational effort.

Keywords: Shallow water equations, boundary fitted coordinate system, Lax–Friedrichs scheme, dam break flow.

Studies on Flow Over Arched Weirs

A. R. Chaudhari[1], A.D. Ghare[1], P. P. Sadan[1*], A. D. Lade[1]
[1]Visvesvaraya National Institute of Technology, Nagpur, India
*prasadsadan97@gmail.com

Abstract

Weirs are widely used for the purpose of flow measurement and flow control in open channels. Non-linear weirs are considered to have better discharging capacities compared to linear weirs for same width of channel. Arched weir is one of the non-linear weirs which has increased effective length compared to normal rectangular weir. The present study investigates the hydraulic performance of arched weirs using FLOW-3D® software. Numerical simulations are carried out on arched weirs having central angles of 50°, 60°, 70°, 80° and 90° whose convex side facing the upstream with corresponding weir heights of 0.18 m and 0.22 m. The variation of coefficient of discharge is examined for varying central angles and (H/P) ratio up to 0.45. Based on numerical results, the coefficient of discharge of arched weir are determined and compared with expressions described in available literatures. The new models are proposed for coefficient of discharge for different weir angles using regression analysis. Arched weir with central angle 90° is observed to provide the maximum flow magnification of 1.32 to 1.18 over rectangular linear weir within the range of H/P values between 0.15 to 0.45. It is interpreted that an arched weir can prove to be effective practice to enhance the discharge capacity of weir.

Keywords – Arched weir, numerical simulations, coefficient of discharge.

Measurement of turbulent flow within channel contraction

Santosh Kumar Singh[1], Susanta Chaudhuri[2*], Koustuv Debnath[3]
[1]Department of Mechanical Engineering, SRM Institute of Science and Technology, Chennai, India
[2]Department of Geological Sciences, Jadavpur University, Kolkata, India
[3]Department of Aerospace Engineering and Applied Mechanics, Indian Institute of Engineering Science and Technology, Howrah, India
*schaudhuri1997@gmail.com

Abstract

The study aims to consider the problem experimentally by measuring the velocity field within the contraction zone and highlighting sidewalls' effects in the contraction region in terms of mean velocity, turbulent intensities and Reynolds stress. A comparative study was done between the velocity profiles for with and without contraction cases to emphasize mean and turbulence characteristics changes. Measurements of three-dimensional velocity fluctuations were performed in fixed bed condition within the channel contraction using Acoustic Doppler Velocimeter and investigated accordingly. The analysis of the velocity data reveals the undulations of mean flow towards the free surface for all the contraction ratios, indicating the presence of the velocity-dip phenomenon due to the secondary currents. These currents change the pattern of turbulence intensities, and Reynolds shear stresses significantly within the channel contraction compared to without contraction. The results reveal that with the increase of channel contraction ratio, the strength of the secondary current increased considerably and resulted in a significant change in flow patterns close to the free surface than the bottom floor.

Keywords: Contraction ratio; Velocity-dip; Turbulence; Secondary currents; Turbulence scales

Physical and numerical modelling of sloping apron stilling basin type of energy dissipator – Case Study

K.T. More*
Scientist 'C', Central Water & Power Research Station, Pune -411024, India
*kiran.t.more@gmail.com

Abstract

Computational Fluid Dynamics, Flow-3D is one such software which has ability to model spillway flow. Exploring these capabilities of Flow-3D as compared to the results of physical models will be the focus of this study. In this study, sloping stilling basin type of energy dissipater was studied using both physical and numerical modelling. Studies for numerical simulation of the flow over spillway for stilling basin with sloping apron for Garudeshwar Weir, Gujarat carried out using CFD software, Flow 3D. k-Ɛ RNG turbulence model used during simulation with Tru-VOF (Volume of Fluid) method for capturing the air-water interface. The objective is to investigate the flow in respect of discharging capacity, water surface profiles, pressure profiles and flow conditions in the sloping stilling basin. Results were compared with physical model studies conducted at CWPRS, Pune. Simulated results demonstrate that the CFD model is able to predict quite accurately several hydraulic parameters such as the discharge over the spillway, water surface profiles, location of front of hydraulic jump and pressures over the spillway surface etc. Such integrated hybrid approach for numerical and physical modelling can be used as a cost-effective and efficient tool in optimizing the designs of the spillway and energy dissipator.

Keywords: Spillway, Sloping Stilling basin, Energy Dissipator, Physical Modelling, Numerical Modelling, Computational Fluid Dynamics.

CFD Simulation of Non-Prismatic Compound Channels using k-ε and k-ω Turbulence Models

Khuntia J. R.[1*], Devi K.[1], Sahoo S.[2], Das B. S.[3], Khatua, K. K.[4]
[1]Assistant Professor, Department of Civil Engineering, Chaitanya Bharathi Institute of Technology (A), Hyderabad, 500075, India
[2]Ph.D. Scholar, Department of Civil Engineering, National Institute of Technology Rourkela, 769008, India
[3]Assistant Professor, Department of Civil Engineering, National Institute of Technology Patna, 800005, India
[4]Professor, Department of Civil Engineering, National Institute of Technology Rourkela, 769008, India
*jnanaranjan444@gmail.com

Abstract

The discharge estimation in rivers is crucial in implementing flood management techniques and essential flood defence and drainage systems. During the normal season, water flows solely in the main channel, but during a flood, the water overflows its banks and spills into the floodplains, resulting in devastating consequences and loss of livelihood. During the flood, the rivers are composed of a main channel and floodplains, collectively referred to as a compound channel. Computing the discharge is a challenging task in non-prismatic compound channels where the floodplains are either converging or diverging in the longitudinal direction. In compound channels, momentum transfer takes place at the interface of the main channel and floodplain due to the difference in flow velocity in the subsections. Due to this reason, the flow behaviour becomes very complex in a non-prismatic compound channel. Among many flow parameters, velocity distribution, bed shear stress and secondary currents are three essential properties affecting the conveyance capacity of a channel. However, due to the complexity of the methodology, very few attempts have been made by previous researchers to compute the flow properties for non-prismatic compound channels by using numerical methods. So, by accounting for those challenges, the present study aims to simulate the flow properties for non-prismatic compound channels using subgroups of *k*-ε and k-ω models. The computational fluid dynamics (CFD) simulations are performed using the ANSYS-Fluent software package. Four different models, i.e., standard *k*-ε, RNG *k*-ε, standard k-ω and SST k-ω are used to simulate the both diverging and converging non- prismatic compound channel. The velocity profiles and turbulent kinetic energy are analysed at three different locations along the longitudinal direction of channel and four places across the channel. The present SST k-ω model has produced satisfactory results, as compared to the other three turbulence models. This study will be helpful to hydraulic engineers and researchers working on compound channels.

Keywords: Computational fluid dynamics, Non-Prismatic Compound Channel, Turbulence model, ANSYS, *k*-ε model, k-ω model.

CFD Simulation and Experimental Validation for Orifice Spillway Flow

Kulhare, A.[1*], Gadge P.P.[2]
[1]Scientist 'C', Central Water & Power Research Station, Pune - 411024, INDIA
[2]Scientist 'C', Dr., Central Water & Power Research Station, Pune - 411024, INDIA
*akulhare@live.com

Abstract

An orifice spillway is used where incoming sediment concentration is high. In order to ensure the safety of a dam structure, various components of orifice spillways need to be designed carefully. A physical model is best suited for visualising and analyzing the flow over the spillway, upstream & downstream flow conditions, and the performance of the energy dissipation system. A number of hydraulic problems of spillways can also be solved numerically. Numerical models can be calibrated and validated using data obtained from physical model studies. Numerical simulation methods are often used to arrive at a preliminary design and save time in model studies.

To investigate the hydraulic characteristics of an orifice spillway, a physical hydraulic model and numerical studies are presented in this paper. Hydraulic model tests were carried out on a 1:45 scale 2-D sectional model. The Computational Fluid Dynamics (CFD) software Flow-3D was used for numerical studies for modelling flow over an orifice spillway. Flow-3D is a general-purpose software application for computing fluid dynamics (CFD). Specifically developed numerical techniques are applied to solve fluid equations of motion to obtain transient, three-dimensional solutions to multiscale, multiphysics flow problems. The RNG turbulence model was used for numerical simulation. To validate the numerical model, data such as flow conditions, discharging capacity, pressure distribution along the bottom profile of the sluice and spillway, velocity, and water surface profile were computed. A numerical model developed based on physical model studies was validated by using experimental values of pressures, water surface profiles, and discharge characteristics. The numerical models were able to accurately simulate the various hydraulic parameters of spillway flows, since the simulated values were close to the experimental results. In the case of parametric studies, this model can be used quite efficiently as an initial investigation of spillway flows, thereby eliminating the need for repeated physical model studies with structural modifications, resulting in saving time and money. The evaluation of the ability of the CFD software Flow-3D to model spillway flow behaviour proved to be quite successful.

Keywords: Hydraulic Model, Computational Fluid Dynamics; Flow-3D; Orifice spillway.

CFD Investigation of Energy Dissipation Using Various Stepped Spillway Design Configurations

Aniket Kumar Sharma[1*], Bharat Jhamnani[2]
[1,2]Department of Civil Engineering, Delhi Technological University, Delhi, India-110042
*aniketkumarsharma_2k21phdce10@dtu.ac.in

Abstract

Spillways are hydraulic structures that are used in flood mitigation operations, river engineering, soil conservation, and water management to remove excess kinetic energy of flood water downstream of the dam. It has become evident over the years that flooding can destroy dam structures due to overtopping, hence it becomes essential to mitigate the effects of flooding over structures by ensuring water can flow freely. The effectiveness of energy dissipation from quickly varying cascades is improved by steps supplied above spillways. In this study, the Volume of Fluid (VOF) method and the CFD methodology is used to model flow over a stepped spillway and resolve the dynamics of the free surface flow. A stepped spillway having a total height of 30 cm is considered for all four experimental models. For those three experimental models the treader (horizontal) of steps is considered as uniform and the riser (vertical) is considered as non-uniform. Six different discharges ranging from 450-7600 cm^3/sec were passed over each model. Results are compared with uniform conventional stepped spillway, and it is noticed that the non-uniform steeped spillway reduced more kinetic energy as compared to the uniform stepped spillway. Generally, relative energy loss for non-uniform stepped spillway is reported 3-4 % higher than for uniform stepped spillways. A good agreement in results is also established with the past studies.

Keywords: CFD, Kinetic Energy, Stepped Spillway, Volume of fluid (VOF), discharge etc.

Seepage and Stability Analysis of Khamhar Pakut Earthen Zoned Dam: A Case Study

Subodh Shrivastava[1], Srinivas Pasupuleti[2] & Vishwas N Khatri[3*]
[1]Research Scholar, Dept. of Civil Engineering, Indian Institute of Technology (ISM)
, Dhanbad-826004, Jharkhand, India,
E-mail: 21dr0190@cve.iitism.ac.in
[2]Associate Professor, Dept. of Civil Engineering, Indian Institute of Technology (ISM)
, Dhanbad-826004, Jharkhand, India,
E-mail: srinivas@iitism.ac.in
[3]Assistant Professor, Dept. of Civil Engineering, Indian Institute of Technology (ISM)
, Dhanbad-826004, Jharkhand, India,
*vishwas@iitism.ac.in

Abstract

This study focuses on assessing two crucial aspects, seepage, and stability, in the analysis of the zoned earth dam of the Khamhar Pakut reservoir project in the Raigarh district of Chhattisgarh. The evaluation involves finite element analysis using GEO STUDIO software on a specific cross-section (CH 28) of the reservoir project. The study brings out findings for the long-term stability analysis of the dam's upstream slope under a total head of 20.85m(steady-state seepage) and drawdown conditions. During steady-state analysis, the phreatic line and the total water head gradually decrease as water flows from the dam's downstream side. In contrast, during the rapid drawdown, the total head and water pressure decreased rapidly over time; accordingly, the factor of safety rapidly reduced from 1.77 to 1.15 within the first 12 hours. In the case of slow drawdown, the total water head and pressure head decrease gradually, and after the 30th day, they become lower than in the rapid drawdown case. Furthermore, in this case, the factor of safety changed from 1.77 to 1.50 over 8 days. Overall, this study highlights the critical importance of different drawdown conditions considering seepage and stability of earth dams.

Keywords: Rapid drawdown, Slow drawdown, Seepage, Stability.

Dam Break Analysis and Flood Mapping in HEC-RAS: Nanak Sagar Dam, Uttarakhand State, India

Dinesh Kumar[1*], Shobhit Kumar & Harsh Chandra
[1]Dr. A.P.J Abdul Kalam Institute of Technology, Tanakpur, India
*dineshacmtskt@gmail.com

Abstract

Dam is a hydraulic structure used to store large quantity of water for various purposes like irrigation, power generation etc. Due to large storage of water the surrounding area of dam is susceptible to flood during dam failure, the aim of this study is to predict the flood inundation area map, peak discharge, arrival time of flood so as to minimize the live and property loss and also for pre planning for these consequences generated during flood. The study involves the use of HEC-RAS software to simulate the flood flow from the Nanak Sagar Dam Reservoir to the downstream connected area , HEC-RAS software uses the data like DEM (Digital Elevation Model), Lateral inflow hydrograph for the storage area , dam or embankment characteristics , Boundary condition for outlet, Normal depth slope to simulate dam break model, the mode of failure considered in this study are overtopping and piping ,the digital elevation model used is Cartosat-1 DEM and hydrograph used is for the probable maximum precipitation (PMP), based upon these data a model is prepared in HEC-RAS, for breach parameter calculation we used Froehlich Equation (2008) , after performing simulation the model results the peak flood discharge of 12729.09 m^3/s with arrival time of 8 hours at immediate downstream in overtopping mode of failure and peak flood discharge of 13305.68 m^3/s having arrival time of 5 hours at immediate downstream in piping mode of dam failure. The Dam breach causes a flood inundation area of 1067.89 km^2 and 982.26 km^2 in overtopping and piping failure respectively. A total of 449 villages in downstream side are affected from flood generated due to overtopping failure and 450 villages due to piping failure of Nanak Sagar. The hydrograph of breach outflow is routed using the model for different downstream locations and the flood wave propagation pattern is analysed, which shows that overtopping mode of failure have more serious consequences compare to piping failure. This study will help the concerned authorities for assessment of damage, developing early warning and rescue plan for the management of the outcomes of dam failure.

Keywords: HEC-RAS, Nanak Sagar Dam, Dam Break, Flood Inundation.

Design guidelines for tailrace tunnels of Pelton turbines

Sushma Vyas[1*], Y.N. Srivastava[1]
[1]Scientist "C", CWPRS, Pune, India - 411024
[2]Additional Director (Retd.), CWPRS, Pune, India - 411024
*vyassush13@gmail.com

Abstract

The tailrace tunnel plays an important role in hydropower plants. It is used to carry the water that has passed through the turbines and is discharged from the power plant back into the river. The tailrace tunnel is typically designed to maintain a constant flow and pressure, allowing for the efficient operation of the turbines. It is also designed for changes in water level or flow rate, ensuring the smooth discharge of water regardless of variations in the power plant's output. To ensure efficient and safe operation of the turbine, the design and construction of the tailrace tunnel must consider various factors. The turbine is installed above the tail race level to avoid splashing the buckets with the tailwater. For the safe working of the turbine, the water collected in the tail race should not submerge the Pelton wheel. The primary objectives in tailrace tunnel design are to minimize energy losses, prevent excessive pressure fluctuations, and maintain stable flow conditions. These objectives are achieved through proper tunnel geometry, hydraulic design, and turbulence control measures. The tunnel cross-sectional area, shape, and slope must be carefully determined to maintain a balance between flow velocity, energy dissipation, and sediment transport. The hydraulic design involves optimizing the tunnel dimensions, including width, height, and curvature, to minimize flow disturbances and hydraulic losses. Turbulence control measures, such as the provision of energy dissipation devices like stilling basins or hydraulic jump zones, help dissipate excess energy and reduce pressure fluctuations. Additionally, the use of appropriate tunnel lining materials and surface treatments can minimize friction losses and ensure smooth water flow. A well-designed and properly built tailrace tunnel guarantees that the Pelton turbine operates efficiently and adds to the overall performance and reliability of the hydropower system. This paper provides an overview of key considerations in the design of a tailrace tunnel for a Pelton turbine and hydraulic model studies for TRT with Pelton turbines.

Keywords: Tailrace tunnel, Pelton, turbine, hydro power, geometry.

Assessment of permeability of foundation strata below Earthen dam of Songaon-Shivni Project- A case study"

Sanjay A. Burele*, G.C. Singarkar, Pravuram Panda, K.A.M. Bagwan & Rizwan Ali
Central Water & Power Research Station, Pune, India
*burelesanjay@cwprs.gov.in

Abstract

Songaon-Shivni earthen dam is situated near the village Chandur Railway, 40 km away from Amravati city, Maharashtra and construction was completed during June 2009. Seepage in the form of saturation of soil at downstream toe of the dam was observed between chainage 690 m to 2010 m, when the reservoir level was raised to RL 304.90 m (i.e. 41% filled) during the year 2016 monsoon season. When storage of the dam was further increased to 79% of total capacity (up to RL 306.85 m), more seepage was observed. Seepage caused water logging in the downstream side between chainage 690 m to 2010 m raising concerns about the permeability of foundation strata. Hence, before finalizing remedial measures in the form of grouting, in-situ permeability tests at Songaon-Shivni were conducted by drilling 27 nos. NX size bore holes from chainage 630 to 2070 m. The permeability test has assessed Lugeon value between 69.20 to 403.64 of foundation strata indicating very high intensity of seepage through foundation. Also, the top of hearting designed to be at RL 310.00 m has been observed to settle ranging from 0.52 m to 5.425 m. On the basis of in-situ permeability studies and bore log details, grouting pattern of foundation strata has been finalized. The suggested grouting pattern consists of five rows of bore hole to be grouted in between chainage 580 m to 2120 m with spacing of 3 m centre to centre and row spacing of 1.5 m and overlap of 50 m on both sides of the high seepage bore holes from chainage 580 m to 2120 m. Similarly top material of earthen embankment may be removed and hearting material may be refilled in compacted layers upto RL 310.00 m.

Keywords: Permeability, Lugeon value, earthen dam, foundation strata, seepage, grouting.

Assessment of Toe Berm by Physical Modelling for the Design of Rubble Mound Breakwater

B R Tayade[1*], Praveen K M, G R Pardeshi[1] & S P Jagtap[1]
Central Water and Power Research Station, Pune, INDIA
*tayade.br @cwprs.gov.in

Abstract

The design of hydraulically stable non-overtopping rubble mound breakwater mainly depends on the damage to the armour and toe berm portion. The damage in the toe berm region is governed by the coefficient of friction of bed material, wave action, water depth, width of toe-berm and weight of armour units. In this study, the influence of a few parameters associated with the hydraulic stability of the toe berm portion of rubble mound breakwater is presented. The study is focused only on the stability of the berm portion of the breakwater without assessing the overall stability of the breakwater. A scale-down model of the breakwater is analysed for the damage of the toe berm portion in wave flume under random wave conditions. The stability response of the toe berm with different weights of stone in the breakwater is analysed in accordance with the toe berm width, water levels, wave height and wave spectrum. The damage parameters in the form of Nod (Number of displaced units) and Sd (Stability parameter) values were calculated and analysed. Various combinations of the weight of the stone, toe berm width and wave spectrum were analysed to arrive at no damage criteria in the toe berm portion. Further, the results were compared with the Nomogram chart for the Threshold movement of stone on the sea bed under wave conditions (British Code BS 6349-7:1991) by using input parameters such as depth of water, wave height and wave period. The present study concentrates only on the stability of the toe berm without commenting on the overall stability of the breakwater. This study provides insight into the hydraulically stable design of toe berm.

Keywords: Rubble mound breakwater, Toe berm, Physical modelling, Damage parameter, Random waves.

Winter Kennedy Method – An online tool for efficiency monitoring of hydro power plants

T.K. Swain*, Raghuchandra Garimella*, Muhammed Faisal Rahman
Central Water and Power Research Station, Department of Water Resources, River Development & Ganga Rejuvenation, Ministry of Jal Shakti, Khadakwasla, Pune, India
*swain_tk@cwprs.gov.in

Abstract

For knowing or satisfying guarantees, improving operation, and confirming efficiency gain after rebuilding the existing hydroelectric power plant, knowledge of efficiency and performance is essential. Numerous hydroelectric stations in India, the majority of which were built between 1950 and 1970, are currently undergoing extensive renovations. This upgrade's primary goal is to boost the generation of renewable energy, which is now much more affordable than electricity from other sources. Along with other hydro-mechanical equipment like runner and wicket gates, the principal hydraulic instrumentation refurbishments include new electronic flow monitoring and power measuring devices. Therefore, improving the efficiency of outdated hydro turbines is crucial in this regard, and the most difficult characteristic to assess is discharge. Shorter intakes and geometrical variance in low head plants make it more difficult to assess discharge using the widely used conventional transit time method. IEC 60041 contains a number of methods for testing hydro turbines in the field. However, when dealing with turbulent water, the traditional electromechanical approach is usually accompanied by unpredictable mistake. IEC 60041 includes the index approach that Winter & Kennedy proposed. This approach is predicated on the idea that the flow through the turbine is proportional to the differential pressure across the scroll case. This technology has not been extensively researched and is only occasionally used in hydroelectric power plants since it is difficult to measure the very tiny differential pressure across the turbine scroll case. The Winter Kennedy Taps have to be installed for all of the new hydropower, but, because to improvements in instrumentation and quick data acquisition, which have given this method increased relevance. This method is special since it allows for online monitoring of the turbine efficiency, which would otherwise take days with the other methods. The report discusses the CWPRS's hydropower plant in India's hydropower principle, instrumentation, precision, accuracy, and practical investigations.

Keywords: Index Method, Data Acquisition, Scroll case, Winter Kennedy Taps

Hydraulic performance of Showerheads as Water Saving Device and suggestions for improving their performance based on Hydraulic and Geometrical Parameters

Nagaraj Sitaram[1*]
[1]Eeast Point College of Engineering and Technology, Bengaluru, India
*naghydro@gmail.com

Abstract

Water Saving Devices is simply defined as the diverse methods employed to emphasize water savings and water efficiency without sacrificing consumer satisfaction or end user. The Water saving devices mainly include pressure regulating devices, faucet aerators, and shower heads. They are installed in domestic and industrial pipelines and save the water consumption and pumping cost. The performance of shower head as water saving device is studied in the laboratory. The research is aimed to develop new models of shower heads based on the improvement of their geometrical and hydraulic characteristics at various flow rates and line pressure. The variables identified for the research include pipeline pressure, flow rate, pattern of holes, their size, shape, air passage geometry, and length of capillary. A series of experiments have been carried out in the laboratory using the hydraulic flow test rig to examine the performance of shower heads. Three models (M/s Jaquar, Kohler,Viking) of showerheads were tested using the hydraulic-test rig at different line pressures (Gauge pressure 1.2, 1.0, 0.5 bar). For each model, various data like geometry, temperature of flow, line pressure, manifold pressure, discharge etc. are noted. Based on the data collected the most efficient showerhead model for a given line pressure is recommended. It is also observed that water saving through shower heads can be improved from 26% to 87% at low pipe line pressures and 46% to 92% at higher pipeline pressures.

Keywords: Water saving devices (WSD), Showerheads, Hydraulic Rig, Water conservation, pipeline, pressure, performance.

GPBoost for Pier Scour Modelling

Mahesh Pal[1*] and Shanmukha K. Singaraju[1]
[1]National Institute of Technology, Kurukshetra, Haryana, India
*mpce_pal@yahoo.co.uk

Abstract

Boosting has extensively been used to improve the predictive performance of weak machine learning algorithms. Keeping in view of its improved performance, several tree based boosting algorithms including Light gradient boosting machine, extreme gradient boosting, Categorical boosting as well as Gaussian Process Boosting which combines Gaussian Process and boosting are proposed in literature. This paper investigates the potential of all four modelling approaches to predict pier scour using field dataset. The dataset consisting of 232 field measurements of which 154 samples were used for training whereas remaining 78 for testing the models. To find the optimal value of various user-defined parameters of LightGBM, XGBoost, CatBoost as well as GPBoost, grid search, random search and Bayesian optimisation approach were used. Comparison of results in terms of both correlation coefficient (CC) and root mean square error (RMSE) suggest better performance by grid search method with XGBoost, CatBoost and GPBoost algorithms whereas Bayesian optimization method is found to work well with LightGBM. Results with optimal values of userdefined parameters suggest a comparable performance by CATBoost and GPBoost (RMSE=0.33, CC=0.95) with test dataset and perform better than Light GBM (RMSE=0.34, CC=0.95) as well as XGBoost algorithm (RMSE=0.39, CC=0.93). Results of this study suggest the potential of GPBoost for data modelling in water resource engineering in comparison to other predictive approaches.

Keywords: Gradient boosting, GPBoost, grid search, hyperparameter optimisation, Pier scour, Field data.

Comparative Analysis of braiding intensity of Kosi River using Remote sensing and GIS.

Anurag Labh Aman[1*], Prof. G S Dwarakish[1]
[1]National Institute of Technology Karnataka, Surathkal, India
*anuraglabhaman.217wo002@nitk.edu.in

Abstract

The river Kosi is well known for its shifting nature. It originates from Tibet and after travelling through Himalaya and plains of Bihar it joins river Ganga at Kursela. As the river flow towards plain of Bihar, due to sudden decrease in slope, the sediment carrying capacity of the river decreases, which causes accumulation of sediment and formation of braided bars in the river. The downstream region of Birpur barrage is highly affected by this shifting tendency of the river. The satellite images of the river for year 1992, 2004 and 2016 were obtained and analysed to study the change in braiding of the river in this period of 24 year. The braiding intensity was measured by using the different braiding indices given by Brice, Rust and Sharma and compared in this study. The study area has been divided into four reaches and the braiding intensity for each of them were calculated. The braiding intensity by Brice varies from 2.38 to 4.93, from 1.06 to 1.75 as given by Rust and 2.45 to 6.5 by Sharma. The calculated braiding intensity indicates the overall decrease of braiding in the area. This study will be helpful to get an idea about the change in braiding intensity of the Kosi River in the downstream side of Birpur Barrage and about future changes.

Keywords: Kosi, Braiding, Planiform Index, GIS

Review of Tidal Energy Technologies for Improved Tapping of Tidal Power Worldwide

Sunil Deshpande[1*], Tophique Qureshi[2], J. D. Agrawal[3], Anil G. Kale[4], Vasant V. Vaze[4]
[1] Research scholar, JJTU, Jhunjhunu, Rajasthan, India
[2]JJTU, Jhunjhunu, Rajasthan, India
[3]Dr. D. Y. Patil Institute of Technology Pimpri, Pune, India
[4]Former Scientist CWPRS Pune, India
* sunil.deshpande@dypvp.edu.in

Abstract

The concern for increase in carbon emissions leading to global warming has made the society to think and opt the green, clean and sustainable way of obtaining electric power. This thought provoked the researchers to concentrate on developing new ways of renewable-based technologies. By and large, up till now, use of hydropower energy is found to be one of the feasible methods to mitigate future electric power shortfall.

As the ocean covers 70% of earth surface and it is the single largest collector of solar energy, amongst all available recourses for harnessing electric power, the ocean power is more promising non-depleting and reliable resource. Ocean power in the form of tidal energy, wave energy, and thermal energy can be used to harness by using respective technologies. Tidal energy is clean and most predictable, which makes it unique and suitable to use it as a power harnessing source.

This paper focuses on tidal energy, which is one of the desirable alternatives. There are three tidal energy technologies namely tidal range technology, tidal current or tidal stream technology and hybrid applications of tidal range and tidal current technologies. This research reviews the tidal energy harnessing technology and their plants deployed all over the world. In view of the limitations of current technologies to be used for harnessing tidal power, the necessity is proposed for some innovative approach to use the complete tidal energy potential even from low tide ranges available all over the world.

Keywords: Renewable energy, Ocean power, Tidal energy

Techno-economic analysis of integrated solar and pumped storage hybrid system: A case study in India

Upendra Bajpai, Prabhat Yadav, Amit C. Bhosale* & Sunil Kumar Singal
Indian Institute of Technology Roorkee, Roorkee, India
* upendra_b@hre.iitr.ac.in

Abstract

Renewable energy sources are intermittent in generating power since their meteorological parameters change continuously and require an energy storage device. A pumped storage hydro system is a viable, large-scale resource that is being utilized today for storing energy. The study aims to design a hybrid solar and pumped hydro storage system to fulfill the increased load demand for ten years in Pauri Garhwal (Uttarakhand, India). For the pumped hydro storage system, a storage site is selected on Nayar River along with the solar radiation analyzed in an hourly basis for the location, with the load demand data collected from the Syunsi substation. The designed solar and pumped storage hybrid system is found to satisfy the domestic and commercial load demand with 2594 panels each of 320 W along with 8100 m^3 reservoir capacity. The pumping and generation of the system are scheduled for 8 and 16 hours, respectively, for which the cost of power generation for solar and pump storage plants is estimated at around 0.051 US $/kWh and 0.069 US $/kWh, respectively. The study demonstrates a successful load-demand balance with an estimated energy cost of 0.093 US $/kWh when calculated analytically and 0.099 US $/kWh by software modeling.

Keywords: Hybrid system, Pumped storage hydro, Solar photovoltaic, Cost of Energy.

Feasibility of Diversion Tunnel for Sediment Management in Reservoirs

M.Z. Qamar[1*], M.K. Verma[2] & A.P. Meshram[3]
[1]Scientist 'C', Central Water and Power Research Station, Pune, India
[2]Scientist 'D', Central Water and Power Research Station, Pune, India
[3]Scientist 'B', Central Water and Power Research Station, Pune, India
*ziaul_qamar@rediffmail.com

Abstract

Reservoir sedimentation causes storage loss, reducing usable storage capacity and rendering the reservoir inefficient for the function for which it was designed. This is becoming more intense as the catchment's sediment supply increases as a result of numerous development activities and the effects of climate change. As a result, several countermeasures must be implemented to manage the sediment. Diversion tunnels, also known as sediment bypass tunnels, are an effective way to slow the process of reservoir sedimentation. The sediment accumulation of both bed load and suspended load is greatly reduced by channelling material around the reservoir into the downstream. A diversion tunnel is also important in the case of hydropower projects in the Himalayan region, where reservoirs have a high suspended sediment load. If not addressed, suspended silt enters the water conductor system via power intakes, causing severe damage to turbines and other power house equipment. This paper emphasises the practicality of diversion tunnels (sediment bypass tunnels), particularly in the case of hydropower plants.

Keywords: Reservoir sedimentation, diversion tunnel, suspended sediment, sediment management.

Tidal Barrage at Estuaries – An Effective Method for Power Generation

Neha S. Burele[1*] & Sanjay A. Burele[2]
[1]VIIT, Pune, India
[2]Central Waterpower & Research Station, Pune, India
* bureleneha1011@gmail.com

Abstract

A Tidal barrage is a dam-like structure used to capture the energy from masses of water moving in and out of a bay or river due to tidal forces. Instead of damming water on one side like a conventional dam, a tidal barrage first allows water to flow into the bay or river during high tide, and releasing the water back during low tide. This is done by measuring the tidal flow and controlling the sluice gates at key times of the tidal cycle. Turbines are then placed at these sluices to capture the energy as the water flows in and out. The barrage method of extracting tidal energy involves building a barrage across a bay or river that is subject to tidal flow. Turbines installed in the barrage wall generate power as water flows in and out of the estuary basin, bay, or river. These systems are similar to a hydro dam that produces Static Head or pressure head (a height of water pressure). When the water level outside of the basin or lagoon changes relative to the water level inside, the turbines are able to produce power. The paper focuses on the potential method for generating electricity. 1D mathematical model is used for producing the required velocity for generating the electricity. The side chosen for generating electricity from tidal energy is near Devgad District of Ratnagiri, Maharashtra.

Keywords: velocity, tidal energy, potential, barrage, estuary

Restorative solution to Toe-drain water collected at Ash Dyke of Thermal power plants

Vinod Kr Mauriya*
Dy. General Manager (PE-Civil), NTPC Ltd, CC-EOC, Hyderabad, Telangana, India-500080,
*vkmauriya@ntpc.co.in

Abstract

In general, coal-ash generated from thermal plants is disposed in the ash-dyke lagoons by wet-disposal method requiring considerable amount of water. A typical 660MW plant annually uses about 16MCM of water, out of that about 8% is used in coal-ash handling operations. From the total water discharged in ash-dyke lagoon, decanted surface water (about 80%) is taken back to ash handling system through recirculation system, however about 20% as sub-surface water gets trapped in deposited ash in ash-dyke lagoon and subsequently released to toe-drain of peripheral ash-dyke. Considering present environmental requirements, now the water received in toe-drain from ash-dyke is necessarily to be collected and taken back for reuse which otherwise was earlier discharged in nearby natural-drains.

For reuse of toe-drain water, based on ground topography of ash-pond area, one option is to direct tap-off from toe-drain of ash-dyke at right locations and connect to one or two sumps for pumping back in the re-circulation system of ash handling operations. However, in case the existing ground topography does not permit feasibility of direct tap-off, then an additional peripheral-drain of RCC or brick masonry is to be constructed with suitable connection to toe-drain at right locations. This peripheral-drain would be routed to one or two pump-house(s) depending on the length of peripheral-drain. The sump/pump-house for collection of toe-drain water will be rightly located at the points of lowest ground levels as per ground topography along the toe-drain/ peripheral-drain. Each pump-house will cater to the water from a defined length of toe-drain and accordingly quantity of water to be handled at each pump-house is decided. The adopted restorative solution to toe-drain water has facilitated recycling and reuse of toe-drain water back to the thermal plant in ash handling operations, thereby reducing water consumption in thermal plants.

Keywords: Industrial water; coal-ash; ash-dyke; toe-drain water; reuse; re-circulation.

Turbulent Flow Characteristics of Asymmetric Sinuous Bend

Gurugubelli Yatirajulu[1*], P. V. Timbadiya[2] & Bandita Barman[3]
[1]Ph.D. Research Scholar, Sardar Vallabhbhai National Institute of Technology, Surat-395007, Gujarat, India.
[2]Associate Professor, Sardar Vallabhbhai National Institute of Technology, Surat-395007, Gujarat, India.
[3]Assistant Professor, Indian Institute of Technology (Indian School of Mines), Dhanbad-826004, Jharkhand, India.
* d20ce014@ced.svnit.ac.in

Abstract

The current study focuses on the experimental investigation of turbulent flow characteristics at the center of the bend apex in an asymmetric alluvial sinuous channel with rigid bank and mobile sand bed. The experiments are conducted on River Tray at the Advanced Hydraulic Laboratory (AHL) of Sardar Vallabhbhai National Institute of Technology, Surat. The length and breadth of the model are 10.8 m and 0.8 m, respectively, and a bed slope of 1 in 1000. The streamwise and lateral averaged velocity, Reynolds shear stress (RSS), turbulent intensity, and turbulent kinetic energy are analyzed at the center of the bend. The 3D velocity was measured using an Acoustic Doppler Vectrino Profiler (ADVP). The streamwise velocity is found to be highest at the center of the flow depth (z/h = 0.385) for a discharge of 0.016 m3/sec. The lateral velocity shows a discontinuous trend with negative values near the bed and positive values near the water surface. The RSS shows positive triangular distribution near the bed and attains a negative value near the water surface, indicating the presence of helical flow at the bend. The turbulent intensity is higher in the streamwise direction as compared to the lateral and vertical directions reveals the dominance of streamwise velocity fluctuation at the bend. The value of turbulent kinetic energy reveals the decay in turbulence at the center of the bend in an asymmetric alluvial sinuous channel.

Keywords: Asymmetric sinuous channel, streamwise and lateral averaged velocity, Reynolds shear stress (RSS), turbulent intensity, turbulent kinetic energy.

MATLAB/Simulink based PI Controller modeling with Unsteady State Simulation results for multiple canal pools system

Rana V.M.*
*Professor, Civil Engineering Department, Institute of Technology, NIRMA University, Sarkhej Gandhinagar Highway, near Vaishnodevi Circle, Ahmedabad, Gujarat, India-380015,
*vm.rana@nirmauni.ac.in

Abstract

In India, the canal operation is conventional operating procedure is normally being followed and according to this, all demands of the command area is accumulated and as per the availability of water, the schedule of canal operation is being prepared. According to this, the water is being diverted from off taking of canal under jurisdiction and the water is being conveyed to the field. But this conventional operation method may not be possible for big canals whereas the length of the canals are in kilometers and with huge conveying capacity of the range from 300 to 800 cumecs. So, instead of this, Controlled Volume Concept (CVC) in which always canal pool will be filled up with fixed volume of water derived as per predetermined depth i.e. at pivot point of canal pool. Based on this pivot point depth, the depth as upstream and downstream of canal pool will be determined from Steady State condition. Now these depth i.e. at U/s & D/s is considered as target depths for canal operation in Unsteady State condition i.e. Real time operation. To achieve the same, number of software are being used for Unsteady State Simulation of canal operation based on Saint Venant's Equation or any other. But it has been observed that if Unsteady State Simulation carried out for whole network system i.e. Main Canal, Branch Canal, Distributary, minor, sub minor, Field channel, etc. then it requires number of combinations, complex calculations, etc. So, it has been tried to use the available mathematical tools like MATLAB to simulate the canal operation for network of canal with the output parameters of simulation model. In MATLAB, the relationship of Time Constant with Resistance and Capacitance as per Control Theory of system is being used. The commands for Input to the system like STEP, RAMP are used to check the depth variations in each canal pool of five pool system for a disturbance/perturbations i.e. change in discharge, etc. For Unsteady State behavior of canal pools based on Controlled Volume Concept of operation for targeted parameters like water levels at upstream, downstream, etc. of Steady State Analysis of canal pools can be obtained by using St. Venant's Equation. But as the numbers of canal pool increases interactions increases or it can be stated as influences of one to another pool also increases and ultimately it will also affect the hydraulic properties of each pool like discharge, depth of water, gate discharge, etc.

This may also results in errors in calculations or inaccuracy in results as limitations of solving techniques are also based certain assumptions. Instead of using other mathematical solutions, etc. attempt is made to use the MATLAB software for testing the stability or response of canal system during real-time operation of canal. The MATLAB software is used for representation of five canal pools system and control actions i.e. Proportional (P) and Integral(I) are applied and fine-tuned for perturbations/disturbances i.e. Step Input and behavior of canal pool is represented graphically and results are discussed.

Keywords: control of irrigation canals, control action, controller, Simulink, step-input, robustness, canal pool, high-order systems

Identifying the Confluence Hydrodynamic Zone in a Rigid Bed Open Channel

Wahidullah Hakim Safi[1*] and Pranab K. Mohapatra[2]
[1] PhD Student, Discipline of Civil Engineering, Indian Institute of Technology Gandhinagar, Gandhinagar, 382355, India; Lecturer, Environmental and Water Resources Engineering Faculty, Kabul Polytechnic Univ., Kabul 1010, Afghanistan
[2] Professor, Discipline of Civil Engineering, Indian Institute of Technology Gandhinagar, Gandhinagar, 382355, India
*wahidullah011@gmail.com

Abstract

Open channel flow confluences occur in natural and man-made systems. The flow field in the confluence hydrodynamic zone (CHZ) is complex and is characterized by the presence of a 3D turbulent flow field and flow separation zone. Thus, it is important to identify the hydrodynamic zone influenced by the confluence (CHZ) for a rigid bed case with steady flow. In this study, first, a dimensional analysis is performed to determine the influencing factors for the CHZ. Then, the flow field in a rigid bed confluence is simulated by using an open-source CFD code, OpenFOAM. The volume of fluid (VOF) method for surface tracking and large eddies simulations (LES) for capturing the turbulence characteristics are used. The simulated results are used to obtain the streamlines (close to the water surface) and water surface elevations. Identification of CHZ is based on these two parameters. It is found that the length of CHZ is governed by the discharge ratio and the confluence angle.

Improved One-dimensional Velocity Deformation Model for Unsteady Flows

Mahavirsinh Dabhi[1*] & Manoj Langhi[2]
[1]M. Tech Student, Institute of Infrastructure Technology Research and Management, Ahmedabad, India
[2]Assistant Professor, Institute of Infrastructure Technology Research and Management, Ahmedabad, India
* mahavirsinh.dabhi.21mc@iitram.ac.in

Abstract

The effect of unsteadiness during the flood events plays an important role, causing the flow characteristics vary during the rising and falling stages of the flood flow. It is crucial to examine the streamwise velocity distribution to comprehend the hydrodynamic properties of unsteady non-uniform flows. 1-D depth averaged models conveniently resolve the problems in the rivers due to its small computational requirements. The underlying principle of such models is to consider a velocity distribution along the depth and determine the bed shear stress by applying the momentum equation. Using similar approach, in the present study an improved velocity deformation model is proposed to study the characteristics of unsteady non-uniform flows in open channels. The proposed model is based on the idea that the vertical profile of the streamwise velocity can be expressed as a power series, with the coefficients of the series are determined by using the unsteady equation of motion. The accuracy of the onedimensional improved velocity deformation model was verified by comparing the simulated results with the existing experimental data. The comparisons of numerical results showed that the model produced a reasonably good agreement with the observed data. The validation of the model was performed by comparing the velocity distribution of the numerical model with that of a previously proposed numerical model. The proposed model offers an efficient and accurate way to simulate the unsteady non-uniform flow behaviours in open channels.

Keywords: Hydrodynamic characteristics, velocity distribution, unsteady flows, non-uniform flows, flood flow

Revitalizing India's aging dams – An electrical engineering approach to sustainable rehabilitation

Chandan Gupta[1*], T.K. Swain[2], Venkat Sai Surendra Bandi[3], Muhammed Faisal Rahman[4]
Central Water and Power Research Station, Department of Water Resources, River Development & Ganga Rejuvenation, Ministry of Jal Shakti, Khadakwasla, Pune, India Corresponding Author
*chandan.gupta@cwprs.gov.in

Abstract

For the security of its water and electricity, India has a vast network of dams. However, as many of these dams were constructed many years ago, they now need to be renovated due to aging. This poses a substantial engineering problem because the restoration work must not only guarantee the dam's structural integrity but also incorporate environmentally friendly procedures for long-term operation. Electrical engineering has a key role to play in India's sustainable rehabilitation of deteriorating dams. By utilizing contemporary turbine-generator technology, many dams can increase their ability to generate electricity. By producing more electricity with the same amount of water, new turbines can improve a dam's efficiency and lessen its environmental impact. The monitoring and control system of the dam needs to be improved as part of sustainable rehabilitation. Modern sensing technologies enable operators to optimize dam operations for optimal efficiency and safety by providing real-time monitoring of water levels, temperature, and other characteristics. Last but not least, electrical engineers can help create a smart grid system that uses renewable energy sources like solar and wind power. This can improve the overall sustainability of the dam and help India meet its growing demand for electricity while reducing its dependence on fossil fuels. A sustainable rehabilitation approach to India's aging dams must encompass a range of electrical engineering solutions to ensure their long-term viability. Upgrading the dam's turbines, implementing advanced monitoring and control systems, and developing a smart grid system can all contribute to achieving this goal.

Keywords: Sustainable rehabilitation, aging dams in India, smart grid, long-term viability, advance monitoring, control system.

Discharge Prediction in Meandering Compound Channel using ANN PSO and M5 Tree

Rajeev Nayan*; Bhabani Shankar Das
Civil Engineering Department, NIT Patna, Patna University Campus, Patna, Bihar 800005
*Nayanrajeev.nitp@gmail.com

Abstract

Common phenomena associated with alluvial river is its meandering behaviour. A meander is formed when the moving water in the river changes its speed of water eroding sediments from outside of abend and depositing them on the inside. Sinuosity is a major parameter use to classify a river is meandering or not. Sinuosity is defined as the ratio of the length of the thalweg (path of deepest flow) to the length of the valley. A meandering compound channel consist of a main channel which carries a base flow and frequently occurring runoff up to bank flow condition, and a flood plain one or both side that carries overbank flow during flood. There are many studies on the hydraulic analysis of flow in meandering compound channel. Various method has been developed based on these studies. In general, this method either have numerical solution of differential equation or need long computation. The present work is focus on discharge prediction in meandering compound channel using using Machine Learning techniques such as Artificial neural network particle swam optimization (ANN PSO) and M5 Tree by considering several non dimensionless parameters such as relative depth, sinuosity, bed slope, width ration and discharge ratio. Results show that the both ANN PSO and M5 TREE predicted the discharge (Qp) satisfactorily with the coefficient of determination (R2) value greater than 0.83 and mean absolute percentage error (MAPE) less than 10 % for training and testing datasets. However, ANN PSO model prediction accuracy is better compared to the M5 Tree.

Keywords: Meandering, Main channel, Flood channel, Sinuosity, ANN PSO, M5 TREE.

Prediction of Energy Dissipation in Skimming Flow of Stepped Spillway by Using Machine Learning Approach

Ritusnata Mishra[1*], C.S.P Ojha[2]
[1,2] Department of Civil Engineering, Indian Institute of Technology Roorkee, Roorkee 247667, Uttarakhand, India.
*rmishra@ce.iitr.ac.in

Abstract

Machine learning has emerged as one of the powerful tools in several areas of water resource engineering. Consequently, in the current work, SVM_Puk and M5Rules models are utilized to predict how much energy would be dissipated by a stepped spillway in a specific region like skimming flow. Different input parameters such as critical flow depth (d_c), slope (θ), width (w), height of the spillway (H_{spl}), step height (h), and number of steps (N) are taken for prediction of energy dissipation. A total of 218 datasets have been collected from the literature, with 75% of those datasets being used for training and 25% being used for testing. To get the optimum outcome, several combinations of input parameters are used. The predicted values of SVM_Puk model shows correlation coefficient (CC) of 0.98, root mean square error (RMSE) of 0.0445, and mean absolute error (MAE) of 0.0322 during testing. With the use of M5Rules a corelation coefficient (CC) of 0.979, root mean square error (RMSE) of 0.0456, and mean absolute error (MAE) of 0.0348 has been achieved during testing. From this analysis, it was found that both the models perform very well in predicting energy dissipation of stepped spillway. However, as per statistical analysis, SVM_Puk model has a superior performance in predicting energy dissipation of stepped spillway.

Keywords: Stepped spillway, Energy dissipation, Skimming flow, Machine learning.

Evaluation of Saltwater Intrusion in the Coastal Strip of Mangalore Region Using Visual MODFLOW Flex

Diana A R[1*], Ramesh H[2], M S Ganesh Prasad[3], Vijay Suryawanshi[4]
[1]Master Student, The National Institute of Engineering Mysuru, India.
[2]Associate professor, National Institute of Technology Karnataka, Surrathkal, Mangalore, India.
[3]Professor, The National Institute of Engineering Mysuru, India.
[4]Research Scholar, National Institute of Technology Karnataka, Surrathkal, Mangalore, India.
*2021chy_dianaar_a@nie.ac.in

Abstract

Groundwater resource is used for a number of reasons and can overcome the problem of seawater intrusion (SWI) in coastal aquifers. Hence the quality of ground water in the coastal belt is negatively impacted by saltwater intrusion, which is a major issue worldwide. Groundwater resources can aid in resolving the issue of seawater intrusion, which is a significant concern in coastal areas. SWI is caused when the ground water supply is depleted as a result of excessive pumping or exploitation. It is critical to preserve natural resources against anthropogenic activities as well as natural events such as natural disasters, climate change, sea level rise, and so on. Researches throughout the world are contentiously putting lots of efforts to address salt water problem, studies are being conducted to address the seawater intrusion, and most projects dealing with groundwater development, preservation, and remediation today include various types of groundwater modelling. The coastal belt of the Mangalore region, India, underwent modelling using Visual MODFLOW Flex as part of the study that was concerned with future developments in modelling of seawater and fresh water interaction. It was used to detect seawater intrusion and vulnerability of the model using Visual MODFLOW Flex, a GUI that combines SEAWAT, in order to simulate SWI in the study area. The groundwater modelling tool is an important structural tool for solving many groundwater-related problems. Hence it was possible to explore inside and outside the model by building a model utilizing hydro-geological parameters and fictitious valves. This study describes the use of Visual MODFLOW flex and the selection of the best flow and transport engines for building models. These engines were chosen after careful consideration of the operating theory and engine application that it uses for SWI simulations. It also provides considerable information about those topics using actual field data. The model output takes into account variations in workflow, concentration, and density; it produced BMP maps and predicts both observational values and model predictions. The difference in contours also used to define the intrusion levels in the coastal belt and along the estuaries of the study area. Consequently, the study addressed groundwater quality, coastal aquifer characteristics, model use and calibration, in addition to validation and future prediction.

Keywords: Seawater Intrusion, Groundwater, Water quality index, conceptual model, Visual MODFLOW Flex.

Role of Approach Channel Leading to Harbour in Natural Wave Energy Attenuation – A Case Study

Sudheer S. Chavan [1*], M.D. Sawant [2], Dr. Prabhat Chandra [3]
[1]Scientist 'C', [2]Assistant Research Officer,
[3]Additional Director Central Water &Power Research Station, Khadakwasla, Pune, 411 024, India
*sudheertask@rediff.com

Abstract

The approach channel or navigation channel leading to harbour from offshore has significant impact on manoeuvring operations of ships as well as on wave pattern / conditions at entrance of the harbour. The layout of an approach channel has gained prime importance since large capital dredging is involved which affects the cost economics of any port or harbour. The harbours located on an open cost are subjected to severe wave actions particularly during the monsoon season. The wave conditions inside the harbour, in the turning circle and at the entrance need to be within certain permissible limits to facilitate smooth berthing and manoeuvring operations. The impact of approach channel and other structures on wave conditions and patterns must be properly studied by using suitable modelling technique. Physical wave models or small scale models are convenient tools of predicting full scale performance and help in better visualization and measurement of the effects of interactions of complicated wave patterns at the entrance and structures like berths, jetties etc. located inside the port area. The present study describes the role of approach channel in natural wave energy attenuation by using physical model for the case study of proposed Gateway Port at Kakinada under Kakinada SEZ in Andhra Pradesh. The layout of Gateway port consists of two breakwaters; North or lee breakwater 570m long and South or main breakwater 2670m long protruding in a depth of about (-) 9.0m to (-) 11.0m. The proposed approach channel is 250m wide and 4km long leading upto (-) 20.2m depth contour offshore. The alignment of approach channel in almost parallel ENE direction and it changed towards SE direction at 1.2km from the tip of port breakwaters. The physical wave model studies were conducted at CWPRS by using a geometrically similar rigid bed model (Scale of G.S. 1/150) . The physical wave model consists of a three dimensional model tray shallow wave basin equipped with the Random Sea Wave Generation (RSWG) facilities with SCADA control and multi-channel data acquisition system. The physical wave model studies were conducted for three most predominant wave directions viz. and ENE (Hs = 1.5 m, Tp = 12 sec), East (Hs = 2.0 m, Tp = 12 sec) and SE (Hs = 3.5 m, Tp = 12 sec). The large dredged depth of the channel and its width as well as channel curvature slopes etc. have contributed significantly in wave height attenuation at the harbour entrance of more than 50% for the predominant directions.

Keywords: Random sea wave, harbour, breakwater, jetties, berths, wave reflection, wave diffraction, Shoaling, wave attenuation.

Importance of Hydraulic Model Studies for the Development of RO-RO Passenger Terminal in a Creek

R.K. Chaudhari[1], S.K. Kori[2], and Dr. Prabhat Chandra[3]
[1]Scientist 'C', CWPRS, Khadakwasla, Pune, India -411024
[2]ARO, CWPRS, Khadakwasla, Pune, India -411024
[3]Additional Director CWPRS, Khadakwasla, Pune, India -411024
*rajeev_cwprs@yahoo.co.in

Abstract

Prevailing waves, currents, tides and littoral drift at site play essential role for development of passenger terminal in the coastal region. The passenger terminal primarily needs sufficient depth along the harbour and enough wave tranquillity for embarkation and disembarkation of the passengers and goods. It should also be ensured that the proposed site should not be highly affected by littoral drift to avoid the frequent dredging. In present paper, the studies carried out for development of Ro-Ro jetty at Revdanda Tal. Alibaug, Dist. Raigad, Maharashtra in the vicinity of the Mumbai are presented. The hydraulic model studies to assess the wave tranquillity and littoral drift have been carried out using numerical models. The simulation with existing condition indicated that the significant wave heights at jetty would remain in the range of 0.2 to 0.4m for all predominant wave directions which are within the permissible limit of 0.40m. Littoral drift studies indicate that net transport in a year is of the order of 0.062 million cum and is towards South and gross transport is of the order of 0.11 million cum. In order to minimize sedimentation in the harbour area, a shallow breakwater of 510m was proposed mainly to avoid bypassing of littoral drift in the channel and in the harbour area. The studies also indicate that the shoreline would become stable after 4 years.

Keywords: Wave tranquillity, Mathematical model, RO-RO terminal, Littoral drift, Significant Wave Height.

Re-engineering the Fishing Harbor Through Numerical Modelling Technique

Dr. Prabhat Chandra[1], R.K. Chaudhari[2*], S.K. Kori[3]
[1]Additional Director', CWPRS, Khadakwasla Pune, India -411024
[2]Scientist 'C', CWPRS, Khadakwasla, Pune, India -411024
[3]ARO, CWPRS, Khadakwasla, Pune, India -411024
*rajeev_cwprs@yahoo.co.in

Abstract

The basic requirement for development of a fishing harbour is that the adequate wave protection should be obtained at the berths and entrance. It is noticed that many fishing harbours especially in southern coastal states where wave attack is more severe, have been facing serious manoeuvring problems at the entrance. As a result, the accidents took place and the vessels have been found to capsize frequently with loss of lives. This hazardous event can be stopped by using suitable modelling techniques to provide required wave protection at entrance. In the present paper, the case study of re-engineering a fishing harbour in Then gapattinam situated in Kanniyakumari district of Tamil Nadu State of India has been discussed. Presently, the fishermen are facing the difficulties to operate their vessels near to harbour entrance due to the high and broadside wave actions and accidents have been reported. To avoid this situation, re-engineering solution had been suggested by using mathematical model studies for wave tranquillity. The studies were carried with various layouts of the fishing harbour in order to provide the tranquillity at the harbour entrance well below 1.0m especially for the waves incident from the south direction. Considering the safe wave tranquillity limit inside the harbour as 0.30m and 0.80m at the entrance, a layout was evolved at CWPRS with 642m total length of the western breakwater extended upto (-)12 m which would provide sufficient tranquillity inside the harbour as well as at entrance of harbour for entire year. As per the shoreline changes studies, it is indicated that the impact of proposed extension of the modified layout would be negligible on the shoreline.

Keywords: Mathematical model, Fishing harbour, Wave tranquillity, Breakwater, Layout

Design of Breakwaters for the Development of Fishery Harbour at Arjipalli (Gopalpur), Odisha

Uday B. Patil[1*], A.V. Mahalingaiah[2], Ganesh N. S.[3]
[1] Scientist 'C', Central Water and Power Research Station, Khadakwasla, Pune 411024, India
[2] Scientist 'E', Central Water and Power Research Station, Khadakwasla, Pune 411024, India
[3]Research Assistant, Central Water and Power Research Station, Khadakwasla, Pune 411024, India
*udaybpatil@gmail.com

Abstract

In order to achieve tranquil conditions in the harbour against the waves, the flexible rubblemound breakwaters are required to be provided. Design of flexible rubblemound structures is complex as it involves various aspects such as complex wave-structure interaction, interlocking characteristics of armour, friction between armour and secondary layer etc. Several empirical formulae such as, Hudson formula and Van der Meer formula are available for preliminary or conceptual design of unit weight of armour. It is a universal practice to finalize the section of breakwater based on hydraulic model tests in wave flumes / wave basins to confirm the conceptual design evolved using empirical methods. The hydraulic model tests are essential to simulate the complex wave structure interaction as well as correct prototype site conditions of seabed slope, water level etc. which can be simulated in the wave flume or wave basin. These physical models are constructed to a Geometrically Similar (GS) scale and are based on 'Froudian' criterion of similitude. The conceptual design of breakwater cross-sections for the development Fishery Harbour at Arjipalli (Gopalpur), Odisha, India was evolved and confirmed its hydraulic stability through wave flume studies. The layout of two breakwaters consist of South breakwater of 756 m length extending up to -8.0 m sea bed level and East breakwater of 1242 m length extending up to -6.0 m sea bed level having an approach channel with clear width of 80 m in between the breakwaters. The maximum significant wave height (Hs) of 5.85 m for 50 year return period and Design Water Level (DWL) of +4.32 m was considered for the design of breakwaters. The design of cross sections of trunk portion consists of 2 t, 4 t and 12 t tetrapods in the armour layer with 1:2 slope on sea side and 1 to 2 t stones in the armour with 1:1.5 slope on lee side. The roundhead portion of breakwater consists of 15 t tetrapods in the armour with 1:2 slope on both the sides. The hydraulic stability tests were conducted in the wave flume by reproducing the sections to a Geometrically Similar (GS) model scale of 1:40. The hydraulic stability of the breakwater cross sections has been confirmed through the wave studies for significant wave height of 5.85 m (Hs) at Design Water Level (DWL) of + 4.32 m. In this paper the design of breakwater for the development of fishery harbour at Gopalpur has been descried in detail.

Keywords: Armour unit, Breakwater, Breaking Waves, Wave Flume, Tetrapods, Geometrically Similar.

Factors Influencing Changes in Estimates of Surges due to Cyclones

B. Gopikrishna[1]*
[1]Central Water and Power Research Station, Pune, India
*bgk9@yahoo.com

Abstract

Tropical cyclones are considered as one of non-nuclear natural hazards. They pose major threat to lives and properties due to their extreme winds developed by low pressure system followed by abnormal rise in sea level, rainfall, extreme flooding. Cyclones imposed surges and their analysis is the prerequisite for planning and designing of any coastal structure for arriving reliable estimates on safe grade elevation especially for nuclear power plants. Understanding the impacts of changes over an area in terms of frequency and intensity of cyclones has gained importance now a days for any development activity along the coast. Hence, the appraisal of causal factors in bringing about changes in surge magnitudes is inevitable. The study aimed at estimating the surges at a location 12 nautical miles from the main sea in Thane creek by analysing different cyclones for different parameters like size, intensity, speed, angle of approach, proximity of landfall, phase of tide at the time of occurrence of cyclones. The study also deals with the impact factors for the attenuation of wave energy nearby coastal site using high resolution grids. A nested model using Mike software has been developed and validated against existing and known cyclone conditions. A wind tool of Mike software was used for generating the gradient winds as an input to the fully deterministic model for estimating the surges. The model results revealed that the direction of approach played a major role in elevating the surge and manning's roughness in attenuating the wave energy.

Keywords: cyclones, angle of approach, intensity, gradient winds, landfall, pressure.

Ship Motion Analysis for Three Types of Ships using OPTIMOOR at Mus

Komal S. Vighe[1*], J. Sinha[2]
[1]ARO, Central Water &Power Research Station, Pune, India
[2]Scientist 'E', Central Water & Power Research Station, Pune, India
* ks.vighe@gmail.com

Abstract

The shipping industry has always been concerned with safe mooring practice. Fundamental aspect of this concern entails the development of mooring systems that are adequate for the intended services, with maximum integration of standards across the range of ship types and sizes. Studies for selection of fender system and ship mooring analysis considering environmental factors for ships calling at Mus are described in this Paper. Geographical location of Car Nicobar Island is strategically important. Mainland ships and inter-island ships call at Car Nicobar regularly. In order to provide permanent harbor facilities at Car Nicobar Island, a harbor at Mus catering for inter-island ships consisting of 490 m long breakwater with a 90 m long wharf on its lee side was constructed. For improvement of the harbor facilities for mainland ships, Andaman & Nicobar Administration has a proposal of extension of existing breakwater, construction of a 200 m wharf along the shore and an extension of existing 90 m long wharf by 45 m at Mus harbor. Ship mooring analysis to examine the behaviour of moored ships at both the Wharves at Mus carried out by Software OPTIMOOR for MV Nicobar (132 m LBP), MV Kalighat (78 m LBP) and MV North Passage (35 m LBP).

Keywords: Ship mooring, Fender, Island

Underwater Controlled Blasting for Rock Excavation During Deepening & Widening of Jawaharlal Nehru Port Channel, Mumbai, Maharashtra

Vijay_Ghodake[1*], Prakash Palei[1], Santhosh Kumar[1], Varsha Jain1 & Rizwan Ali[1]
[1]Central water and Power Research Station, Pune- 411 024
*ghodake_vk@cwprs.gov.in

Abstract

Vibrations generated and propagated by blasting, power generating equipment's, movement of heavy vehicles, etc. or natural vibrations generated due to earthquake, tsunami etc. affect the natural echo-system and biodiversity. Environmentalists, different NGOs, local population etc. are often fearful about the ill effects of vibration generated due to blasting carried out for large and mega power projects as the same is associated with undesirable outcome in terms of ground vibration, fly rock, air blast and gases. Apart from surface blasting, underwater blasting is associated with two major unwanted effects such as ground vibration and under water pressure development having potential to cause damage to the nearby civil structures viz. ports and harbours, historical monuments and biodiversity. However, adverse effects of underwater blasting can be minimized by suitable design of blasting pattern which includes hole size (diameter and length), burden, spacing, stemming length, selection of explosive, maximum amount of charge per weight and delay detonators. In the present paper, methodology of underwater controlled blasting has been used for the deepening and widening of the navigational channel of Jawaharlal Nehru (JN) Port Channel, Mumbai providing protection to the nearby important structures including Elephanata Caves, as well as ensuring the safety of aquatic creatures around the blasting zone. Since, Elephanta Caves are the historical monuments recognized as the World heritage, a highly conservative safety criteria has been adopted to safe guard the caves from the unwanted effects of blasting. The excavation work has been successfully completed without endangering the safety of these structures and aquatic life.

Keywords: Controlled Blasting, Charge per weight, Environmental Impact, Vibration, Peak Particle Velocity, Safety criteria.

Assessment and Prediction of Shoreline Change along the Kozhikode Coast, Kerala, India

Saikrishnan K, K. V[1*], Anand & Agilan V.[1]
National Institute of Technology Calicut, Kozhikode, India
*saikrishnank18@gmail.com

Abstract

Coastlines in the world are dynamic, where shoreline change occurs due to various natural and anthropogenic factors. Accurate shoreline data is required to design coastal protection structures, identify vulnerable areas, and for coastal developmental plans. Erosion has been a major hazard along the coast of Kerala since the last century. As the population near the coastal areas increases daily, assessment and forecasting shoreline changes are essential for effective protection plans. In the present study, shoreline assessment for 33 years (1990 - 2022) and forecasting of future shorelines is carried out for the Kozhikode coast, located in the northern part of Kerala. The Digital Shoreline Analysis System (DSAS) is used for shoreline assessment and prediction. Satellite images from Resourcesat 2, Cartosat 1, Landsat 5 and 8 are used in the study. The maximum likelihood supervised image classification technique is used to classify land and water to obtain the shoreline and the accuracy of the extracted shoreline is tested by comparing it with measured data for the same period. The shoreline change rate for 33 years is calculated using the End Point Rate (EPR) and Linear Regression Rate (LRR) methods in DSAS. Based on the shoreline change rates values obtained from DSAS analysis, the location is classified into seven classes (very high, high, moderate erosion, stable, moderate, high and very high accreting coast). The results show a maximum erosion rate of 8.35 m/year and similarly maximum accretion rate of 5.9 m/year. The forecasting for the next 20 years has been done using a validated Kalman filter model. The results show that 30% of the coastal length is estimated to be under very high and high erosion by 2042 in Kozhikode district.

Keywords: End Point Rate, Linear Regression Rate, Prediction, Shoreline change, DSAS.

Assessment of Spatial Dependence in Significant Wave Height over the Indian Ocean

Dhanyamol.P[1*], Agilan.V.[2] & K.V. Anand[3]
National Institute of Technology, Calicut, Kerala, India
*pdhanya25@gmail.com

Abstract

The information regarding the spatial dependence of met-ocean conditions is important in the reliable design of coastal structures and various marine engineering activities. The significant wave height is one of the most important wave parameters for coastal and offshore structural design. Climate change and various climate variabilities are expected to change the various met-ocean parameters at global and regional scales. The current study aims to investigate the spatial dependence in the significant wave height over the selected domain (latitude ranges from 9ºN to 25ºN and longitudes range from 40ºE to 105ºE) of the Northern Indian Ocean. Wave time series data during the period 1979-2022 from the global atmospheric reanalysis ERA-5 by European Centre for Medium-Range Weather Forecasts (ECMWF) is used for this study. The collected wave data have a spatial resolution of 0.5° longitude ×0.5° latitude and a temporal resolution of 6 hours. From the collected wave data, the seasonal (DJF-MAM-JJA-SON) maximum and annual maximum data series of significant wave height is extracted for the past 44 years (1979-2022). The spatial dependence assessment is carried out for the four seasons (DJF-MAM-JJA-SON) and the annual data. Three correlation methods, namely, Variogram analysis, Cross-correlation techniques, and Global Moran's method, are used for the spatial dependence analysis. The correlation methods are used to characterize and visualize the spatial clustering or dispersion in the selected domain. The analysis results indicate that there is a clustering in significant wave height over the selected domain of the Northern Indian Ocean.

Keywords: Cross-Correlation, Global Moran's Analysis, Indian Ocean, Spatial Dependence Assessment, Significant Wave Height, Variogram Analysis.

Studies on Protection of Coastal Road along Chennai, India

P K Suresh[1], R Sundaravadivelu[2], Nilanjan saha[2], V. Ponraj[3], C Prabakar[4], D Diwakar[4] [1]Meenakshi Sundararajan Engineering college, Chennai, India
[2]Indian Institute of Madras, Chennai, India.
[3]Water Resources Department, Chennai, India
[4]Institute of Hydraulic & Hydrology, Poondi, India
* collegemsec@gmail.com

Abstract

The Northern Coast of Chennai was under heavy threat of erosion. The coast is having lot of engineering Industries, Tamil Nadu electricity plant, housing colonies and road connecting Ennore port. The coast is located North of Chennai Port trust. The initial erosion for a length of 8km was controlled by constructing sea wall and groin field. After that again erosion was noticed further north of Chennai harbour (13° 6'58.24"N, 80°17'59.97"E). The coast is having an estuary far North. The newly constructed Ennore port (13°15'54.94"N, 80°20'10.50"E) is located further north of estuary. Coast is influenced by South West monsoon (June to September) and North East monsoon (October to December). Detailed studies including secondary data desk studies, Satellite imageries, Wave climate and numerical model studies were carried out. The analyses of wave climate indicate the waves approach from south east most of the time. During North East monsoon the waves approach from North East direction. Mike21 numerical model was adopted for study. The desk studies indicate that along shore sediment is predominantly towards North. Based on the preliminary studies, short groins of nineteen numbers were proposed. The net littoral drift that is expected along the coast based on is about 0.35 Mm3. The details of proposed groin field and post observations were discussed in detail.

Keywords: Erosion, Ennore, MIKE21, Numerical modelling.

Numerical Modelling of Hydrodynamics in Gulf of Khambhat

Aruna Kumar Avula[1*], M.G. Muni Reddy[2], M.V. Ramana Murthy[3], & B.K. Jena[4]
[1]Research Scholar, Department of Civil Engineering, Andhra University, Visakhapatnam, India
[2]Professor, Department of Civil Engineering, Andhra University, Visakhapatnam, India
[3]National Centre for Coastal Research, Chennai, India
[4]National Institute of Ocean Technology, Chennai, India
*arun.aak@gmail.com

Abstract

The Gulf of Khambhat is a bay located on the Arabian Sea along the West coast of India bordering the states of Gujarat and Maharashtra. The northern most part of Gulf of Khambhat experiences high tidal range of 13m comparable to that of Bay of Fundy. In this study we discuss about the two-dimensional numerical model for the Gulf of Khambhat that has been developed using Delft3d flow module to understand the dynamics of complex tidal regime. The model domain extends from latitude 18.2333 N to 22.4333 N and longitude to 69.6833 E to 73.0666 E and covers an area of approximately 1300 square km. The model has been forced at the open boundary (mouth of the Gulf) with tidal constituents extracted from the TOPEX/Poseidon 7.2 Global Inverse Tidal Model at the open boundary. Sensitivity analysis has been carried out for manning roughness coefficients with different resolutions of grid to achieve a precise calibration. The hydrodynamic model has been calibrated against observed water levels, currents for the spring and neap tidal cycles of monsoon and non-monsoon seasons. Model is also validated with observed currents and drogue paths. Computed water levels in the Gulf of Khambhat at locations Diu, Dahej, and Nirma showed good agreement with the observed water levels during both the monsoon and noon monsoon seasons. Similarly, computed currents in the Northern Gulf at Adhelai, Dadar, and Narmada showed good agreement with the observed current speeds during both the monsoon and non-monsoon seasons.

Keywords: Gulf of Khambhat, numerical model, hydrodynamics, tides, currents, roughness.

Assessment of Comprehensive Physical and Socio-economic Vulnerability in an Indian Coastal Floodplain

Vineetha Putta[1,2], Vineela Nandam[2*] & Patel P L[2]
[1]Tata Consulting Engineers Limited, Bangalore, India
[2]Sardar Vallabhbhai National Institute of Technology,
*d18ce004@ced.svnit.ac.in

Abstract

Coastal regions play a pivotal role in a nation's economic development, driving population migration towards growing coastal hubs. However, human interventions in these ecosystems increase coastal vulnerability. The Surat city faces a high flood risk due to the combined impact of tidal surges from the Arabian Sea and the floodwaters discharge from the Tapi River. This study evaluates the integrated coastal vulnerability of a 52 km estuarine stretch located close to Surat city by considering both physical (9) and socio-economic (5) indicators. Weights for the indicators are determined using the Analytic Hierarchy Process (AHP), which incorporates expert judgment. Further, spatial variation of the calculated vulnerability is determined using Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS) approach. In terms of physical parameters, landform geomorphology, coastal slope, elevation, and shoreline change rate (SLR) are weighed more important, while port-activity and population density are ranked to be most important among socio-economic indicators. Through SLR analysis, using Liner Regression Rate (LRR) a significant amount of up to 88.84% erosion and 11.16% deposition occurred during a span of 30 years, i.e., from 1990 to 2020. The average rate of erosion was found to be -13.95 m/yr, whereas the average rate of accretion is 24.39 m/yr. High erosion rates are observed along most of the coastal stretch considered, whereas deposition is predominant at the confluence of Tapi river and the Arabian Sea. The integrated vulnerability reveals that approximately 68% of the area falling within 7 km along coastline which includes nearly 35 villages are under very highly vulnerable zones. This work can assist coastal management authorities in implementing essential preventive measures to mitigate risks effectively.

Keywords: AHP, Integrated Coastal Vulnerability, Shoreline change rate, Surat city, TOPSIS.

Unravelling the Complexity of Turbulent Flows Driven by Waves

Vikas Kumar Das[1, *], Bellie Sivakumar[2], Koustuv Debnath[3], Susanta Chaudhuri[4]
[1]Department of Earth & Atmospheric sciences, NIT Rourkela, Odisha, India- 769008
[2] Department of Civil Engineering, Indian Institute of Technology Bombay, Powai, Mumbai, Maharashtra 400076, India
[3]Department of Aerospace Engineering and Applied Mechanics, Indian Institute of Engineering Science and Technology, Howrah, India
[4]Department of Geological Sciences, Jadavpur University, Kolkata - 700032.
*k.d.vikas5@gmail.com

Abstract

The interaction of waves and currents in coastal zones is a critical factor in the design of coastal protection and harbor sheltering structures. This study aims to explore the complexity and chaotic nature of wave-dominated turbulent flows by introducing the concepts of chaos theory. The experiments are conducted in a laboratory flume, with two separate tests carried out: a steady flow test and a test with the addition of waves to the steady flow under identical flow conditions. Two chaos theory-based methods are used to examine the complexity and chaotic nature of the wave-current dynamics: The False Nearest Neighbor (FNN) method and the Lyapunov Exponent method. These methods are complemented by the wavelet, power spectral density, and Shannon entropy methods, which are employed to verify and interpret the results from the chaos theory methods. The results from the chaos theory methods suggest that there is positive evidence of the existence of chaotic behavior in the combined wave-current flow. The complexity is found to be greater at the near-bed region with an aperiodic nature of the eddy scales. The complexity decreases when moving towards the near-surface flow region, indicating that the turbulent flow structure is less complex at the surface. The complexity for the steady flow case is high, and it decreases with the addition of the waves. The reduction in complexity is more pronounced with an increase in the wave frequency. This is because the introduction of waves results in highly ordered and organized turbulence scales, as observed from the Shannon entropy values. Observations from the wavelet and spectral analysis show the presence of isotropic and homogenous turbulence structures at the near-surface flow region, suggesting the presence of periodic and organized flow structures. The results demonstrate that the addition of waves to the steady flow alters the turbulence characteristics of the flow and introduces periodic and organized flow structures. The implications of these findings are significant for wave dynamic monitoring, modeling, and forecasting. This study provides insights into the complexity and chaotic nature of wave-dominated turbulent flows, which are essential for proper design and management of coastal protection and harbor sheltering structures. In conclusion, the study introduces chaos theory concepts to examine the complexity and chaotic nature of surface-generated waves in comparison to steady flow states. The results demonstrate that the addition of waves alters the turbulence characteristics of the flow, resulting in periodic and organized flow structures. The findings have important implications for wave dynamic monitoring, modeling, and forecasting, providing a foundation for improved design and management of coastal protection and harbor sheltering structures.

Keywords*:* Surface wave dynamics; Turbulence; Nonlinear dynamics; Chaos theory; False nearest neighbour; Lyapunov exponent

662 Rehabilitation and Strengthening of Damaged Breakwaters along the West Coast of India

Aruna Kumar Avula[1], Abhishek Tavva[1*], Shyamala Varthini [1], D. V. Srinath Reddy[1] Purnima Jalihal[1] & B.K. Jena[1]
[1]National Institute of Ocean Technology, Chennai, India
*abhishek.niot@gov.in

Abstract

Breakwaters are used in Ports & Harbors to create tranquil conditions for safe mooring of vessels and protection of harbor infrastructure. They are also used to regulate sedimentation and improve maneuvering condition for vessels at Harbor entrances. The functionality of the Breakwaters is achieved by attenuation of wave action on the leeside. However, the serviceability of the Harbor is lost when the Breakwaters are damaged. During Monsoon of 2022, the breakwater of a fishery harbor along the West Coast of India was damaged at the junction of Trunk & Head section. This paper provides an overview of how recent advances in technology have been applied for field investigations and model studies to assess the damage and combined with design for rehabilitation and strengthening of damaged breakwaters.

To identify the causes of failure, field investigations and review & analysis of designs & data was carried out. Field investigations involved vertical control surveys, water level measurements, aerial topography, 3-D underwater imaging of the breakwater and its surroundings etc. A review of geotechnical investigations, oceanographic data, seabed engineering investigations and breakwater design was carried out. Underestimation of wave loading, insufficient crest level and deviation in design were identified as causes of failure of the Breakwater. Since the demolition and reconstruction of the breakwater is not economical, the cross section of the breakwater was first designed as per site conditions. This was followed by strengthening of the existing breakwater to meet the site conditions. Laboratory tests were carried out to validate the designs.

Keywords: Damaged Breakwater, Breakwater Rehabilitation, Breakwaters Design

Determination of Crop Water Requirement and Irrigation Scheduling for Veraval Region Using CROPWAT 8

Paresh Ahir[1], Dinesh Dolasiya[1], R.K. Jain[1], M.M. Shaikh[1], Sudhanshu Dixit[1]
[1]L.D. College of Engineering, Ahmedabad, Gujarat, India
*pahir746@gmail.com

Abstract

In order to maximize agricultural output and water resource management, it is essential to determine the crop water requirements and implement the proper irrigation timing. We concentrated on groundnut farming in this study since it is a significant oilseed crop that is planted extensively in Gujarat regions. The goal was to provide an effective system for calculating the water requirements of groundnut crops and creating an appropriate irrigation schedule to satisfy those demands. The Food and Agriculture Organization's (FAO) CROPWAT 8 Software is used in this study, which focuses on groundnut farming, to calculate crop water needs and plan irrigation schedules for groundnut crops. The FAO Penman-Monteith approach is used by the CROPWAT 8 software to estimate reference evapotranspiration (ETo) based on weather variables. 80% of critical soil moisture depletion was considered for irrigation. The model predicted the daily, decadal as well as monthly crop water requirement at different growing stages of Groundnut crop. The simulation results analysis suggests that crop water requirement of Groundnut (kharif) crop is 391.3 mm and irrigation requirement is 123.9 mm. crop water requirements of the Groundnut (Rabi) crop is 391.3 mm/dec and irrigation requirement is 387.9 mm/dec. Considering the above findings it was suggested to use the CROPWAT 8.0 model to predict the crop water requirements for different crops.

Keywords: Crop Water Requirement, Irrigation Scheduling, CROPWAT 8.0

Comparative study of Pressure and Demand Driven Approach in Water Distribution System using EPANET and ML

K.V. Shah[1*] & H.M. Patel[2]
[1]Faculty of Technology & Engineering, The Maharaja Sayajirao University of Baroda, Vadodara, India
[2] Faculty of Technology & Engineering, The Maharaja Sayajirao University of Baroda, Vadodara, India
*kushang.shah.6014@gmail.com

Abstract

Current practices focus on the advancement of water distribution systems, where data-driven approaches are developed for anomaly detection, valve operations, zoning, and sensor placement strategies. A study was conducted to develop a hydraulic model which tests against pressure and demand-dependent techniques in EPANET which targets the required pressure allocations during peak demands. The development of a hydraulic model consisting of an existing water distribution network of a town planning scheme of Vadodara city resembles a real-time scenario of intermittent water supply where consumers can ensure full demand during peak hours by managing the required pressure in the system. The system also reflects the observations of partial demands for water losses from joints, valve operations, open tapping points, and trials during non-supply hours. This resemblance is created by providing controls in EPANET in test scenarios of the Pressure Driven Approach (PDA) and Demand Driven Approach (DDA) to ensure the demand delivery at nodes and examine the capabilities to simulate the water distribution system. The study also aims at the significance of PDA over DDA. The outcome of the comparative study provides the background of decision support systems, clustering, and pattern-recognizing strategies as the study resembles the real-time scenario of an intermittent water supply system. Simulation results are treated for the classification of demand-based pressure zones using the clustering technique of Machine Learning (ML).

Keywords: Classification, Demand Driven Approach. EPANET, Machine Learning, Pressure Driven Approach, Water Distribution System

An Intensified Search Metaheuristic: The Krill Herd Algorithm for Optimal Design of Medium-sized Hanoi Water Distribution Network

S. N. Poojitha[1], V. Jothiprakash[2*]
[1]Post Doctoral Student, Department of Civil Engineering, Indian Institute of Technology Bombay Powai, Mumbai, Maharashtra, India – 400076; Email: pooji.pujitha@gmail.com
[2]Professor, Department of Civil Engineering, Indian Institute of Technology Bombay Powai, Mumbai, Maharashtra, India – 400076
*vprakash@iitb.ac.in

Abstract

The water distribution network (WDN) is an essential civic infrastructure to distribute potable water from elevated or ground service reservoirs to communities. The key hydraulic component, the network pipes, accounts for significant financial investment in designing the WDN. Enormous research has been conducted for the optimal design of network pipes, proposing various optimization algorithms to minimize their investment cost. Nevertheless, concerning the WDN design complexity that increases with the number of design variables, the research momentum in recent decades has been toward formulating a computationally efficient nature-inspired metaheuristic algorithm that efficiently solves the real-scale WDNs. The present study demonstrates the application of recent swarm-intelligence innovation, the krill herd algorithm (KHA), examining its computational efficiency in designing a medium-sized network.

Krill is a small marine animal of 30 to 50 mm familiar for its under-dispersed grouping actions, a non-random phenomenon. Inspired by this interesting natural process, *the herding behavior of krills*, the search strategy of KHA is formulated. It is a multi-objective process searching through the search space for optimal solutions with an intensified search around better solutions. For this reason, the study considers the fine-tuned KHA (FIT-KHA), the advanced version of KHA, for designing the medium-sized WDN, the Hanoi network (HN) in Hanoi city. HN is one of the widely-studied WDNs with three loops structured with thirty-four pipes interconnected by thirty-two nodes. With thirty-four pipes as design variables and each having six available commercial diameter options, the number of design possibilities for HN is 6 34 (2.865 × 10 26). Though it is a medium-sized network, it is familiar as a complex problem with many locally optimal solutions.

For optimally designing HN, the sensitivity analysis is initially performed to evaluate the optimal values for control parameters of the FIT-KHA model. From the sensitivity analysis results, a

minimum population size (P_S) of 1,000 is essential for an adequate and efficient search through the search space of HN. With a P_S of 6,000 and a maximum iteration size ($I_{s,max}$) of 500, the FIT-KHA model converged to the pipe investment cost of 6,148,884 units. It is the lowest possible optimal cost located by the FIT-KHA model for HN of all the P_S varied from 1,000 to 10,000. Increasing $I_{s,max}$ beyond 500 by allowing the population members to evolve further is found not beneficial. Moreover, the computational results manifest that even after a long stretch trap at the same solution, the FIT-KHA model exploits the available information and locates the best possible solutions at the following immediate iterations. This ability of the FIT-KHA model highlights its extraordinary exploitation feature, one of the essential characteristics of the metaheuristic algorithms. Therefore, though the algorithm did not converge to the best cost found to date (6,081,564 units), the results signify the excellent intensified searchability of the FIT-KHA model. Nonetheless, the results also highlight the need for diversified search features of the FIT-KHA model for better solving complex search spaces of the WDN design problem.

Keywords: Hanoi Network; Krill herd algorithm; Optimal design; Water distribution network

Hotspots identification of critical elements of Urban Drainage network using MIKE URBAN

Divyanshi Pandey[1*] and K. K. Singh[1]
[1]NIT Kurukshetra, Kurukshetra, India
*divyanshi1504@gmail.com

Abstract

In recent years, climate change and urbanization have become major concerns for developing countries, and this will continue to exacerbate in the future. It has triggered abundant challenges, among which urban flooding is becoming one of the most important challenges. In this study, the impact of extreme rainfall on the urban drainage systems is analysed through a case study of Rohtak City in Haryana, India. For the study, MIKE URBAN one-dimensional hydrodynamic and rainfall-runoff model was adopted. The main objective of the study is to assess urban flood vulnerability zones, and to identify individual hotspot nodes which causes flooding. The extreme rainfall event of July 2022 was retrieved from India-WRIS and incorporated into MIKE URBAN as a time-series for the simulation of the rainfall-runoff. The hydraulic parameter used was the water level in nodes and pipes, which was used to determine the hydraulic capacity of a drainage system. The simulation results indicate that the city's drainage system became hydraulically inefficient in dealing with the extreme rainfall events that caused urban flooding. For the studied drainage system, 33 overflooding nodes, 116 pressurized links and 13 critical catchments were found to be vulnerable. Remedies to this drainage failure could be either redesigning the drainage system or designing some sustainable detention pond that could serve the purpose.

Keywords: Urban flooding, MIKE URBAN, Modelling, rainfall-runoff, flood vulnerability zones

Transition to Regional Hydrology for Road Bridges

Sudesna Biswas[1], Satesh D. Rahatwal[2*], Nayana D.[3]
[1]Head, Hydrology, TI IC, Larsen and Toubro
[2]Sr. Engineering Manager, TI IC, Larsen and Toubro
[3]Sr. Design Engineer, TI IC, Larsen and Toubro
*rahatwal@lntecc.com

Abstract

In road infrastructure networks, bridges and other cross-drainage structures form the critical link in terms of connectivity. Bridge hydrology plays a significant role in determining the levels and spans of these connecting structures, with rainfall considerations forming the basis of any hydrology calculations. Climate change has induced a clear variation in rainfall patterns and thus, there is an increase in frequent flash floods at different parts of India, heavy rainfall with unanticipated filling and consequent upstream dam flood release, all these pose a threat to the existing road bridges. Bridges designed based on historical data may not be resilient enough to withstand the changing climate patterns, causing regional flood patterns making them more susceptible to failure. In recent years due to climate changes, the whole river basin experiences heavy rainfall rather than a localized area in the basin. Recent studies have shown that floods alone causes nearly 51.89% of bridge failures in India leading to a huge socioeconomic losses. Thus, the consideration of accurate hydraulic and hydrologic design parameters are important to ensure safety and serviceability. This calls for the need of evaluation of Regional Flood Hydrology, while fixing the design parameters of road bridges. Nowadays, study of watershed parameters, land use pattern, river morphology etc. can be done by using highly advanced, state-of-the-art technology, one of which is the available GIS tools, which aid in Regional Hydrologic modelling of the catchment, making use of satellite data. Flood modelling software are then used to obtain design discharge for the evaluation of high flood level (HFL) and scour. The flood maps for critical rainfall events obtained by hydraulic modelling give the maximum flow velocity, water surface elevation, flood depth etc. These parameters are then used for fixation of minimum soffit level of a bridge, highway Finish Road Level (FRL) and further, structural design. The values obtained using these tools incorporate a holistic approach and regional hydrology base and therefore more accurate in predicting the hydraulic and hydrologic parameters including HFL, which forms the basis for any bridge design. The design and analysis of road bridges in India, mainly follow IRC-5: 2015, MORTH guidelines and CWC flood estimation reports. As per IRC:5 recommendation, hydraulic and hydrologic parameters for bridge design, namely, discharge, waterway, scour, High Flood Level (HFL) at bridge location, afflux and scour depth, may be done using modelling tools for evaluation of design parameters for regional flooding conditions. Also, with the multiple modelling scenarios, providing outputs aimed at more accuracy and safety, and realistic project cost working, modelling tools are now evolving to be effective tools for regional flood assessments for hydrology experts. This paper gives an insight into the changing methodology of hydrologic and hydraulic design of road bridges, thereby emphasizing the importance and evolution of Regional Flood Hydrology over past years in road bridges designs.

Keywords: High Flood level(HFL),Design Flood, Regional hydrology

Leak Detection in Urban Pipe Networks

Akshay Ranjith[1,*], V.V. Srinivas[1,2,3] & Lakshminarayana Rao[2,4]
[1]Department of Civil Engineering, Indian Institute of Science, Bangalore 560012, India
[2] Interdisciplinary Center for Water Research (ICWaR), Indian Institute of Science, Bangalore 560012, India
[3]Divecha Center for Climate Change, Indian Institute of Science, Bangalore 560012, India
[4]Centre for Sustainable Technologies (CST), Indian Institute of Science, Bangalore, India
*rakshay@iisc.ac.in

Abstract

The transportation of potable and wastewater through pipelines has become an essential aspect of modern society. Pipelines offer significant advantages such as ease of continuous operation, high efficiency, automation potential, and low energy requirements. However, the risk of pipeline bursts or leaks poses a substantial threat, leading to potential disasters. Consequently, the detection and localization of pipeline leaks have become a critical concern. This paper presents a methodology to detect and locate leaks within urban pipe networks. Towards this, investigations were carried out on a lab-scale water distribution network that provides a controlled environment for introducing leaks at various points within the pipe network and analyzing the effect of demand nodes on leaks by collecting real-time data on multiple flow parameters. It also has provision to study the effect of different pipe materials (ductile iron, galvanized iron, and polyvinyl chloride) with multiple leak points in 100 mm nominal pipe diameter, which better depicts reality in real-world urban pipe networks. The facility experimentally simulates leaks and collects real-time data on various fluid parameters. A digital twin was constructed using EPANET and WaterGEMS software to create a realistic simulation of the pipe network. The lab-scale water distribution network, in combination with the digital twin, offered a comprehensive and high-quality dataset, enabling the development of a robust leak detection methodology for urban pipe networks. By analyzing this dataset, an algorithm was trained to identify and localize leaks within the network under various flow rates (Reynolds number) to demonstrate the algorithm's effectiveness in leak detection and localization.

Keywords: Leak detection, pipe network, digital twin, optimization, EPANET, WaterGEMs.

Deep Learning and its applications in Water resource: A literature review

P.S. Kulkarni[1*], S. N. Londhe[2] & P. R. Dixit[1]
[1]Vishwakarma Institute of Information Technology, Pune, India
[2]Vishwakarma Institute of Information Technology, Pune, India
*Preeti.kulkarni@viit.ac.in

Abstract

Water resources play a critical role in environmental, economic, and social sustainability. Efficiently harnessing and manging water resource can yield substantial benefits in many areas of flood risk mitigation, planning and design water systems etc. Data driven techniques have been used by many researches for the same in recent past. Recent advancements in computational technologies have created enthusiasm particularly for deep learning (DL), in Water resource. DL, which have strong capabilities for mapping highly nonlinear relationships with acceptable calculation speed, have been increasingly applied in the areas of water resource. A surge of application can be viewed in the area of streamflow forecasting and water quality determination using DL. However, a comprehensive literature of utilisation of DL in Water resource is seldom seen. The present review provides a comprehensive overview of the application of DL in water resource domain, covering developments from till 2022. An introduction to DL variants like the recurrent neural network (RNN) and long short-term memory network (LSTM) along with their applications in areas of Runoff prediction and flood forecasting, water level forecasting, rainfall forecasting, Water quality prediction /Management, Ground water level forecasting etc. are presented. The state of art review will be done with an emphasis on data acquisition, input data selection, data splitting and preprocessing, model selection, model training, and their performance assessment criteria for training and testing. Finally, the challenges and prospects of utilising DL in water resource will be highlighted. This review paper serves as a handy guideline for the researchers in the field of DL-based Water Management.

Keywords: Deep Learning, Water resource, Recurrent Neural Network, long short-term memory network

Applications for Water Resources Management in Foot-hill: A Comprehensive Review

Sagar Basumatary[1*], & Soumen Maji[1]
[1]Department of Civil Engineering, Central Institute of Technology Kokrajhar, Kokrajhar, Assam, India
*ph21ce1006@cit.ac.in

Abstract

Foothill hydrology refers to the study of water resources in hilly or mountainous regions where water supply and distribution are often impacted by complex terrain and weather patterns. Effective management and allocation of water resources require accurate and timely information about their availability and distribution. Geospatial applications have emerged as powerful tools in water resources management, providing crucial insights into water systems' spatial and temporal dynamics in foothill hydrology. It aims to bridge the gap between theoretical concepts and practical applications and emphasizes the acquisition of practical experience with software relevant to water resources engineering, enabling participants to make informed decisions and develop sustainable solutions. This review paper presents a comprehensive analysis of geospatial applications in the field of foothill hydrology, highlighting their contributions, advancements, and challenges. It also, explores various remote sensing platforms, such as a wide range of areas within water resources engineering, including watershed delineation, rainfall-runoff simulation, stormwater management, land use/land cover (LULC), satellite image processing, river profile study, and various water resource modeling. Furthermore, the integration of remote sensing with geographic information systems (GIS) facilitates the development of accurate water resource databases, enabling efficient decision-making processes. This review work provides a comprehensive analysis of geospatial applications in foothill hydrology water management, highlighting their transformative potential in addressing the challenges of water scarcity, and sustainable water governance. The findings of this review would serve as a valuable resource for researchers, policymakers, and practitioners involved in water resources management and planning.

Keywords: Water resources management, Geospatial applications, Remote sensing, Foothill hydrology, Geographic Information Systems.

An Assessment of Available Node-Head Flow Relationships for Pressure Dependent Analysis of Water Distribution Networks

Satyam Tiwari[1*], K. Sai Raj [2] & Rajesh Gupta [3]
[1]PhD Scholar, Department of Civil Engineering, Visvesvaraya National Institute of Technology Nagpur-440 010, India
[2] PG Scholar, Department of Civil Engineering, Visvesvaraya National Institute of Technology Nagpur-440 010, India
[3] Professor, Department of Civil Engineering, Visvesvaraya National Institute of Technology Nagpur-440 010, India
*dt22civ006@students.vnit.ac.in

Abstract

Pressure dependent analysis (PDA) is preferred over normal demand dependent analysis (DDA) to evaluate the performance of the network under pressure deficient conditions. The PDA requires a relationship, called node-head-flow relationship (NHFR) between available head and available flow at a node to know whether the demand is fulfilled completely, partially or not at all, depending on the available pressure. Several NHFRs have been suggested in the past. An assessment of these NHFRs have been made by considering some real-life networks, wherein demands of several consumers located at different elevations are lumped. Herein, the secondary networks of minimum pipe sizes taking-off from a node on the primary networks are analysed by considering different heads at the off-taking point and variation of total supply from the off-taking point is plotted against available heads considered at that point. This provided the actual variation and thus considered as the observed NHFR at the node of a primary real-life networks. Different NHFRs reported in the literature are then used to predict the outflow in secondary network at different available pressures. Evaluation of NHFRs is carried out by calculating errors in prediction using chi square for their effectiveness in prediction. It is observed that actual NHFR is not that smooth as the approximated by the different NHFRs. Nonlinear behaviour between available flows and available heads for partial flow conditions is observed to be the best in most of the cases with proper values of constants in defining NHFR. This assessment recommends consideration of different NHFR at different nodes of the primary network for PDA considering the nature of pressure requirement in secondary network of lumped demand nodes.

Keywords: NHFR, PDA, Secondary Network, Water Distribution Network.

Numerical Modeling of Longshore Sediment Transport and Associated Shoreline Change along the Subarnarekha Coastal Stretch, East-Coast of India

R. Prasad[1*], S. Arjun[1] & K. Ruchi[1]
1 Hatch Marine Consultants, Trivandrum, Kerala, India
*prasadnechikottil@gmail.com

Abstract

The management/development of any coastal zone needs a well-structured case study to estimate the longshore sediment transport (LST) and its associated shoreline change. In the present study, LST and shoreline change along the Subarnarekha coastal stretch, east-coast of India, has been carried out. Process-based numerical models are widely used to investigate the coastal processes responsible for the littoral transport, since a direct measurement/estimation of LST is very tedious. Here Littoral Processes FM (LPFM) of LITPACK (DHI's MIKE21), is used to numerically estimate the littoral transport and shoreline change along this coastal sector. The numerical modeling of LST is carried out by using Littoral drift module and long-term shoreline change by coastline evolution module of LPFM. The study shows that the annual net longshore transport (LST) is predominantly towards north, except for the post-monsoon months of November, December and January. The net transport is showing magnitude of -0.53 x10^6 m^3/year (-ve sign shows a northerly transport as per the sign convention for the east coast) and the gross transport is 0.64x10^6 m^3/year during 2021. It can be observed that the monthly LST is showing a southerly transport during the NE monsoon period and for the rest of the period including SW monsoon, the transport is towards north. The simulation of shoreline evolution has been carried out during the period of 2010-2021 for the present scenario. The model result has been validated for the year of January 2021, where the simulated shoreline matches well with the observed, with a relative mean absolute error (RMAE) of 0.019 (1.9 %). It can be observed that erosion of about 250 to 300 m occurs immediate west of the Subarnarekha inlet. This observation also corroborates well with the decadal shoreline change analysis (2012 to 2022) carried out using satellite imageries. Accretion of about 100 m is seen towards west, which is more or less same as seen from the decadal change analysis of satellite imageries. Shoreline evolution for a period of 28 years commencing from 2022 up to 2050 has been carried out after introducing two groins, at Chaumukh, which is towards the western side of the Subarnarekha inlet. As per the simulation results, a shoreline advancement of about 250 m is observed to the immediate west of the western groin, at the end of the year 2050. The study shows that the western groin will block the net northerly transport predominant for the entire year. This study will be supportive for any kind of developmental activities, such as port/harbour construction, along the Subarnarekha coastal stretch.

Keywords: coastal processes, longshore sediment transport, numerical modeling, shoreline change, erosion, Littoral Processes FM.

Comprehensive Analysis of Landslide Susceptibility Factors in Assam: A Case Study

D. Saikia[1*], M. Goswami[1], R. Zaman[2] & M. Kalita[3]
[1]Central Institute of Technology, Kokrajhar, India
[2]Bineswar Brahma Engineering College, Kokrajhar, India
*ph18ce1805@cit.ac.in

Abstract

Landslides are a significant natural hazard that can gravely damage infrastructure, cause fatalities, and disrupt socioeconomic activity in many places, including Dima Hasao Assam. To lower danger from landslides, accurate mapping of landslide susceptibility is crucial. The foundation of the study is the gathering of various geographic data and records of prior landslides. These data are then integrated to a Geographic Information System (GIS) platform for analysis and modelling. In this study, landslide susceptibility mapping is carried out using logistic regression method. Utilizing the proper statistical metrics and validation methods, such as receiver operating characteristic (ROC) curves and area under the curve (AUC) values, the model's performance is evaluated. The most trustworthy model is determined by comparing the prediction potency of each one, applying the chosen model to the full study area produces the final map of landslide susceptibility. This method provides an idea about which are the most dominant factor of landslide in the area. The generated map divides the region into zones with varying levels of landslide vulnerability, such as low, moderate, and high. The outcomes of this research provide valuable information for land-use planning, infrastructure development, and disaster management in Dima Hasao, Assam. The landslide susceptibility map can assist decision-makers in identifying areas at high risk of landslides and implementing appropriate mitigation measures.

Keywords: Landslide, Logistic regrasssion, GIS, ROC, AUC, Landslide susceptibility map, Modelling.

Numerical Modelling Using ECMWF and IMD Data on the West Coast of India

A.S. Borkar [1*], Dr. Prabhat Chandra [2]
[1]Scientist C CWPRS Pune India,
[2]Additional Director CWPRS Pune India
*newamol_borkar@rediffmail.com

Abstract

Waves are generated due to winds deep inside the ocean and propagate to the nearshore area. Wave transformation plays an important role in the development of ports and harbors. In the present study, wind generated waves using global wind datasets of ECMWF and regional IMD data are used for Numerical model studies. The data from both sources is given as input to the Spectral wave model Mike-21 to get the nearshore wave climate. The comparison of significant wave heights by using both methods is carried out near the west coast of India, Karnataka, Byndoor. The near wave climate obtained is utilized for wave tranquility studies for the development of a Marina basin that has a stringent permissible wave limit of 0.15m and a fish landing jetty under the Sagarmala scheme using MIKE21–BW model. Under the existing condition with no breakwater at the entrance, the downtime is about 64 days in a year at the Marina basin. An optimum layout was evolved with the help of studies which consisted of a north breakwater of 605m length and a south breakwater of 345m length. With this layout, adequate wave tranquility would be available at the fish landing jetty throughout the year and a marginal downtime of about 10 days may occur at Marina. In addition to providing adequate wave tranquility, the proposed breakwaters would also serve the purpose of arresting the littoral drift. The present mathematical modeling studies to evolve harbour layout satisfies wave tranquility criteria and also ensures minimum siltation in the harbour.

Keywords: Transformation, Wave tranquillity, Numerical modelling.

Urban Heat Islands (UHI) or Urban Cool Islands (UCI): Examining the spatial variation of Land Surface Temperature (LST) in the city of Bongaigaon, India

Nirup Sundar Mandal[1], Sachidanand Kumar[2] & Kironmala Chanda[3]
[1]PhD Scholar, Department of Civil Engineering, Indian Institute of Technology (Indian School of Mines), Dhanbad -826004, Jharkhand, India,
[2]Research Associate, Department of Civil Engineering, Indian Institute of Technology, Indore – 453552, MadhyaPradesh, India
[3]Associate Professor, Department of Civil Engineering, Indian Institute of Technology (Indian School of Mines),Dhanbad - 826004, Jharkhand, India
*nirupsundarmandal39@gmail.com

Abstract

Manmade activities like increase of urban settlement and depletion of natural vegetation and water bodies has led to analteration of the global energy balance. This, in turn had led to the development of Urban Heat Islands/Urban Cool Islands, a phenomenon in which, a significant temperature difference is observed in urban regions and their adjoining non-urban regions. This article explores the variation of Land Surface Temperature (LST) in the refinery city of Bongaigaon, Assam, India and its immediate surroundings. Landsat images, one each from both summer and winter of 2004, 2008, 2012, 2016 and 2020 were examined for the spatial variation of LST and the formation of Urban Heat Island Intensity (UHII). The results didn't indicate a perceivable change in UHII (0.08° C to 0.23° C) but the LST maps indicated formation of Urban Cool Islands (UCI), possibly dueto the presence of greenery even within the built-up areas of the city. It was observed that LST had a negative correlation with spectral indices such as Normalized Differenced Vegetation Index (NDVI) [R = -0.42 to -0.6 across different years] and Modified Normalized Differenced Water Index (MNDWI) [R = -0.01 to -0.32 at different years] whereas a positive correlation was observedwith Normalized Differenced Built-up Index (NDBI) [R = 0.34 to 0.6] and Normalized Differenced Bareness Index (NDBaI) [R =0.3 to 0.38]. A preliminary investigation of the LST predictive ability of Machine Learning (ML) based models in the study area showed a moderate performance with Random Forest Regression [R = 0.45 in summer, R = 0.56 in winter] and a relatively poor performance with Support Vector Regression [R = 0.21 in summer, R = 0.57 in winter], indicating the need for more refined modelsfor future LST projection in a changing climate and changing land cover.

Keywords: Urban Heat Island (UHI), Urban Cool Island (UCI) Normalized Differenced Vegetation Index (NDVI), Normalized Differenced Built-up Index (NDBI), Modified Normalized Differenced Water Index (MNDWI), Random Forest Regression (RFR)

Prediction of Hydrological Drought Pattern and Duration in DataScares Catchments with Catchments' Physio-Climatic Attributes

Dr. Ankit Deshmukh*[1]
[1]Department of Civil Engineering, Pandit Deendayal EnergyUniversity, Gandhinagar, 382421
*deshmukh.acad@gmail.com

Abstract

Droughts are slow-onset disasters and affect developing economies significantly more than developed ones. Changing climatic conditions impact developing economies such as India more than developed ones, and many regions are experiencing water stress and long-term drought. The hydrological drought (represented by lower streamflow than historical) prediction is challenging for data-scare regions such as the Indian subcontinent. Prediction of hydrological drought requires the forecasted streamflow, and the accuracy of the prediction depends on the choice of model, quality, and quantity of historical streamflow data, and model parameter calibration. Getting long-term streamflow data for most Indian catchments is the most challenging one. On the other hand, computing meteorological drought is relatively easy as it is the function of simple climatic variables such as daily precipitation and temperature. Studies indicate that the relationship between hydrological drought and meteorological drought exists, but the degree of prediction of hydrological drought with meteorological drought is difficult as each catchment has different catchment characteristics. In this study, we try to understand how catchments' attributes, such as soil type, topography, long-term land use, and meteorological drought, help to predict hydrological drought without needing any complex hydrological model setup for each catchment. We first develop a catchment attributes dataset with more than 40 attributes. Then select ten years with climatic and streamflow historical data. Hydrological droughts characterize Standardized Streamflow Index (SSI) and meteorological drought computed with Standardized Precipitation Index (SPI) and Standardized Precipitation Evapotranspiration Index (SPEI) indicators. We use a machine learning algorithm Classification and Regression Trees (CART) and time series analysis to understand how catchment physio-climatic attributes and meteorological drought explain the hydrological drought in the region

Prediction of Heatwave Days over Rajasthan Using SVR and RF Algorithms

Srikanth Bhoopathi[1], Manali Pal[2*]
[1]Research Scholar PhD, Department of Civil Engineering, National Institute of Technology, Warangal, Telangana, India – 506004
[2]Assistant Professor, Department of Civil Engineering, National Institute of Technology, Warangal, Telangana, India – 506004
*manalipal@nitw.ac.in

Abstract

Heatwaves have become increasingly frequent and severe in recent years, highlighting the need for accurate prediction models to mitigate their adverse impacts. This study proposes a heatwave prediction approach utilizing support vector regression (SVR) and random forest (RF) algorithms based on meteorological variables. Rajasthan has been selected as the study area that is an arid region and is more susceptible to heat waves. In this study, historical meteorological data which includes air temperature, relative humidity, geopotential height, u-wind and v-wind speed from the ECMWF Reanalysis version5 (ERA5) for the time period of 1991-2020 are used as the predictors. The number of heatwave days of summer (May, June, and July) is the predictand and obtained from India Meteorological Department (IMD) for the same time period i.e.,1991-2020.Both SVR and RF algorithms are employed to model the complex relationships between the meteorological variables and the occurrence of heatwaves. SVR utilizes a kernel-based approach to map the input variables into a higher-dimensional feature space, while RF employs an ensemble of decision trees to capture non-linear interactions. Model hyperparameters are fine-tuned to optimize performance. The prediction models are evaluated using various performance metrics, such as mean squared error (MSE), root mean squared error (RMSE) and coefficient of correlation (R). Future work involves expanding the scope of the study to incorporate additional meteorological variables and exploring the integration of other machine learning algorithms. Furthermore, the models can be enhanced by incorporating data from remote sensing sources and considering the spatial aspects of heatwave prediction. Such advancements will contribute to more accurate and reliable heatwave forecasting systems, enabling better preparedness and resilience against extreme heat events.

Keywords: Heatwave days, Forecasting, Climate change, Machine learning algorithm, Random Forest, Support Vector Regression

Quantifying the Risk Level of the Projected Extreme Rainfalls over Coastal Ramsar Wetlands in India Using Fuzzy Logic

Shivukumar Rakkasagi[1*] & Manish Kumar Goyal[1]
[1]Department of Civil Engineering, Indian Institute of Technology, Indore, India
*phd2101104006@iiti.ac.in

Abstract

Wetlands are often found in areas that undergo periodic flooding, such as coastal seas, lakes, and rivers. Especially, the coastal wetlands are more vulnerable to climate change effects, such as changes in precipitation patterns, risk of extreme rainfall, cyclone/storms. This study assessed the uncertainties associated with extreme rainfalls in terms of return levels (RLs; 20 and 50 years) and quantified the potential risk level of these events in the future for coastal wetlands in India. The extreme precipitation indices (EPIs) were evaluated using a non-stationary approach, and the results showed that Thane Creek had the highest RLs, followed by Kolleru Lake. The risk level for each wetland was assessed using the fuzzy logic approach, which considered parameters such as exposure, vulnerability, and threat. The overall risk assessment showed that Thane Creek, Kolleru Lake, Pallikaranai Marsh Reserve Forest, and Tampara Lake are at a "High" risk level for both RLs of EPIs. Furthermore, the automated SWIR thresholding technique was employed in Google Earth Engine to create inundation maps of wetlands. This study also indicated that Thane Creek is at risk of flooding based on the analysis of spatiotemporal changes. The impact evaluation of Thane Creek indicated that the rapid urbanization has encroached upon the creek's boundaries. Therefore, the variability of EPIs may be affected by climatic oscillations, which could lead to an upsurge in extreme rainfalls, causing the coastal wetlands to flood. Policymakers can use these findings to develop effective strategies for the proper management of the coastal wetlands.

Keywords: Coastal Ramsar Wetlands, Non-stationary Approach, Fuzzy Logic, Risk Level, Inundation Patterns, Spatiotemporal Changes

Response of Groundwater to Dry and Wet Rainfall Spells in Different Climatic Zones of India

Alice Thomas[1], K. Sreelash[2], Micky Mathew[3,4*]
[1] Mar Baselios college of Engineering and Technology, Thiruvananthapuram 695015, Kerala, India.
[2] National Centre for Earth Sciences, Akkulam, Thiruvananthapuram, 695011, Kerala, India.
[3] Hatch Marine Consultants, Shasthamangalam, Thiruvananthapuram-695010, Kerala, India.
[4] School of Environmental Studies, Cochin University of Science and Technology,682022, Kerala, India
*contact.micky@gmail.com

Abstract

The influence of the amount of rainfall and intensity of rainfall has been reported to play a significant role in determining the groundwater fluctuations across India. However, the influence of duration and amount of rainfall from different spells (dry/wet spell, prolonged dry /wet spell) on the groundwater level changes has not gained much attention. Here the influence of dry and wet spells on groundwater level variations were analyzed across different climatic zones of India. The lowering of groundwater levels was found to be significantly correlated to count and magnitude of dry and prolonged dry spells of rainfall. From arid to humid regions a positive to negative transition exists in the influence of rainfall contributions on groundwater from wet and prolonged wet spells. The influence of rainfall spells along with the amount and intensity of rainfall has to be taken into consideration for predicting and managing groundwater resources and sustainability assessments.

Keywords: Precipitation, Groundwater level, Rainfall anomaly index, Groundwater anomaly index, Rainfall Intensity, Dry/wet Spell

Electrical Conductivity's Closed Form Expression from Climate and Land Use Parameters for Krishna River Basin, India

[1]Graduate Student (Ph.D. Research Scholar), Department of Civil Engineering, Birla Institute of Technology and Science, Pilani, Hyderabad Campus, Jawahar Nagar, Kapra (mandal), Medchal District, Hyderabad, Telangana, India – 500 078

[2] Professor, Department of Civil Engineering, Birla Institute of Technology and Science, Pilani, Hyderabad Campus, Jawahar Nagar, Kapra (mandal), Medchal District, Hyderabad, Telangana, India – 500 078

[3]Associate Professor, Department of Civil Engineering, Birla Institute of Technology and Science, Pilani, Hyderabad Campus, Jawahar Nagar, Kapra (mandal), Medchal District, Hyderabad, Telangana, India – 500 078

[4]Assistant Professor, Department of Civil Engineering, Birla Institute of Technology and Science, Pilani, Hyderabad Campus, Jawahar Nagar, Kapra (mandal), Medchal District, Hyderabad, Telangana, India – 500 078

*p20190416@hyderabad.bits-pilani.ac.in

Abstract

The electrical conductivity of water is typically determined by the amount of contaminants or dissolved particles present. It measures the amount of saltiness in water and is influenced by temperature. In short, the ability of a solution to convey current through its ionic process is measured by electrical conductivity (EC). As per WHO guidelines, the EC should not exceed 400 µS/cm. The relative state or health of the water body and its associated biota can be declined due to significant changes or increased conductivity. Moreover, the measure of conductivity provides an overview of a water supply's hygienic status and is considered one of the vital water quality parameters. In this study, a closed-form expression is derived from artificial neural network modeling of EC from climate parameters such as precipitation and temperature; and land use parameters such as urban, forest, agriculture, grassland, and shrub land use factors of Krishna River Basin. The EC data is obtained from Andhra Pradesh Pollution Control Board (APPCB), and the climate data is obtained from Indian Meteorological Department (IMD). The same procedure can be used to derive expressions for other water quality parameters of Krishna River Basin's water quality modeling, analysis, and predictions.

Keywords: electrical conductivity, Climate Parameters, Land Use Parameters, Krishna River Basin, Water Quality Modeling, Artificial Neural Networks.

Forecasting Future Precipitation Trends using GCMs and Model Trees

S. S. Shah[a], S. N. Londhe[b]
[a] Ph. D. Student, Civil Engineering, Vishwakarma Institute of Information Technology, Pune, India
[b] Professor, Civil Engineering, Vishwakarma Institute of Information Technology, Pune, India
*shalaka18@hotmail.com

Abstract

Many projects are underway around the world to downscale the data from Global Climate Models (GCM). Most of the statistical tools have a lengthy procedure to follow for the downscaling activity. To improve its accuracy, the GCM data is re-gridded according to the grid points of the observed data, standardized, and, in some cases, bias-removal is required. Soft tools can extensively reduce the time and effort required for these steps. The present research will provide the audience with an understanding of the capabilities of a soft tool, Model Trees (MT), as a statistical downscaling tool. The current work suggests that future precipitation can be predicted by using precipitation data from the nearest four grid points as input to soft tools and observed precipitation as output. This research aims to estimate precipitation trends in the near future (2021-2050) for the city of Pune, in the state of Maharashtra, India. The findings indicate that MT can model the precipitation with excellent accuracy compared to the traditional method of Distribution Based Scaling (DBS). For this purpose, 5 GCMs were used, and the results show that MT overpowers DBS in downscaling the climate data. This work is one of a kind in that it provides insights into the changing monsoon season in Pune. The results show that rainfall may occur all over the year instead of just from June to September. The detailed methodology and results will be discussed in the larger paper.

Keywords: Rainfall, Climate change, Downscaling, Model Trees

Estimation of Storm Surge due to Tropical Cyclone Biparjoy using Numerical Models

Aruna Kumar Avula[1*], Abhishek Tavva[1], Shyamala Varthini[1], Purnima Jalihal[1] & B. K. Jena[1]
[1]National Institute of Ocean Technology, Chennai, India
*arun.aak@gmail.com

Abstract

In recent years, the frequency of occurrences of cyclones and duration of the cyclones in the North Indian Ocean is increased due the climate change. The predictions of extreme weather events are important for proper planning of disaster management to save the human lives and to protect the coastal infrastructure. Consideration of surge level in the estimation of design elevation of various major coastal infrastructure like breakwaters, jetties, intake structures, power plants, ports and harbours will prevent damages during extreme events. Tropical Cyclone Biparjoy originated in the Arabian Sea as a Depression and intensified into a Very Severe Cyclonic Storm within a period of two days. This further intensified into an Extremely Severe Cyclonic Storm by June 11,2023. Biparjoy later subsided into a Very Severe Cyclonic Storm Off the Coast of Gujarat and continued to traverse off the Gujarat coast for nearly 3 days until it made landfall as a Very Severe Cyclonic Storm near 23.1 N & 68.3 E about 30km South of Jakhau Port, 110km Northwest of Dwarka. A numerical model was setup to estimate the tropical storm induced surge due to Tropical Cyclone Biparjoy. The observed Cyclone data from IMD and Joint Typhoon Warning Centre were used as input. Cyclone Biparjoy resulted in inundation of low-lying areas of coastal districts of Gujarat.

Keywords: Biparjoy, Cyclone, surge level, Extreme events, Numerical model

Multi-Model Ensemble prediction using Machine Learning approach for North-East India

Abdul Rahman[1*], and Sreeja Pekkat[2]
[1*] Research Scholar, Department of Civil Engineering, India Institute of Technology, Guwahati, India
[2] Associate Professor, Department of Civil Engineering, India Institute of Technology, Guwahati, India
*r.abdul@iitg.ac.in

Abstract

MMEs, or multi-model ensembles, are often used to reduce the uncertainty in general circulation models (GCMs) simulations and forecasts. This work aims to analyze the performance of MMEs using machine learning (ML) algorithms with various combinations of GCMs ordered according to performance and to establish the ideal amount of GCMs to be used in an MME. In this study, ML algorithms, including Artificial Neural Network (ANN), K-Nearest Neighbour (KNN), Support Vector Machine (SVM), and Relevance Vector Machine (RVM), were used to create MMEs for the maximum (Tmax) and minimum (Tmin) temperature over North-East India using GCMs from CMIP6 under the Intergovernmental Panel on Climate Change (IPCC) sixth assessment report. India Meteorological Department (IMD) daily temperature data from 1965-2014 was used as observed data and evaluated with a gridded spatial resolution of $2^\circ \times 2^\circ$ for the study area. Statistical performance indicators were used to rank GCMs, and each GCM's overall rank was then estimated using a thorough Rating Metric (RM). This study's findings will aid academics and decision-makers in selecting the best climate model for each location when conducting hydrological and climate change impact studies.

Keywords: CMIP6, Multi-Model Ensembles, GCM ranking, Performance Indicators, Machine Learning, Climate change.

Observed Interannual Variability and Projected Scenarios of Drought using Drought Indicators

Nitesh Gupta [1], Shivani Gond[2], Jitendra Patel[3], Padam Jee Omar[4], Ravi Prakash Tripathi[5]
[1]Dept. of Civil Engineering, Institute of Technology, Nirma University, Ahmedabad, 382481, India.
[2]Centre for Technology Alternative for Rural Areas, Indian Institute of Technology, Bombay 400076, India
[3]Dept. of Civil, Chemical, Environmental and Material Engineering, Alma Mater Studiorum - Università di Bologna, 33 - 40126 Bologna, Italy
[4]Dept. of Civil Engineering, Babasaheb Bhimrao Ambedkar University, Lucknow-226025, India
[4]Dept. of Civil Engineering, Rajkiya Engineering College, Sonbhadra, 231206, India
*nitesh.gupta@nirmauni.ac.in

Abstract

The observation-based analysis of drought development in the Uttar Pradesh region, showed that, despite the area being relatively large, agricultural drought exhibits high spatial variability across the region. However, the lack of net radiation data hinders the capacity to provide reliable estimates of evapotranspiration (ET), affecting the assessment of drought occurrence since its propagation across the hydrological system is very sensitive to the estimation of evapotranspiration, ET method. The accuracy of current satellite Normalized Difference Vegetation Index (NDVI) products and lack of information of irrigation in agricultural areas limits the ability to properly establish a relationship between drought and vegetation response. Based on the observations, the most prominent precipitation deficits occur during monsoon season June to October, showing that changes in the large-scale circulation are responsible for the impact of severe drought in the various part of study region. In agreement with previous studies, El Niño-Southern Oscillation (ENSO) modulates the variability of drought with warm ENSO phase favouring drought development with the strongest influence between August and October. The climate change projections under RCP4.5 and RCP8.5 scenarios suggest the intensification of drought events in the Uttar Pradesh region at mid-century, with Chambal River of Ganges River basin being most affected area in terms of precipitation decrease and warming. The projected scenarios correspond to an increase of 1.7 ^{o}C for mean temperature and 3.5 ^{o}C for minimum and maximum temperature in the 2050 horizon and a decrease of 400 mm to 800 mm for annual precipitation is projected under both RCPs.

Keywords: Drought, Evaporation, Statistical Downscaling, Projections

Multi-Covariate Non-Stationary Flood Frequency Modeling Under the Influence of Climate Change and Reservoir Controls in the Narmada River Basin

Sachin Bhere[1], Manne Janga Reddy[1,2]
[1]Department of Civil Engineering, Indian Institute of Technology Bombay, Mumbai-4000076, India
[2]Interdisciplinary Program (IDP) in Climate Studies, Indian Institute of Technology Bombay 4000076, India
*studentsachinbhere@gmail.com

Abstract

The stationary assumption for flood frequency analysis is becoming obsolete due to climate and anthropogenic change. The non-stationary flood frequency assumed that distribution parameters change with covariates. In this study, the non-stationary models are developed considering the multiple covariates and compared with the stationary and single covariate models focusing on the reservoir control's influence. The annual maximum discharge data of 13 hydrometeorological stations of the Narmada basin is used to develop these models. For covariates, the time, daily maximum rainfall, total annual rainfall, five climate indices North Atlantic oscillation, Southern oscillation index, Nino3.4, Dipole mode index, and DMI for the western Indian Ocean, and modified reservoir index (MRI) to quantify the influence of the group of reservoirs on river discharge is used. For all the stations where the group of reservoirs existed, the single covariate models with MRI as a covariate performed better than any other model when compared with the Akaike information criteria. For other stations, the daily maximum rainfall and annual rainfall are performing better as a covariate. It is observed that the multi-covariate models are performing better than single-covariate non-stationary models and stationary models. Multi-covariate non-stationary models showed that at most of the stations, along with the reservoir influence, the rainfall and climate indices like Western Indian oscillation and Dipole mode index are also contributing to changing river discharge. The study concludes that the multi-covariate non-stationary models gave superior performance, and the reservoir's influence is much more significant than other covariates.

Keywords: Non-stationary flood frequency, multi-covariate non-stationary models, Narmada river basin, modified reservoir index, climate indices, flood risk

Trends due to Climate Change in Precipitation and Stream Flows: A Case Study of Italy

Geetha Sakamuri[1], Nishanth Mothkuri[1], Bindu Madhavi Atla[1], Manu.Vyas[1], Samyadeep Ghosh[1], Srinivas Kondapalli[1], Xing Zheng[2], Keith Sawicz[2], Kiran Chinnayakanahalli[2], Hemant Chowdhary[2]
[1]Verisk Extreme Event Solutions, India
[2] Verisk Extreme Event Solutions, USA
*gsakamuri@verisk.com

Abstract

The changing climate is expected to affect the frequency and severity of climate driven natural disasters throughout much of the world. Floods are a significant driver of damage to property and will be directly affected by a changing climate. To establish flood risk management strategies and make informed policy decisions, it is crucial to understand how the characteristics of significant floods may change due to climate change. In our study, we looked at the spatial distribution of trends from observed hydrometeorological variables in Italy between 1979 and 2018. For meteorological trends, we analysed trends in precipitation accumulation at different durations, such as 24 hours and 168 hours, as well as in the mean spring temperature, both taken from a downscaled ERA5 gridded (8x8 km) dataset. For streamflow trends, we used Annual Maximum Flows (AMF) from about 200 river gauges that are not influenced by the anthropogenic factors like reservoir regulation. We observed that (i) for precipitation, 13% and 3% of grids show statistically significant positive and negative trends respectively, (ii) for mean spring temperature, 28% showed significant positive and no negative significant trends. (iii) for AMF, 6% of gauges show significant negative trends and 3% significant positive trends. Additionally, we explored the sensitivity of the AMF trends for different time periods of the data through multitemporal analysis. We will also discuss impacts on flood quantile at high return periods after detrending of Precipitation and AMF data to near-present climate, an important aspect for assessing the tail risk in the flood (re)insurance and industry.

Keywords: Climate Change, Trend Analysis, Precipitation, Stream Flow Theme: Climate Change

Investigating Hydraulic Structures and Their Impacts on Groundwater Recharge and Land Surface Dynamics

Rohit Sharma[1*], Zulfequar Ahmad[2], Rahul Dev Garg[3]
Indian Institute of Technology Roorkee
*r_sharma@ce.iitr.ac.in

Abstract

Rivers play a crucial role in shaping the landscape and sustaining ecosystems. The management of rivers and their associated water resources has been a subject of interest for researchers and policymakers. Hydraulic structures, such as anicuts and barrages, are engineered interventions that are employed to regulate and control the flow of water within river systems. These structures serve various purposes, including irrigation, flood control, and navigation. However, their impact on the hydrological cycle extends beyond the immediate vicinity of the structures themselves. The study aims to analyze the impact of localized ponding of water by these structures below and above the surface of the earth. The study area is carried out on the confluence of rivers Mahanadi and Pairi, as the density of structures is good in this reach. The study is carried out from the year 2013 to 2022. During this phase, there was a rapid escalation in the ponding of water within the river. This reveals the complex interconnections between surface water and subsurface aquifers. The research shows that the quantity of groundwater improves in the study area as the ponding of water helps in the recharging of the aquifers. In addition to hydrological analysis, satellite images of Landsat-8 were used to explore the study area on the Google Earth Engine (GEE) platform. Several parameters such as the Modified Normalized Difference Water Index (MNDWI), Land surface temperature (LST), and Soil Moisture Index (SMI) were derived for the pre-monsoon and post-monsoon phases. The derived parameters were thoroughly examined and interpreted, providing significant insights into the dynamics of the study area during the specified time periods. The MNDWI values revealed a significant increase in water distribution and extent between the pre-monsoon and post-monsoon phases and in recent years even during the summer season there is an adequate amount of water within the river due to the presence of hydraulic structures. The LST data highlighted localized temperature variations within the study area and due to the presence of water in the region there is a significant drop in the LST in recent years when compared to earlier years. These variations can be attributed to factors, such as land cover, vegetation density, and surface moisture content. Overall, these findings contribute to a better understanding of the complex relationships between surface water dynamics, land surface temperature, groundwater, and environmental conditions. These findings are useful for making informed decisions when managing water resources, protecting ecosystems, and planning land use in a sustainable manner.

Keywords: Soil Moisture Index, Google Earth Engine, Land Surface Temperature.

Assessment of Groundwater Level Variation in Relation to LULC in Aurangabad District

Sarika. B. Patil[1*], Vijendra Kumar[2] & Kul Vaibhav Sharma[2]
[1]Research Scholar, Department of Civil Engineering, Dr. Vishwanath Karad MIT World Peace University, Pune, Maharashtra, 411038, India.
[2]Assistant Professor, Department of Civil Engineering, Dr. Vishwanath Karad MIT World Peace University, Pune, Maharashtra, 411038, India.
*sarikabpatil20 @gmail.com

Abstract

Groundwater is an essential source of freshwater reserve on which billions of people rely primarily for their various uses. Changes in land use/cover (LULC) place inevitable strain on water resources, either directly or indirectly. Using Landsat photos and hydrological data from the Aurangabad area, this study studied LULC variations and their effects on groundwater level. Land sat pictures with a spatial resolution of 30 m were downloaded by decade (1990, 2000, 2010, and 2018). Using a Geographic information system (GIS), the downloaded photos were then categorised into five different LULC classes: farmland, barren land, vegetation, water bodies, and urban area. Study analysis shows that the agricultural land increased from 5349.06 sq. km in 1990 to 7105.24 sq. km in 2018, whereas barren land decreased by nearly half, from 4424.30 sq. km to 2226.52 sq. km between 1990 and 2018. From 2010 to 2018, the urban area rose dramatically, rising from 44.43 sq. km in 2010 to 438.37 sq. km in 2018. From 1990 to 2018, spatiotemporal maps for pre-monsoon, post-monsoon, and recharge were created, revealing a significant depletion and volatility in groundwater level over the last two decades. Correlation study was performed by comparing the average groundwater level depth of each decade of every monitoring well in the district with the respective decade's land cover map. The collected data show that LULC changes have a significant impact on groundwater level.

Keywords: Groundwater level, Land use/Land cover change, Satellite imagery, GIS, remote sensing

Demarcation of groundwater probable zones for Hasdeo river basin, Chhattisgarh, India with GIS and AHP Techniques

Shravan kumar[1*] , Rudraswamy G K[2], B Satish[3], Anamika Yadav[4]
[1]Sreenidhi Institute of Science and Technology Hyderabad
[2]NIT Warnagal, Warangal - 506004
[3]Manager, Department of Geology, Central Mine Planning and Design Institute, Coal
[4]Department of Agricultural Engineering, Trigunasen School of Technology, Assam University Silchar, Pin 788011
*shravankumarsm@sreenidhi.edu.in

Abstract

Groundwater exploitation and climate change have combined to pose a significant concern, resulting in a drop-in groundwater level. It has raised serious concerns about the necessity for groundwater resource monitoring and utilization. The key to determining the best extraction and augmentation of current groundwater resources is to define the potential zones. In the contemporary research identifying the potential zones of groundwater (GWPZ) mapping was carried out for the watershed boundary of Hasdeo river basin, covering an area of 9633 km^2. Nine coalfields are inside the watershed boundary: Korba, Mand-Raigarh, Hasdo-Arand, Sonhat, Chirimiri, Sendurgarh and the eastern part of Sohagpur coalfield. For groundwater potential zone demarcation thematic films viz., Geomorphology, density of Lineament, geology, soil type, dynamics of land use change, density of drainage, the terrain slope, and the wetness of topography were prepared and studied. Individually the thematic layer has been assigned weightage, based on their water potential capacity and attributes using the multi criteria decision making method Analytical Hierarchy Process (AHP) in geographical information system (GIS). The output was cross-validated against the 26 CGWB wells, resulting in an overall precision of 85%. The resulting groundwater potential zone map was further reclassified in to 5 classes using the classic natural breaks method and accordingly to the, the intense and mild GWPZ encompass approximately 50% and 43% of the river basin, respectively. Around 3% of the basin area lies under very low and high groundwater potential zones, and the very high potential zones account for less than 1% of the basin's total area.

Extreme Rainfall and Temperature Analysis of Telangana for 1990 to 2020

Seenu P Z[1]*, Buddhi Nagaraju[1], Thalari Jagjeevan Ram[1]
VNR VJIET, Hyderabad, India
*seenu_pz@vnrvjiet.in

Abstract

The unpredictability of the climate has drawn much interest globally, especially that of the maximum and minimum temperature and extreme rainfall. The degree of the components' variability or fluctuations varies depending on the area. Therefore, it is crucial to analyse the climate changes and recommend workable adaptation solutions by looking at the spatial and temporal variations of meteorological changes in the context of climate change, especially in nations where agriculture is prevalent. In order to do this, the current study looks at both long-term trends and short-term variations in extreme rainfall and temperature in the Telangana district, India. In this study, analysis of both precipitation and temperature has been studied from 1990 to 2020. Gridded rainfall data from IMD with a 0.25-degree resolution is used for this study. The trend and the magnitude of the trend were determined, respectively, using the Mann-Kendall test and Sen's slope model. A spatial interpolation technique like Kriging was applied to interpolate the spatial pattern across the study area in a GIS context. The rainfall trend is significantly increase in the north-western districts of Telangana, while the temperature trend is significantly increase in the south-western districts. Monsoon season shows a negative trend in extreme rainfall events. The north-eastern districts of Telangana receive the highest rainfall, while the south-western districts receive the lowest rainfall. The temperature is also higher in the north-eastern districts than in the south-western districts. According to the study's findings, Telangana is already experiencing the effects of climate change, and these effects are only expected to worsen in the future.

Keywords: Extreme event, Telangana, Temperature analysis, Trend analysis

Mapping of Meteorological and Agricultural Drought for Tamirabarani River Basin using Remote Sensing and GIS

Subbarayan Saravanan[1*], Janardhanam Niraimathi[1], Nagireddy Masthan Reddy[1], Devanantham Abijith[1,] Hemavarshini B R[2]
1 Department of Civil Engineering, National Institute of Technology, Tiruchirappalli, India
2 Department of Remote sensing, Bharathidasan University, India
*ssaravanan@nitt.edu

Abstract

Droughts, marked by below-normal precipitation, impact regions significantly. The Tamirabarani river basin, pivotal for agriculture in southern India, frequently faces droughts with consequential effects on local communities and ecosystems. This study employs Remote Sensing & GIS techniques to gauge drought vulnerability in the Tamirabarani Basin, Tamil Nadu. Drought repercussions, especially in agriculture, are profound. Remote sensing is crucial for monitoring and assessing droughts, furnishing vital data for mitigation. Various spectral indices, like the Normalized Difference Vegetation Index (NDVI) derived from satellite images, offer insights into drought indicators like vegetation health and water availability. To comprehensively assess drought, the Combined Drought Index (CDI) integrates the Vegetation Condition Index (VCI), Temperature Condition Index (TCI), Soil Water Index (SWI), and Precipitation Condition Index (PCI). The study tracks meteorological and agricultural droughts in the Tamirabarani Basin from 2000 to 2022. VCI data reveal no drought in the west during 2015, but severe drought in the east in 2019. TCI data indicates a severe drought in the east in 2000, with minimal impact in 2021. PCI data show no drought in the west in 2007, but severe occurrences in the northwest in 2016 and 2018. For SMI, a substantial part of the area experienced severe drought in 2001, while the entire Tamirabarani basin reported no droughts in 2021. This analysis contributes to comprehending and addressing drought vulnerability in the Tamirabarani river basin.

Keywords: Drought assessment, Tamirabarani, Remote sensing, GIS

Understanding Crop Production Impacts through Climatic Indices

Ayush Kumar[1], Ashok Mishra[2*] & Idhaya Chandhiran Ilampooranan[1]
[1]Water Resources Development & Management Department, Indian Institute of Technology Roorkee Roorkee, Uttarakhand 247667, India
[2]Agricultural and Food Engineering Department, Indian Institute of Technology Kharagpur Kharagpur, West Bengal 721 302, India
[*]amishra@agfe.iitkgp.ac.in

Abstract

Climate change is associated with rising temperatures and changing rainfall patterns, which can degrade soil and reduce crop productivity. The study analyzed the effect of the Expert Team on Climate Change Detection and Indices (ETCCDI) based on precipitation and temperature extreme indices on rice and wheat yield for the period (1998-2019) in Bihar's 38 districts. We considered nineteen precipitation and temperature-based indices. Results indicate that rice and wheat yield trends are increasing except for Arwal, where a decrease in wheat yield was observed. Increasing yield is because of improved agricultural practices like high-yielding seeds, fertilizer, tillage, and modern technologies. Trend analysis shows a decreasing trend in the number of colder days during the kharif season (TX10P_KHARIF, TN10_KHARIF) and consecutive wet days (CWD) in most districts, whereas an increase in warmer days and higher daily temperature extremes, attributable to erratic rainfall and droughts. Analyzing the relationship between climate extremes and crop yields, positive correlations were observed with precipitation indices, which boost plant growth and soil microbial activities, enhancing productivity. Specifically, wheat benefited from increased precipitation. However, certain temperature indices, like summer days (SU), days when minimum temperature > 90th percentile (TN90P), and days when maximum temperature > 90th percentile (TX90P), negatively impacted yields due to elevated temperatures causing early plant maturity and affecting kernel weight. The findings will guide policymakers in creating strategies to counter climate change's impact on crops. More studies are needed to understand how these climate extremes affect plants' phenological stages and overall yield.

Keywords: Trend Analysis, Crop yield, Climate Change, Extreme rainfall indices, Extreme temperature indices.

Impact of Climatic Oscillations on the Productivity of The Rice and Wheat Crops in Karnataka State of Peninsular India: A Wavelet Based Approach

Geethu G Das[1*], Adarsh S[2]
[1-2]Department of Civil Engineering, TKM college of Engineering, APJ Abdul Kalam Technological University, Kerala, India.
*adarsh_lce@yahoo.co.in

Abstract

The threat of climate change is felt most keenly in countries with a large agricultural population, like India. The primary food grain crops in India are wheat and rice, and monsoon fluctuations have a significant impact on their production. Crop yields are known to be affected by the El Nino Southern Oscillation (ENSO), Indian Ocean Dipole (IOD), North Atlantic Oscillation (NAO), and Pacific Decadal Oscillation (PDO) in different parts of the world. When developing a strategy programme for food security, it is crucial to relate crop output to the primary climatic oscillations and large-scale climatic variation. The co-movements between crop yields (rice and wheat) and climate oscillations are looked at in order to study the coherence over various time horizons. In this study, meteorological information and annual crop yield are examined to better understand climatic oscillation and crop production. Bivariate wavelet coherence (BWC)are employed for Peninsular India over a 52-year period from 1966 to 2017 using annual data on crop production and climate oscillation. Average wavelet coherence (AWC) shows that ENSO has the most dominant influence on rice yield and IOD has the dominant influence on wheat yield. Further the role of multiple oscillations was studied using partial wavelet coherence (PWC), and multiple wavelet coherence (MWC) approaches considering 54 different combinations. The percentage of the significant coherence (PoSC) statistics showed considerable co-movement between climatic oscillation and crop yield. The PWC investigation, which revealed a substantial reduction in PoSC values compared to the BWC analysis, demonstrated a significant link between various COs and crop yield for both the crops. By doing MWC analysis its clear that other than IOD, PDO is having influence on wheat yield.

Keywords: Crop yield, Wavelet, Climate Oscillations, Peninsular India, Coherence

Investigation of Teleconnections between Streamflow and Potential Climatic Drivers Using Wavelet Analysis

Bincy Chandran P [1*], Arunkumar R [2*]
[1]Department of Civil Engineering, National Institute of Technology Calicut, Kozhikode – 670601, Kerala, India
[2] Department of Civil Engineering, National Institute of Technology Calicut, Kozhikode – 670601, Kerala, India
*bincychandranjan25@gmail.com

Abstract

Streamflow is a vital component of the water resources system and its variation has a significant impact on water supply, flood management, and reservoir operations. Analysing the complex interactions between climate drivers and streamflow will enhance our understanding of the variation pattern of streamflow and to devise appropriate water resources plans. Therefore, the main aim of this study is to investigate the relationship between the potential climatic drivers and streamflow for multiple time scales using wavelet analysis by incorporating methods like Bivariate wavelet analysis (BWC), Multiple wavelet analysis (MWC), and Partial wavelet analysis (PWC). The four prominent global climate indices chosen for the study are the Indian Ocean Dipole (IOD), North Atlantic Oscillation (NAO), El Niño Southern Oscillation (ENSO), and Pacific Decadal Oscillation (PDO). The analysis was done on the Chalakudy river basin, which is one of the regions widely affected by floods in Kerala. From the results obtained, BWC showed that streamflow has an in-phase coherency with rainfall whereas an anti-phase coherency with maximum temperature which was found strong at intra-annual and annual time scales. Average wavelet coherence (AWC) was calculated to measure the coherency, revealing that rainfall has the highest coherency among local climatic drivers which was followed by maximum temperature. In the case of global climatic drivers, ENSO was found most coherent with streamflow which is followed by IOD. MWC and PWC were examined in various combinations, with the results pointing out the impact of rainfall and ENSO on streamflow. Understanding the correlation of streamflow with climatic drivers and considering their influence in studies is important for risk assessment, climate change impact assessment, and ecosystem protection.

Keywords: Bivariate wavelet analysis, Multiple wavelet analysis, and Partial wavelet analysis, Average wavelet coherence

Impact of Land Use Land Cover and Climate Change on Evapotranspiration and Potential Evapotranspiration in A Semi-Arid Region of Southern India

Nathi Ajay Chandra[1*], Sanat Nalini Sahoo[2] & Anisha Das[3]
[1]Research Scholar, Department of Civil Engineering, NIT Rourkela, Odisha, 769008, India
[2]Assistant Professor, Department of Civil Engineering, NIT Rourkela, Odisha, India
[3] M. Tech Scholar, Department of Civil Engineering, NIT Rourkela, Odisha,769008, India
*nathi.ajaychandra@gmail.com

Abstract

This study examines how changing climate and LULC in southern India's semi-arid Chitravathi basin affect evapotranspiration (ET) and potential evapotranspiration (PET) in the near future (NF) (2015-2030). The future LULC map is produced using cellular automata and artificial neural networks (CA-ANN). ET and PET were estimated using the hydrological model SWAT (Soil and Water Assessment Tool). This study used the meteorological data (precipitation and temperatures) with a resolution of 0.25˚x0.25˚from ten gauging stations across the basin. Based on the Coupled Model Intercomparison Project 6 (CMIP6), Global Climate Model (GCM) MPI-ESM1-2-LR, the NF climate under the socioeconomic pathway SSP2-4.5 is projected. The SWAT model is calibrated for discharge data at a gauging station. SUFI-2 algorithm was used in the SWAT-CUP for the automation calibration of the SWAT model. Statistical measures were used to assess model performance, including coefficient of determination (R^2) and Nash Sutcliffe efficiency (NSE). The model demonstrates an overall accuracy with R^2=0.83 and NSE=0.81. The estimated future parameters were compared with the baseline (1985-2014) parameters. Results revealed that ET is 332 mm during the NF, and PET is 1683 mm. Compared to baseline values, 13.5% decreased ET and 37.5% increased PET were observed. This research will help design and implement adaptation measures to mitigate the effects of land cover and climate change on Chitravathi basin's water resources.

Keywords: Climate change, CA-ANN, ET, PET, SWAT, SUFI-2

Impact Assessment of Climate Change on Groundwater Level Using Trend Analysis

Aum Upadhyay[1*], Sanket S. Lakum[1], Dr. M.M. Shaikh[1], Sudhanshu Dixit[1]
[1]L.D. College of Engineering, Ahmedabad, Gujarat, India
*aumupadhyaya04@gmail.com

Abstract

One of the most critical concerns that humanity is now experiencing is climate change. Effects of which are varied and extensive, impacting many different areas of the Earth's processes, such as the availability of groundwater. To maintain ecosystems, agriculture, and human lifestyles, groundwater is found to be essential. Therefore, for efficient water resource management and adaptation methods, it is indispensable to understand how climate change is affecting groundwater levels. In this study, long-term data of the Ahmedabad district covering groundwater levels and climatic factors including temperature and precipitation are analyzed using trend analysis. Sen's slope approach and Mann-Kendall trend tests are used to find significant long-term trends and links among parameters. The study shows the trend of groundwater level and climatic variables such as temperature and precipitation in the Ahmedabad district from 2001 to 2019. Due to the climatic variability, the result of the average maximum temperature and average minimum temperature have Z values of 0.56 and 3.29 respectively, which shows incremental trends. These incremental trends affect precipitation as well as groundwater levels, causing decreasing and increasing trends respectively, having Z values of -0.35 and 0.84 respectively. Among all the trends average minimum temperature is very crucial. This analysis and results found that despite having a decreasing trend in precipitation, there is an increasing trend in groundwater. The outcomes of the trend analysis offer valuable insights into how climate change affects groundwater levels.

Keywords: Groundwater, Climate Change, Trend Analysis, MAKESENS

Detection and Attribution of Climate Change: A Review

M.C. Hitni[1*] & G.D. Kale[1]
1Sardar Vallabhbhai National Institute of Technology Surat-395007, Gujrat, India
mallurajhitni120@gmail.com

Abstract

An alteration in the state of climate that lasts for a longer duration of time, usually decades or more, which can be detected by variations in mean and/or variability of its characteristics is known as climate change (CC). The "detection" of CC is the process of showcasing that climate or a system impacted by climate has altered in some definite statistical manner, without giving a cause for that change, whilst "attribution" is the method of examining the relative contribution of various causal aspects to a change or event with determination of statistical confidence, as per the good practice guidance paper of IPCC on detection and attribution (D&A) of CC. It is necessary to understand the CC occurring all over the world and the reason behind it. Therefore, this study has reviewed various methods and advances in methodologies used for CC D&A during the past few decades. For the trend analysis both parametric and non-parametric methods are used in most of the reviewed studies. Fingerprinting, optimal fingerprinting and artificial neural network (ANN) methods are the three main attribution techniques found in the literature. The fingerprinting (FP) method has drawback of reduced signal to noise ratio. Optimal fingerprinting (OFP) uses multivariate regression which has four basic assumptions, and it is difficult to satisfy these assumptions. Therefore, the result of multivariate regression may not be reliable. The climate system is considered to be a nonlinear system and ANN models are non-linear, so ANN models are useful for attribution of CC.

Keywords: Climate Change, Detection, Attribution, Artificial Neural Network

Observed Linkage of Global Climatic Indices and Monsoonal Rainfall of Indian River Basins in Global Warming Scenario

Ashwini Ranade*
[1] National Institute of Hydrology, Roorkee-247667, India
*ranadeashwini@gmail.com

Abstract

The inter-annual variation in Indian monsoon rainfall is caused by a number of interrelated phenomena operating at various spatiotemporal scales. We hereby asses the nonlinearity in the trends of 15-, 31-, 51- and 101-year running means are assessed using Cramer's t_k statistics. The results show that, the Brahmaputra and Brahmani basins consistently show a large decline in monsoon rainfall for all subperiods compared to the full record, while Pennar basin and WCDS consistently show an increase. The spectral analysis reveals that the interannual variability of the monsoon rainfall of all river basins during 1813-2020 across the country is highly dominated by periodic short-term fluctuations of 1-10 years (~75%), followed by decadal changes between 10-30 years (15%) and long-term variability more than 30 years (~10%). Using correlation analysis, the links between monsoon rainfall in river basins and ten selected global climatic variables are investigated. Interrelationships of monsoon rainfall of major river basins with 10 selected global climatic indices are studied using correlation analysis. All India monsoon rainfall is significantly correlated with the NINO3.4 followed by SOI, AO, PDO and DMI. On basin scale, SOI is the most correlated climatic index, followed by AO and NINO3.4. Most of the indices are substantially correlated during June and September as compare to July and August. While monsoon rainfall of river basins in central and northern west coast, southern-central peninsula and central east coast are significantly correlated with tropospheric warming over three chosen domains of NSBT, North Indian basin rainfall is solely correlated with NSBT-2. On monthly scale, the main contributory months for rainfall months (July through Aug) are highly associated with NSBT-2. The east-west oscillation in the North-Subtropical warming and Tibetan anticyclone's strengthening is a significant factor in the differences in monthly rainfall across India.

Keywords: Interannual variability of river basin rainfall, Global Climatic Indices and Indian Monsoon rainfall, Tropospheric thickness Index

Drought Propagation from Meteorological to Agricultural Drought

Saranya Das K.[1*] & Chithra N.R.[2]
[1] Research scholar, Department of Civil Engineering, NIT Calicut.
[2] Associate Professor, Department of Civil Engineering, NIT Calicut.
*saranya_p210117ce@nitc.ac.in

Abstract

Drought is a recurrent natural phenomenon resulting from prolonged water deficiency. Drought causes destructive impacts on agriculture, ecology, and society. To mitigate the impacts of droughts, it is important to distinguish between different types of drought and to understand how drought propagates from one type to another. Decreasing precipitation combined with higher evaporation rates reduce the root zone soil moisture content leading to agricultural droughts. The deficiency in soil moisture conditions severely affects plant growth and agricultural production. Hence this study attempts to investigate the propagation between meteorological drought and agricultural drought in the Palakkad district of Kerala, India and also to develop a Support Vector Machine (SVM) model for the short-term prediction of agricultural drought. The meteorological drought and agricultural drought are characterized by the Standardised Precipitation Evapotranspiration Index (SPEI), and Standardised Soil moisture Index (SSI), respectively. The Pearson correlation coefficient was used to analyse the propagation relationships between the two types of droughts. The results show that there is a time lag of 1 month for the propagation of meteorological drought to agricultural drought in the study area. The developed SVM model predicted one-month lead SSI with great accuracy (R^2 = 0.8). Accurate prediction of agricultural drought helps to take proactive measures to minimize the adverse impacts of the drought event. The findings of this study provide early warning information of agricultural drought. As Palakkad is known as the Rice Bowl of Kerala, it is of great significance to conduct this study for accomplishing, drought resistance, and food security.

Keywords: Drought propagation, Prediction, SPEI, SSI, SVM.

Is the Increase in Probable Maximum Precipitation in A Changing Climate Really Significant?

Jaya Bhatt[1*] & V. V. Srinivas[1,2,3]
[1]Department of Civil Engineering, Indian Institute of Science, Bangalore 560012, India
[2]Interdisciplinary Centre for Water Research (ICWaR), Indian Institute of Science, Bangalore 560012, India
[3]Divecha Centre for Climate Change, Indian Institute of Science, Bangalore 560012, India
* jayabhatt@iisc.ac.in

Abstract

Probable maximum precipitation (PMP) is a key input for arriving at the probable maximum flood, which forms the basis for the design and risk assessment of large hydraulic structures. The safety of these structures is imperative, as their failure could cause catastrophic socio-economic losses. In conventional PMP estimation approaches, it is assumed that the current climatic conditions remain stationary/unchanged even in the future. However, there is piling evidence in recent literature on the increase in the magnitude of extreme precipitation (even beyond PMP estimates derived using conventional approaches) due to global warming. Therefore, exploring the consequences of relaxing the stationarity assumption in PMP estimation is necessary. Against this backdrop, investigations are undertaken on the frequent flood-prone Mahanadi river basin using the moisture maximization approach. They are focused on (i) estimating PMP by a top-down approach that dispenses the stationarity assumption and accounts for future projected climate trends, and (ii) assessing how and when those estimates differ from the stationarity assumption-based PMP estimates. The results indicate that there is a significant difference between non-stationary PMP estimates and their stationary counterparts. This difference is expected to be witnessed early (in the future period) for high-emission scenarios. The PMP estimates obtained from this analysis could be used to force a rainfall-runoff model to determine the increase in risk associated with projected future floods at various hotspots in the Mahanadi basin. The information is necessary to devise appropriate mitigation strategies to ensure the safety of the existing large hydraulic structures in the basin.

Keywords: Probable maximum precipitation, moisture maximization, non-stationary, climate change, probable maximum flood.

Combined Impact of Land Cover and Climate Change on Urban Flooding: A Review

Anisha Das[1*], Sanat Nalini Sahoo[2] and Nathi Ajay Chandra[3]
[1]M. Tech Scholar, Department of Civil Engineering, NIT Rourkela, Odisha,769008, India,
[2]Assistant Professor, Department of Civil Engineering, NIT Rourkela, Odisha, India
[3]Research Scholar, Department of Civil Engineering, NIT Rourkela, Odisha,769008, India,
* anisha.das2@gmail.com

Abstract

Urban flooding is an increasing threat worldwide, affecting many places and populations. The risk of urban flood has significantly increased due to combining effects of climate change and urbanisation. Urbanisation turns natural landscapes into impervious surfaces, reducing the ability of cities to drain water, while climate change alters rainfall patterns. This study aims to review the combined impacts of land cover and climate change on urban flooding using Storm water management model (SWMM) and Hydrologic Engineering Centre's River Analysis System (HEC-RAS), and for this purpose, recent Coupled Model Intercomparison Project 6 (CMIP6) global climate models (GCMs) were believed to be the most accurate projections as it evaluates future scenarios by using Shared Socio-economic pathways (SSP1-5). Literature on future climatic projections will be assessed using CMIP6-based GCMs and regional climate models (RCMs). SWMM is a dynamic rainfall-runoff simulation model used to simulate the amount of runoff. HEC-RAS was used for unsteady flow analysis. By considering the time-varying inputs such as rainfall, and inflow from tributaries, the software calculates the water surface profiles, flow velocities, and other hydraulic parameters at different locations throughout the flood event. This paper also summarises various mitigation measures to deal with the adverse consequences of urban flooding.

Keywords: Urbanization, SWMM, Climate Change, HEC-RAS, LULC

Impact of Climate Change on Landslide Occurrence: A Case Study of Dima Hasao District of Northeast India

D. Saikia[1], & M. Goswami[2]
[1]Central Institute of Technology, Kokrajhar, India
[2]Central Institute of Technology, Kokrajhar, India
*ph18ce1805@cit.ac.in

Abstract

A Rainfall-Induced Landslide (RIL) is one of the most destructive disasters in hilly regions causing loss of life and livestock, damage to agricultural lands and dwellings, and destruction of infrastructure and communication facilities. Landslides also add to the woes of the affected communities by injuries and loss of livelihood and result in serious economic losses. Incidences and hence impacts of landslides are increasing worldwide due to anthropogenic factors manifested in rapid development, deforestation, and urbanization on one hand and seemingly due to the impact of climate change, predominantly perceived in the form of altered patterns of rainfall, on the other. Rainfall affects slope stability by way of increased groundwater infiltration and pore pressure and imbalance between shear stress and resistance in soil mass on sloping terrains. The hill district of Dima Hasao of Assam is one of the regions of Northeast India that is severely affected by numerous landslide events as witnessed in recent years mostly during heavy and continuous rainfalls of monsoon season. In the months of May and June2022 alone, RILs caused debris flows, river flooding, the collapse of rail and road bridges, sweeping away of roadways, dislocation of railway lines in at least 26 sites, documented loss of three lives and damage to scores of properties affecting more than 30,000 people in the district. In this study, statistical analyses were undertaken to detect changes, if any, in intensity-frequency-duration characteristics of rainfall over the past 83 years by using hourly gridded precipitation data sourced from the reanalysis database of the ECMWF, and to find point biserial correlation, if any, between antecedent rainfall and landslide occurrences by developing an inventory of landslides of the study area covering the Dima Hasao District over the past seven years and using the precipitation data of those years. The results indicate a linkage between increased landslide and coincident rainfall events and point to the detrimental impact of climate change on RILs in the study area. This study shows the importance of antecedent rainfall that need to be considered together with physiographic factors as determinants of landslide events and would be helpful in creating a landslide hazard map of a study area for disaster prevention under a changing climate.

Keywords: Climate Change; Rainfall induced Landslide; Antecedent rainfall, Point Biserial Correlation, Logistic Regression

Disaster Vulnerability Mapping: A Block Level Analysis for Gujarat State, India

Shubham M. Jibhakate[1*], P. V. Timbadiya[2] & P. L. Patel[3]
[1]Ph.D. Research Scholar, Sardar Vallabhbhai National Institute of Technology Surat, Surat-395007, Gujarat, India.
[2]Associate Professor, Sardar Vallabhbhai National Institute of Technology Surat, Surat-395007, Gujarat, India.
[3]Professor, Sardar Vallabhbhai National Institute of Technology Surat, Surat-395007, Gujarat, India.
*shubhamjibhakate1771@gmail.com

Abstract

Gujarat state is situated in the western most part of India. It has the longest coastline in the country due to adjacent Arabian Sea. The state is vulnerable to multiple disasters, including cyclones, storm surges, sea level rise, floods, droughts, etc. The disaster vulnerability assessment of Gujarat state was carried out by focusing on, often neglected socio-economic dimensions at the block level. The census-based socio-economic sensitivity and adaptive capacity indicators are selected for a total of 226 blocks in the entire Gujarat state. The principal component analysis (PCA) technique has been used to remove any possible correlation among the selected indicators. Further, data envelopment analysis (DEA) technique has been used to obtain the vulnerability score for each block. The decadal change in socio-economic vulnerability has been analysed using 2001 and 2011 census data. During 2001, 44 blocks, nearly 21 % of the geographic area of the state, are found to be under high to very high vulnerable category. This has been found to increase to 75 blocks and 31 % of the geographic area of the state during 2011. The transformation matrix indicates that the vulnerability remains constant in 89 blocks and increased in 76 blocks over the decade (2001-2011). The developed socio-economic vulnerability maps can be integrated with the respective hazard maps for calculation of risk. By identifying vulnerable blocks and understanding their specific risk profiles, authorities can efficiently allocate resources and implement targeted measures to reduce the potential impacts of disasters.

Keywords: Gujarat, Socio-economic vulnerability, Block-level analysis, Principal Component Analysis, Data Envelopment Analysis.

Essential Climate Variables for Accurate Climate Change Impact Studies on Hydrological Regime: A Comprehensive Review

R. Avinash[1*], & G.S. Dwarakish[2]
[1]National Institute of Technology Karnataka, Mangaluru, India
[2]National Institute of Technology Karnataka, Mangaluru, India
*avinashr.227wo001@nitk.edu.in

Abstract

Essential Climate Variables (ECVs) are a set of key climate variables, identified by the Global Climate Observing System (GCOS) for understanding the climate system. Understanding the interactions between ECVs is critical for accurately modeling and predicting the impacts of climate change. In addition to the direct impacts of changes in ECVs, there are also complex feedback mechanisms that can either amplify or dampen the effects of climate forcings at a larger scale. While many researchers may use slightly different sets ECVs, some significant climate variables that are sometimes neglected, which can lead to underestimating or overestimating the impacts and introduce significant uncertainties in the results. This review paper aims to provide an overview of the climate system, ECVs, climate feedbacks, climate forcings and methodologies for identifying the significant ECVs for climate change impact studies on hydrological regime and to understand the uncertainties introduced due to neglecting few ECVs. A comprehensive review was conducted, consisting of an in-depth analysis of approximately 120 relevant scholarly articles. Methodologies for identifying the ECVs are discussed which involve multi-disciplinary approach that combines empirical analysis, climate model simulations and ensemble approach. It can be inferred that ECVs that have a significant impact on hydrological regimes, such as groundwater, soil moisture, and atmospheric humidity, etc. are often excluded from analysis due to a lack of available spatial and temporal data. In conclusion, improving the availability and accessibility of data for important ECVs is imperative, and can be achieved through investing in new monitoring methods and technologies, enhancing data sharing and collaboration among institutions and researchers, and prioritizing funding for data collection and analysis.

Keywords: Essential Climate Variables, Feedback Loops, Feedback Mechanisms, Climate System, Climate Forcings, Ensemble

Understanding Observed Trends in Heatwaves in Changing Climate

Saptashree Deb[1], Aparna Raut[1], Poulomi Ganguli1[1*]
[1]Indian Institute of Technology Kharagpur, Kharagpur India
*pganguli@agfe.iitkgp.ac.in

Abstract

Heatwaves are an inevitable natural threat of destruction. Other than heat-related mortality and health impacts, persistent heat exposure often lead to cascading failures, such as multiday blackout events because of increased electricity demand when air conditioning is required the most and reduced power production, threatening power grids, and loss of crop productivity, overstraining food-water-energy nexus. This study first synthesizes the physical understanding and elucidates typology, indices, and their multivariate characterization of humid heatwaves. Next, it illustrates changes in indices of the extreme humid heatwave characteristics over a few identified observational 'hotspots' over the South Asia (SAS) and Middle East and North Africa (MENA) regions during 1971-2023. A humid heatwave is detected when daily maxima wet-bulb temperatures exceed a pre-defined n th percentile (n = 85 and 90) thresholds centered on a 31-day window over a 30-year (e.g., 1981-2010) reference climatology. The change assessment is based on annual maxima wet-bulb temperature, and moderate to extreme humid heatwave conditions, detected by 85th percentile variable threshold with > 3 days long heatwave duration, and 90th percentile variable threshold with > 5 days long heatwave duration. The decadal trends are determined using Sen's slope, while trend significance is assessed through the standard bootstrap procedure. We show that considering threshold-based indices, larger spatial extents varying from 26-34% experience robust upward trends in humid heat stress compared to significant decreasing trends ranging from 13-15% of sites. This suggests that threshold-based indices offer viable avenues for assessing extreme humid heat stress risk compared to index solely based on the block maxima approach.

Keywords: heatwaves, humidity, climate hotspots, trend analysis, resilience

Disentangling non-stationarity linkages between Streamflow and Climate Variables at the River-basin Scale

Singh A.[1*], Sharma P.J.[2], Teegavarapu R.S.V.[3]
[1]Ph.D. Research Scholar, Indian Institute of Technology, Indore – 453552, INDIA
[2]Assistant Professor, Indian Institute of Technology, Indore – 453552, INDIA
[3]Professor, Florida Atlantic University, Boca Raton, Florida – 33431, USA
*achala.singh2304@gmail.com

Abstract

The impact of climate change on water resources have remained a focal point of ongoing research. This study investigates the impact of climate change on extreme flow events in the Tapi River basin. Hydroclimatic indices, at an annual time scale, defining the mean and extreme behaviour of rainfall, temperature, and streamflow are derived using the daily observed data for the period 1973-2021. Statistical analysis using trend tests, change point tests, and non-overlapping block stratified random sampling is employed to assess the temporal invariance of hydroclimatic indices. Non-stationarity has been observed in rainfall and temperature extremes, indicating significant changes over time. However, the streamflow extremes exhibit stationary characteristics, suggesting relatively consistent patterns. To delve deeper into this, we propose and employ an Imperfect Attribution Analysis (IAA) to scrutinize the interplay between climate variables and their impact on streamflow. Additionally, the IAA aims to pinpoint the predominant factor contributing to alterations in streamflow. This analysis uses a non-overlapping moving window of five years to investigate trend variations through the Modified Mann-Kendall test and assess the uniformity of slope changes using a parametric Equal Slope test. Understanding non-stationarity is crucial for comprehending the basin's dynamic nature and its response to influences like climate change, land use changes, and other human activities. The study concludes by delving into the intricate connections between streamflow and climate variables, aiming to uncover the relationships and dependencies between these two crucial factors. Unravelling the complex relationships between streamflow and climate variables enables infrastructure design advancements and promotes sustainable water management practices.

Keywords: Non-stationarity, Climate extremes, Non-overlapping block stratified random sampling, Trend tests, Tapi basin.

Changes in the long-term rainfall centroid and seasonality over the Tapi River basin, India

Lalit Kumar Gehlot[1*], P.L. Patel[1] & P.V. Timbadiya[1]
[1]Department of Civil Engineering, Sardar Vallabhbhai National Institute of Technology, Surat, India
*gehlot.lalit1994@gmail.com

Abstract

Global atmospheric changes lead to regional variations in the seasonality of hydroclimatic variables. Quantification of these regional variations helps in undertaking suitable adaptive measures. The rainfall centroid (RC) is a representative day around which annual rainfall is temporally distributed. The rainfall seasonality index (RSI) quantifies the temporal non-uniformity of annual rainfall. The present study uses the long-term gridded rainfall data of IMD to ascertain shifts in rainfall centroid and seasonality. The methodological framework uses a non-parametric Modified Mann-Kendall test for assessment of the statistical significance of the temporal changes. The trend assessment of RC and RSI for 1901 to 2020 shows increasing trends at 100% and 97.3% area of the Tapi River basin (TRB), respectively, including statistically significant trends at 14.8% and 38.9% areas, respectively. On average, the RC in TRB lies between July 28 to August 10, while the increasing RC shows lagging Indian Summer Monsoon Rainfall (ISMR) over the TRB. Similarly, the average RSI ranges between 1.1 to 1.33, which signifies that most rainfall is in less than three months. The increasing RSI shows a further concentration of temporal distribution of annual rainfall over TRB. The changing seasonality and lagging ISMR emphasize the careful operation and management of reservoirs and cropping activities in the TRB.

Keywords: ISMR, Modified Mann-Kendall, Rainfall centroid, Rainfall seasonality, Tapi River basin.

Assessing the flood risk potential using advanced statistical and machine learning model in lower Gangetic floodplain region, India

Moumita Kundu[1*], Ramkrishna Maiti[2]
[1] Research Scholar, Vidyasagar University, Midnapore, West Bengal-721102.
[2] Professor, Department of Geography, Vidyasagar University, Midnapore, West Bengal-721102.
*Moumita.kundu1002@gmail.com

Abstract

The number of natural hydro-meteorological disasters continuously increases worldwide due to global warming and weather anomalies. However, compared to other disasters, floods, due to their dire nature and socio-economic losses, are gaining international importance. The Bhagirathi River Basin in West Bengal, India, has been recognized as a flood-prone area for the past few decades. Through this article and identification of the flood-susceptible regions of the Bhagirathi basin, flood-vulnerable and risk areas have also been identified separately for disaster assessment. Based on 12 flood inventory conditioning parameters, susceptibility analysis performs through bivariate, multivariate, and machine learning models such as Linear regression (LR), Frequency Ratio (FR), Random Forest (RF), Support Vector Machine (SVM), K-Nearest Neighbour (KNN), Xtreme Gradient Boost (XGB). According to the acceptance of AUC, the RF model accepts to highlight the flood susceptibility of the Bhagirathi basin. Parametric vulnerability indices develop by susceptibility, exposure, and resilience on a blockwise small scale to assess socio-economic damage due to floods. Based on that the spatial distribution of flood risk has been developed through the amalgamation of the pixel-based flood susceptibility obtained by raster normalization and the flood vulnerability generated by the block-based spatial distribution using Arc GIs interface. Study revealed that Kandi, Sagardighi, Kaliganj, Nakashipara, Nabadwip, Krishnanagar II, Ranaghat I, and Purbasthali II block identify as the most flood risk prone areas in the Bhagirathi basin due to overall susceptibility and vulnerability. The results obtained from these observations will help the policymakers to develop holistic, sustainable development through flood prevention and control plans by considering the local environment and climate at the block level micro scale.

Keywords: Flood Susceptibility; Flood Vulnerability; Flood Risk; Bivariate and Multivariate model; Machine Learning approach

Fractal Characterization of Extreme Climatic Indices of Indian Megacities using Detrended Fluctuation Analysis

Shamseena Vahab[1], Aayisha Salim[1]& S. Adarsh[1*]
[1]TKM College of Engineering, Kollam, India
*adarsh_lce@yahoo.co.in

Abstract

Climate change has altered the characteristics and frequency of extreme precipitation and temperature. Characteristic analysis of extreme climate indices is essential for the planning and management of water resources and disaster preparedness. This study performed the fractal characterization of extreme climatic Indices over four Indian megacities of Mumbai, Guwahati, Cochi and Delhi of different climatic zones using multifractal detrended fluctuation analysis (MFDFA). Firstly eight temperature indices and five precipitation indices of the cities are estimated from daily rainfall, maximum temperature and minimum temperature of 1951-2021 period. The climatic indices included the four percentile based indices (Cool nights, Warm nights, Warm days, Cool days), seven absolute indices (R10mm, R20mm, PRCPTOT, TXx, TNn, Rx1day and Rx5day) and duration based indices like number of summer days (SU) and tropical nights (TR). The scaling behavior of different extreme indices is found to be ranging between biweekly to seasonal scale of 3 months in different time series. The results showed that most of the percentile based temperature indices deciphered long term persistence (Hurst exponent ranging between 0.55 to 0.92) and strong multifractality, irrespective of the city location, whereas rest of the temperature indices showed weak multifractality in all the cities. Precipitation indices are short-term persistent in character, which displayed multifractaity only for the data of Delhi. Multifractal spectrum of majority of the climatic indices indicated a right asymmetry indicating high probability of high fluctuations, except for the city of Guwahati. TN90p series of all cities exhibited string multifractality, which is due to the predominance in broadness of probability density function.

Keywords: Precipitation, Temperature, Climate Indices, Multifractal, Persistence.

Assessing the Influence of Climate Extremes on Streamflow in the Wainganga Basin: A Study of Vulnerable Hotspots and Temporal Variability

Chakkaralla Mahammad Rafi [1], Vamsi Krishna Vema[1]
[1]Department of Civil Engineering, National Institute of Technology Warangal, Warangal, India.
*cm712008@student.nitw.ac.in

Abstract

The impact of climate change on Earth's ecosystems has become more severe than initially anticipated, posing a danger to all natural ecosystems globally. Concerning the Wainganga Basin, the area has seen major climatic events over the past few decades that have significantly changed streamflow patterns. This study aims to examine the interaction between climate extremes and streamflow, particularly emphasizing the link between streamflow patterns and extreme climate indices generated from precipitation, maximum and minimum temperatures. This study aims to identify vulnerable places within the Wainganga Basin marked by variations in streamflow by assessing an in-depth assessment at different time scales. Due to the temperature and precipitation temporal and geographical fluctuation, as well as their time-delayed impacts, these sensitive hotspots experience seasonal changes. This study uses statistical techniques to evaluate the effects of extreme climatic events on streamflow patterns by analysing climate data and streamflow records. The research intends to provide insight into how climatic extremes influence streamflow dynamics by identifying extreme climate indices and their relationship with streamflow. Additionally, locating vulnerable regions and assessing temporal variability will give policymakers and resource managers significant information they can use to develop strategies that will effectively mitigate the adverse effects of climate change on the ecosystems and water resources in the area.

Keywords: Climate indices, Combined index, Principal Component Analysis, Vulnerable hotspots, Temporal Variability.

Analysis and Forecasting of Meteorological Drought in Upper Mahanadi River Basin using SPI and ARIMA in R

Kirtisuta Bhoi[1], Saismruti Mohapatra[2], Prof. Prakash Chandra Swain[3], Dr. Satyabrata Das[4]
[1]Assistant Professor, Department of Civil Engineering, Veer Surendra Sai University of Technology (VSSUT) Odisha India – 768018
[2]M. Tech Scholar, Department of Civil Engineering, Veer Surendra Sai University of Technology (VSSUT) Odisha, India – 768018
[3] Former Professor, Department of Civil Engineering, Veer Surendra Sai University of Technology (VSSUT) Odisha, India – 768018
[4]Associate professor, Department of Information Technology, Veer Surendra Sai University of Technology (VSSUT) Odisha, India – 768018
*kirtisutabhoi@gmail.com

Abstract

Rainfall and temperature are most important indicators for availability of water and evaporation control. These parameters can be used as indicators of drought. The present study aims at drought analysis and prediction in the upper Mahanadi river basin. Prolonged shortage in supply of water (atmospheric, surface or groundwater) represents an event of drought. In this work meteorological drought will be analysed using SPI for 3, 6, 9 and12 month time scales. The Standardized Precipitation Index (SPI) depends on precipitation and used for monitoring of meteorological drought and is calculated for different time scales, which is a great advantage. After data processing of the SPI, ARIMA, a time series model is applied for forecasting of drought event, such as autoregressive (AR) model, moving average (MA). ARIMA model has 3 parameters such as p, d, q where p provides lag parameter of the AR function of ARIMA model, which are acquired from PAC plot of time series data. q provides lag parameter of MA and is obtained from the ACF. SPI and ARIMA models are used for drought assessment using R package. It is observed that the upper Mahanadi basin is under near normal and mild drought condition.

Keywords: Standardized Precipitation Index (SPI), Autoregressive (AR) Model, Moving Average (MA), Autoregressive Integrated Moving Average (ARIMA), Autocorrelation Function (ACF), Partial Autocorrelation Function (PACF), In-situ bioremediation of groundwater using Meshless Local Petrov Galerkin (MLPG) simulation coupled with Differential Evolution (DE).

Assessment of Maximum Temperature for Future Time Series over Maharashtra State, India

Barokar Y. J.[1], V.S. Pradhan[2]
[1]Research Scholar, Department of Civil Engineering, Jawaharlal Nehru Engineering College MGM University, Chpt.Sambhajinagar, Maharashtra State
[2]Professor, Department of Civil Engineering, Jawaharlal Nehru Engineering College MGM University, Chpt.Sambhajinagar, Maharashtra State
*yogeshbarokar@gmail.com

Abstract

Climate change and its impacts constitute a critical issue requiring urgent attention due to their adverse effects on diverse sectors like agriculture, ecosystems, and the economy. There exist multiple approaches to tackle this problem, and downscaling is one such method. Downscaling involves extracting global-level information and applying it at a local level (Wilby R.L. 1998). General Circulation Models (GCMs) play a pivotal role in climatic downscaling. Numerous countries have developed their GCM models, providing climatic variable values globally for future timeframes. Through downscaling, we can determine climatic variables for our local areas. The two main types of downscaling are statistical downscaling and dynamic downscaling. In this particular study, statistical downscaling was employed using the Statistical Downscaling Model (SDSM) to project future trends in maximum temperature (Tmax) over the Maharashtra state region. The primary objective of this research is to analyze temperature patterns over Maharashtra within short-year spans and compare these findings with the projections made by the IPCC regarding increasing temperature patterns in the foreseeable future under different Representative Concentration Pathways (RCPs). The CMIP5 (CanESM2) GCM model was utilized for downscaling, carried out under three RCPs: RCP 2.6, RCP 4.5, and RCP 8.5. The baseline period considered for this analysis spans from 1961 to 2005. The statistical model was calibrated for the years 1961-1980 and validated for the years 1981-2000. Future results were evaluated using three future series: 2020s (2011-2040), 2050s (2041-2070) and 2080s (2071-2099). To assess the increase in temperature values for future time series in relation to the baseline period, the study scrutinized results over short-year spans: 2006-2015, 2016-2025, 2026-2035, 2036-2045, 2046-2055, 2056-2065, 2066-2075, 2076-2085, 2086-2095, and 2096-2099. The findings across these spans were analyzed both statistically and graphically. The results for the selected three future series exhibited increasing trends of Tmax values over Maharashtra state under all three RCPs concerning the baseline period. The increases in Tmax values for these series are as follows: under RCP 2.6 - 0.47°C, 1.63°C, and 0.83°C; under RCP 4.5 - 0.54°C, 1.85°C, and 1.49°C; and under RCP 8.5 - 0.58°C, 2.50°C, and 2.99°C. Additionally, results for the short-year spans indicated increasing trends of Tmax values over Maharashtra state across all RCPs. These short-year span results align with the conclusions drawn by the IPCC. Specifically, under RCP 2.6, Tmax exhibits an increasing trend, but near 2099, it indicates a decreasing trend. In contrast, under RCP 4.5, Tmax shows an increasing trend, with a slight decrease near 2099. Under RCP 8.5, it shows a persistent increasing trend across the future series.

Keywords: Tmax, SDSM, CMIP5, RCP 2.6, RCP 4.5, RCP 8.5

Hot and Wet Weather Extremes Assessment for Central India Smart Cities

Vijay Jain[1*], Manish Kumar Goyal[1]
[1]Indian Institute of Technology, Indore, India
*tomarvijay5514@gmail.com

Abstract

In 2015, the Indian smart cities mission was initiated with one of the objectives of making these cities resilient to climate change and extreme weather events like heat waves, extreme precipitation, urban drought, etc. The present study computes the heat waves and extreme precipitation risk for West Central Indian smart cities. We assessed the heat wave hazard for the cities based on the influence of the heat wave characteristics like duration, frequency, and intensity during historical and future climate scenarios. The historical and future datasets of heat waves were analyzed using IMD and CMIP 6 datasets. The extreme precipitation events were computed using IMD datasets, and we assessed the nonstationary influence of the climate oscillations over them using extreme value analysis. Using these extreme events datasets, we have assessed hot and wet weather extremes for the Central India smart cities. The cities in this region are more prone to the risk of heat waves and extreme precipitation events. Cities like Sagar, Satna, Raipur, and Bilaspur observe frequent increases in the hot and wet weather extremes. This study assists smart city policymakers in making adaptation and mitigation plans for improving the urban health well-being across smart cities of these regions.

Keywords: Climate Change, Extreme Precipitation, Heat Waves, Central India, Smart Cities

Agricultural Drought Risk Assessment in Southern Plateau and Hills using Multi Threshold Run Theory

Hussain Palagiri[1], Manali Pal[*1]
[1]Department of Civil Engineering, NIT Warangal, Telangana - 506004, India
*manalipal000@gmail.com

Abstract

An agricultural drought index, namely Standardised Soil Moisture Index (SSMI) is derived to characterise agricultural drought and assess its risk in Southern Plateau and Hills (SPH), India. Run theory is applied for SSMI with three thresholds to identify grid-wise drought events and characterize them in terms of duration (D_d), frequency (D_f), intensity (D_s), and peak (D_p). SSMI's performance in assessing drought risk is evaluated by comparing it with Standardised Precipitation Evapotranspiration Index (SPEI). The observed spatial distribution of D_f is found to be consistent with that of D_d for both the indices suggesting that regions experiencing longer drought events also tend to have more frequent drought occurrences. The D_d, D_f, D_s by SSMI showed slightly lower drought risk compared to SPEI whereas SPEI indicated relatively lower drought risk in terms of D_p. This also suggests that meteorological droughts are more intense (higher D_s) occurring more frequently (higher D_f) with longer duration (higher D_d by SSMI) and less severity (lower D_p) compared to SSMI in SPH from 1991 to 2020. There is strong heterogeneity in the spatial distribution of drought events as identified by both the indices. The comparison of SSMI with SPEI shows that the spatial distribution of drought risk identified by SSSMI is similar to the analysis using the SPEI suggesting that the SSMI is a reliable indicator of drought risk. The Archimedean copula functions are used to assess the joint occurrence of drought characteristics. The results show that the joint occurrences of duration and peak, intensity and frequency, and duration and peak are all high. This suggests that these drought characteristics are often correlated, which has important implications for drought risk management. The application of copula functions to agricultural drought risk provides valuable insights into the joint behaviour of drought characteristics. This information can be used to improve our understanding of drought dynamics and to develop more effective drought warning and risk management systems.

Keywords: Agricultural Drought; European Space Agency (ESA) Climate Change Initiative (CCI) SM (ESACCI SM); Standardised Soil Moisture Index (SSMI); Standardised Precipitation Evapotranspiration Index (SPEI); Run Theory.

Assessing Future Climate Extremes in Northeast India and Bangladesh: A Multi-Model Ensemble Approach

Ashesh Rudra Paul[1] & Rajib Maity[1*]
[1]Indian Institute of Technology, Kharagpur, India
*rajib@civil.iitkgp.ac.in

Abstract

In recent times, India has borne witness to the devastating repercussions of extreme weather phenomena, particularly in the Northeast India (NEI), renowned for its abundant natural resources. Regrettably, existing research has often neglected to acknowledge the geographical continuity of NEI with its neighbouring nation, Bangladesh, thereby presenting an incomplete panorama. To bridge this informational void, a comprehensive approach was undertaken, encompassing the entirety of NEI, including Bangladesh as well as, collectively referred to as NEIB. The current study rigorously examined climate extremes in the NEIB region using 8 precipitation-based and 12 temperature-based indices developed by the Expert Team on Climate Change Detection and Indices (ETCCDI). The 14 GCM models were utilized to extrapolate climate trends from 2015 to 2100, considering four distinct Shared Socioeconomic Pathways (SSPs) scenarios. Notably, under the rigorous SSP585 scenario, our study predicts a substantial temperature surge, with maximum and minimum temperatures set to rise by 4 and 5.5˚C. Warming indices, including the Warm spell days index (WSDI) and the summer days index (SU), are expected to increase significantly, with WSDI surging by 2 days and SU rising by nearly 53 days. The frequency of heavy precipitation days (R20mm) is projected to amplify by as many as 14 days, with a notable focus on Meghalaya. The Simple daily intensity index (SDII) is projected to increase to 16.8 mm/day from its current value of 14.4 mm/day. These transformative climatic shifts are poised to exert profound impacts on critical facets of society, including water resources, agriculture, public health, and essential infrastructure.

Keywords: Climate change; Northeast India; CMIP6; Water resources management; Adaptation responses.

Spatio-Temporal Variation of Annual, Crop-Seasonal and Diurnal Temperature Range for Temperature in Amaravathi Basin, Tamil Nadu, India

S. Hemanandhini[1] & L. Vignesh Rajkumar[2*]
[1]Research Scholar, Department of Environmental and Water Resources Engineering, School of Civil Engineering, Vellore Institute of Technology, Vellore, Tamil Nadu, India.
[2]Assistant Professor, Department of Environmental and Water Resources Engineering, School of Civil Engineering, Vellore Institute of Technology, Vellore, Tamil Nadu, India.
* vigneshrajkumar.l@vit.ac.in

Abstract

Temperature is the most important climate parameter to study for climate change. The current study analyzed the trends of annual average temperature, crop-seasonal temperature and Annual Diurnal temperature range (DTR) over the Amaravathi river basin, Tamil Nadu, India, using observed daily data from seven stations during the period of 1985–2020. Non-parametric tests, like sequential Mann-Kendall (SqMK) test and Innovative Trend Analysis (ITA) results revealed that the annual average temperature has a significantly increasing trend, mainly during the years after 2010, and the magnitude has increased very rapidly, signifying the evidence of climate change and global warming. The Kharif season observed an increasing trend in average temperature except for Mayanur station, and the Rabi season experienced an increasing trend in average temperature except for Uthamapalayam station, respectively. The Annual Diurnal Temperature Range (DTR) exhibited an increasing trend except for Kamatchipuram, Viralipatti, and Mayanur stations. Significantly rising temperature trends may have a huge impact on the study area's agricultural production and water availability. This regional-level temperature trend analysis will help policymakers develop regulations or amendments to existing policies pertaining to achieving the Sustainable Development Goals (SDGs) of SDG 13 (climate action) and SDG 2 (zero hunger).

Keywords: Amaravati basin, Temperature trends, Sequential Mann-Kendall test (SqMK), Innovative Trend Analysis (ITA)

Changing Dynamics of Extreme Precipitation Events in Upper Indus Basin

Mani Kanta Malla[1*], Dhyan Singh Arya[1]
[1]Department of Hydrology, Indian Institute of Technology Roorkee, Roorkee, India
*mkanta@hy.iitr.ac.in

Abstract

The Hindu Kush Himalayan region, a crucial geo-ecological region, comprises one of the most important mountain systems in the world. The Indus River originates in this region and feeds over 270 million people across six countries, including India. In this study, we (i) investigated precipitation extremes trends and (ii) studied dry and wet spells in the Upper Indus Basin. The analysis of extreme events follows World Meteorological Organization guidelines on the analysis of extremes, and ETCCDI climate change indices are used. The study covers a time span from 1901 to 2019 using gridded data from India Meteorological Department. The analysis depicts the intensification of droughts, which is generally associated with significant decreasing trends in the lower quantiles. A significant trend in the higher quantile indicates an increasing pattern of extreme precipitation events. There is a decrease in lower elevation regions in high quantiles of the winter season and an increase at higher elevations. Increasing in both scenarios causes skewness in the precipitation distribution, which affects the water availability and management. The results of this study reveal the hidden trend in extreme events in the world's most susceptible climate region.

Keywords: Hindu Kush Himalaya, Trend Analysis, Mann-Kendall, Sen's slope, Quantile regression

Design of Power Intake – A Case Study

K.C. Sahu[1*] & K. Rajesh[2]
[1]CW&PRS, Pune, India
[2] CW&PRS, Pune, India
*erkcsahu@yahoo.co.in

Abstract

Power intake in a hydropower scheme is an entry point of water conductor system which carries water to the power house for power generation. It is a very important structure and due care must be given to its design. It should be designed such way that there should not be any flow circulation in front of intake which could lead to formation of air- entraining vortices. Each project has a unique design and layout of intake and therefore it is difficult to predict the probability of formation of an air entraining vortex based on the available empirical equations developed by many Researchers in the past. It is therefore necessary to conduct hydraulic model studies for intakes to get confidence even though if it is safe based on available Researcher's formulas. Recently, a study was conducted for Power intake of Kholongchhu H.E Project, Bhutan on a geometrical similar model having a scale of 1:40.The adequacy of submergence over intake corresponding to minimum draw down level (MDDL) was checked prior to carrying out hydraulic model studies by plotting the point (P) on a graph of Dimensionless submergence versus Froude Number, where various researchers equation were plotted and nothing could be concluded based on the earlier researcher's guide lines and therefore it was decided to conduct the physical model studies. Model studies shows occasional formation of Type 1 and 2 vortices near the trash rack piers. These vortices are incoherent surface swirl to surface dimple coherent swirl vortices and are non air-entraining. As the vortices are of non air-entraining type, there is no need for anti-vortex devices. Study shows normal flow conditions in front of intake and in the reservoir.

Keywords: Power Intakes, Water Conductor, Vortex, Trash Rack

Illuminating the Shadows: An In-depth Review of Risks in Hydropower Development

Nikhil Garg[a], Sanjeev Kumar[a*], Sourav Kumar Das[b] and Manish Pandey[c]
[a]Department of Civil Engineering, Graphic Era Deemed to be University, Dehradun, India
[b]Department of Civil Engineering, Manipal University, Jaipur, India
[c]Department of Civil Engineering, National Institute of Technology, Warangal, India
*er.sanjeevkr@gmail.com

Abstract

As the world strives to harness renewable energy sources, hydropower development has emerged as a vital component in the energy mix. Nevertheless, it comes with a range of multifaceted and intricate risks. This review paper offers an in-depth examination of the various risks linked to hydropower development, classifying them under technical, environmental, social, economic, and political categories. This study elucidates the technical risks, from design and construction challenges to operational and maintenance issues. It then sheds light on the environmental risks, which include biodiversity loss, habitat disruption, and water quality degradation. Further, the paper delves into the social and economic risks, encompassing community displacement, cultural impacts, and changes in local employment patterns. Lastly, the political risks, such as regulatory uncertainty and stakeholder conflicts, are analyzed. To address these risks, the review also presents potential mitigation strategies, exploring best practices in engineering, community engagement, and policy frameworks. Moreover, the paper highlights future research directions aimed at enhancing the sustainability of hydropower development, emphasizing the need for innovative approaches and interdisciplinary collaboration.

Keywords: Hydropower, Hydropower development, renewable energy, sustainability, water quality degradation.

Determination of Optimum Diameter of Penstock for Hydro Power Project using Conventional Optimization Method and Particle Swarm Optimization Method (PSO)

V.M. Rana[1*] & H.M. Patel[2]
[1]Faculty of Technology & Engineering, The Maharaja Sayajirao University of Baroda, India
[2] Faculty of Technology & Engineering, The Maharaja Sayajirao University of Baroda, India
*vijayrana-ced@msubaroda.ac.in

Abstract

A hydro power project is the most suitable and effective means to generate electric power at reasonable low cost without harming the environment. One of the most important objectives in planning of hydro power plant for a river valley project is to select the most suitable diameter of penstock pipe. The process of selection of the most suitable diameter needs optimization of penstock diameter under different condition of flow. The optimization of penstock pipe involves maximizing efficiency of conveyance system of hydro power plant linked between reservoir and turbine. The penstock must be designed to minimize loss of head due to friction and turbulence of water during flow. The condition of flow may be steady state or unsteady state. The diameter of penstock should not be too large which invites operational difficulty and should not be too small which invites increase in friction loss. The surface roughness of penstock is also an important factor for maintaining turbulence free flow in conveyance system. Pressure variation and friction factor of penstock material must be considered as the decision variables for formulating optimization problem. In this paper an attempt has been made to optimize the diameter of penstock using conventional method of optimization and advanced method like Particle Swarm Optimization (PSO).

Keywords: Hydro power, Penstock, Particle Swarm Optimization, Optimum diameter, Unsteady flow

Comparative Study of Experimental and Cfd Analysis for Hydraulic Performance of Trench Weir

A. Acharya[1*], S. Bhave[2] & M. Patel[3]
[1]Visvesvaraya National Institute of Technology, Nagpur, India(student)
[2]Visvesvaraya National Institute of Technology, Nagpur, India
(Assistant professor, Department of civil engineering)
[3]Dr. B. R. Ambedkar National Institute of Technology Jalandhar India
(Assistant professor, Department of civil engineering)
*Ansuman.acharya.1999@gmail.com

Abstract

Water from a river is typically diverted into a conveyance system for hydropower, irrigation, and water distribution projects using diversion structures. In boulder streams with steep slopes, where significant sediment transport and flood flow occur, trench weirs are a frequently employed diversion tool. It is exposed at the stream's bed level, and a bottom rack is placed on top of it. Bars of various shapes, such as circular, T-shaped, and rectangular, are used as bottom rack. The primary goal of using a bottom rack over a trench weir is to maximize water flow while minimizing sediment retention. This present study is about T- shaped rack because it has low sediment ingestion and maintenance.

This study examines the main results obtained by using clear water flow through rack and ramp, in laboratory and Computational Fluid Dynamics (CFD) methodology. Ansys-Fluent software is employed to solve the three-dimensional flow problem of the CFD, which is based on the numerical solution of the Reynolds Averaged Navier-Stoke equation and turbulence model with various void ratios of the rack. In this current work, a ±15% inaccuracy in result is found in the comparison of flow depth for three distinct ramps and three different rack slopes using experimental and numerical data.

Keywords: Diversion structure, Trench weir, Bottom rack, CFD, Ansys-Fluent

Efficient Energy Dissipation in Low-Head Diversion Structures: A Hybrid Modelling Approach Investigation

C. Balaji[1], D. Diwakar[2], P. Anbarasan[2], Soumendra Nath Kuiry[1*]
[1]Indian Institute of Technology, Madras, Chennai, India
[2]Institute of Hydraulics and Hydrology, Poondi, Chennai, India
E-mail: ce22d041@smail.iitm.ac.in, diwa08354@gmail.com, arasan1965@gmail.com,
*snkuiry@civil.iitm.ac.in

Abstract

The Adhanur Kumaramangalam Barrage, a proposed low-head diversion structure on the Coleroon River in Tamil Nadu (TN), India, has undergone a comprehensive evaluation of its energy dissipation arrangements. This assessment aimed to ensure the effectiveness and stability of the structure. The study was carried out using a novel hybrid model approach, combining both Flow-3D simulation and experimental model studies. The primary purpose of the barrage is to divert water to the canal through head sluices and canal sluices, offering various applications, including groundwater quality improvement, flood control, discharge measuring structure, and transportation facilitation. Consequently, the project incorporates outlet structures like barrages and scour vents, strategically positioned at different crest levels to release water downstream. The energy dissipation arrangements situated downstream of the barrage play a crucial role in safeguarding the riverbed and ensuring the stability of the entire structure. The study focused on analyzing the effectiveness of the energy dissipation arrangements under various operational scenarios, both with and without basin blocks. The investigation yielded significant findings, indicating that basin blocks are not necessary for low-head diversion structures. These insights offer valuable guidance for optimizing future design and construction of similar structures.

Keywords: Hybrid Model Study, Section Model, Barrage, Energy Dissipation arrangements, Basin Blocks.

Assessment of Structural Safety of Hydraulic Structures against Induced Vibrations

Prakash K. Palei*, Santhosh Kumar, Vijay Ghodake, Rizwan Ali
Central water and Power Research Station, Pune- 411 024
*prakash.palei@cwprs.gov.in

Abstract

Civil structures in Hydropower stations are always subjected to induced vibrations due to operation of generation units. Vibration monitoring (VM) at these structures will enhance the performance of generation units as well as ensures safety of the civil structures. Vibration monitoring of generation units always reduces the probability of damage and break down chances, so that generation unit remains in active operation for a longer period. Further, vibration analysis is considered as one of the most effective tool used to check the health of plant machinery and diagnose the causes. The health of turbine unit as well as civil structures are assessed by periodical vibration monitoring which provides early indication of the failure so that necessary countermeasures can be taken up timely to avoid catastrophic failure. In view of the above, in the present paper an attempt has been made to study the effects of vibration induced by the four generation units running simultaneously on the power house structure located in Rengali, Odisha. The study has been carried out under the full load operating conditions of the four turbine units and vibration measurement has been carried out at various locations of the power house structure. Based on analysis of the vibration results, it has been found that the observed vibration levels are well below the acceptable limit of vibration.

Keywords: Powerhouse, Turbine, vibration monitoring, generation unit

An experimental Study on Trench Weir with Flat bars under free flow condition

Ashish Dabral[1*]; P.K. Sharma[2]; Z. Ahmad[3]; Sanjeev Kumar[4]
[1]Research Scholar; [2]Associate Professor; [3]Professor and [4]Professor
[1,2,3]Indian Institute of Technology Roorkee, Roorkee, Uttarakhand 247667, India.
[4] Graphic Era Deemed to be University, Dehradun
*adabral@ce.iitr.ac.in

Abstract

Trench weirs are a common structure for diverting water from a boulder stream for various purposes such as hydropower, irrigation, and water supply, etc. To ensure the proper functioning of the trench weir, a trench is built below the bed level of the stream and is covered with bars to prevent sediment from entering into the trench. These types of weirs offer clear benefits as they do not impede the river's natural flow. This paper describes an experiment that investigates various parameters that affect the discharging capacity of a trench weir. From the structural consideration, the flat bars are used in the present study due to more flexural rigidity. A ramp was placed on the upstream side of the main channel at the brink of the trench to minimize the entry of sediment into the trench.

Experiments were performed for free flow conditions for bed slopes of the main channel (S) =1/50, 1/ 100 and 1/200; rack slopes (s_r) = 0, 1/10 and 1/15; thickness of flat bars (t) = 5mm; clear spacing of rack (s) = 2.0 mm, 5.0 mm and 9.0 mm; ramp angle (s_p)= 10^0, 15^0 and $20^0$and for each set of these parameters, five different discharges. An attempt has been made to examine how different factors affect the discharge characteristics of a trench weir. The factors considered included the clear spacing of rack bars, the slope of the bottom rack, the approach depth of flow, specific energy, the Reynolds number, the Froude number, and the height of the ramp. The findings demonstrate that when these parameters increase, the coefficient of discharge decreases. In summary, the study yields significant information regarding the performance of trench weirs and the factors that impact their discharge characteristics.

Keywords: Trench weir, boulder stream, diversion channel, Flat bars, coefficient of discharge

Effect of Layout of Approach Channel on the Discharging Characteristics of Spillway

Vankayalapati_S. Ramarao[1*], M. G. Muni Reddy[2], K. C. Sahu[3]
[1]PhD Research Scholar, Department of Civil Engg. Andhra University & Visakhapatnam, Andhra Pradesh
Scientist -C, Central Water and Power Research Station, Khadakwasla, Pune, Maharashtra
[2]Professor, Department of Civil Engg. Andhra University, Visakhapatnam, Andhra Pradesh
[3]Scientist -C, Central Water and Power Research Station, Khadakwasla, Pune, Maharashtra
* sramaraov@gmail.com

Abstract

Spillways are the structures meant for controlling the incoming flood into the reservoir. Among various spillways, ogee is widely used one due to its better hydraulic characteristics. The discharging capacity of the spillway is the important aspect of the dam safety. It is governed by various factors like the profiles of the upstream, crest and the downstream of spillway, effective length of the spillway, design head, tailwater levels, etc. In addition to these, the approach flow conditions, either supercritical/ subcritical, play crucial role in obtaining maximum discharging capacity of the spillway. When the spillway is located away from the main course of the river, an approach channel is to be excavated to divert the flow towards the spillway. It has the entrance in the reservoir and exit connected to the spillway. The approach channel alignment may be straight, curved or partially straight and partially curved. The spillway approach channel is frequently submerged with confined/ unconfined boundaries and symmetrical/ asymmetrical in layout. Proper alignment of approach channel minimizes the head loss by reducing the oblique flows towards a spillway and thus improves its discharging capacity and also ensures the safety of the abutments. The ratio of the height of crest above the bed level of the approach channel and the design head also influence the discharging capacity of the spillway. Moreover, the approach channel configuration influences the abutment contraction coefficient, the nappe profile and also the flow characteristics through the spillway and its stilling basin. The flow conditions in the channel get improved by its straightening, removing constrictions and by its widening. Excavation of auxiliary approach channel may also improve the discharging capacity of the spillway. But these conditions are site specific. Hydraulic model studies play substantial role in testing these kinds of layouts to find out an optimum layout that improves the discharging capacity of the spillway. Studies were carried out on a 1:140 scale model of spillway with straight, curved approach channel layouts, to improve the discharging capacity of the ogee spillway. Studies indicated that the straight and wider approach channel has better discharging capacity due to improved flow conditions in the vicinity of the spillway.

Keywords: Discharging capacity, Approach channel, asymmetry, guide bund, flood, spillway.

Design of Innovative Energy dissipator for Subansiri Lower Dam Spillway, Arunachal Pradesh/ Assam

Vankayalapati S. Ramarao[1*], R.R. Bhate[1]
[1]Scientist- C, Central Water & Power Research Station, Khadakwasla, Pune- 411 024.
*sramaraov@gmail.com

Abstract

Energy Dissipators are the structures provided for the spillways for dissipating the energy generated by impounding water, when released down, without causing damage to the spillway structure and its downstream. The various factors that influence the provision of a suitable type of energy dissipator are the design flood, design head, tailwater levels and the geology downstream of the spillway. The most commonly used types of energy dissipators provided for spillways are in the form of stilling basin, ski jump type buckets, solid and slotted roller buckets. But, sometimes, to suite to the hydraulic, hydrologic, topographic, geological conditions of location of spillway and responding to the dam safety issues, the energy dissipators are required to be provided by modifying their original form, making them an innovative type. An innovative type of energy dissipator was recommended for spillway of Subansiri Lower H.E. Project, Arunachal Pradesh/ Assam, by carrying out hydraulic model studies in CWPRS. A 116 m high and 271 m long concrete gravity dam is being constructed across the Subansiri river to generate 2000 MW (8 units of 250 MW each) utilising a gross head of 91 m. The spillway is designed to dispose of a maximum outflow flood of 35,000 m^3/s at MWL El. 208.25 m. The original design of spillway was 83 m long and with 9 spans 11.5 m (W) x 14.7 m (H) having crest at El. 150 m. The original energy dissipator was in the form of ski jump bucket with invert at El. 128.732 m. Extensive hydraulic studies were conducted in CWPRS on various alternatives for evolving suitable design of energy dissipator. The performance of the original design of ski jump bucket, stilling basin with apron elevations at El. 85 m and El. 94 m were studied, as suggested by the Technical Expert Committee (TEC) set up by Planning Commission. Further, as suggested by the Dam Design Review Panel (DDRP), model studies were conducted for the modified spillway with an innovative type of energy dissipator, comprising of 213 m long extended chute ending in multi level ski jump buckets for different spans at elevations of El. 108 m, El. 118 m and El. 125 m, and found that the energy dissipator has been performing satisfactorily, and recommended for adoption and the project is under constructions. In this paper, the various studies carried out on 1: 90 physical hydraulic model to arrive at this innovative energy dissipator and the hydraulic performance are described.

Keywords: Energy dissipator, ski-jump bucket, pre-formed plunge pool, stilling basin, hydraulic jump.

A comprehensive investigation of wake recovery distance of modified Savonius turbine with vertical and horizontal alignment

Upendra Bajpai[1*], Dr. Manoj Sood[2] & Dr. Sunil Kumar Singal[3]
[1]Research Scholar, Hydro and Renewable Energy Department, IIT Roorkee, Roorkee, India
[2]Project Fellow, Hydro and Renewable Energy Department, IIT Roorkee, Roorkee, India
[3]Professor, Hydro and Renewable Energy Department, IIT Roorkee, Roorkee, India
*upendra_b@hre.iitr.ac.in

Abstract

For sustainable growth, In-stream technology utilizing the flow energy available in the water with the help of a turbine gained the attention of researchers. The helical Savonius turbine, known for its superior starting characteristics and higher power coefficient than the conventional Savonius turbine has been selected in the present study. The numerical study analyzes the wake recovery distance, pressure, and velocity characteristics of the helical Savonius turbine for horizontal and vertical alignment, considering 0.9 m/s flow velocities and 0.9 optimal TSR. The numerically simulated results are validated against experimental data, showing good agreement. Velocity contours unveil higher velocity vortices at the tip of the advancing blade in case of vertical alignment and at the end plate and along the length of the rotor in case of horizontal alignment. Notably, the near, transition, far wake zone is found to be extended up to 2D, 2D to 4D, beyond 4D for vertically aligned turbine and 1.5D, 1.5D-3D, beyond 3D for horizontally aligned turbine. The wake recovery distance for vertically and horizontally aligned turbines are reported as 12D and 8D, respectively, enabling closer installation of horizontally aligned turbines compared to vertical ones. These findings are valuable for optimizing arrays of helical Savonius turbines to achieve maximal energy extraction. The study is of great importance to researchers and industrialists looking to improve power generation through in-stream technology.

Keywords: In-stream technology, Helical Savonius turbine, Wake recovery, Velocity contours, Pressure contours**.**

A review on risk in hydropower development and management

Venkata Sai SurendraBandi*, T.K. Swain, Chandan Gupta & Raghuchandra Garimella*
Central Water and Power Research Station, Department of Water Resources, River Development & Ganga Rejuvenation, Ministry of Jal Shakti, Khadakwasla, Pune, India
*surendra.bandi@cwprs.gov.in

Abstract

Hydropower development and management is an important source of electricity production, especially in developing countries. However, process of hydropower development poses several risks particularly regarding power related issues like inadequate planning, unsuitable site selection and poor maintenance that may affect the projects performance and overall power generation. Furthermore, natural disasters such as floods and landslides would damage the projects infrastructure, leading to loss of power production and increased costs. Another significant challenge in hydropower management is the fluctuation in water supply. Changes in water levels may significantly impact power generation as it directly affects turbine efficiency and power output. This in turn leads to revenue and financial losses for the project. The electricity generated by hydropower is often transferred through transmission lines, which are also subject to potential risks such as weather-related outages, equipment failure and damage from natural disasters. Therefore, it is crucial to implement appropriate measures to ensure the reliable and efficient transmission of electricity. This paper reviews the risk involved in Hydropower development, management of power related issues and suggests some mitigation measures such as proper planning, selection, preventive maintenance, which may enhance the projects performance and profitability.

Keywords: power generation, risk management, mitigation measures, optimal revenue generation, project performance.

Mitigating Hydraulic Transients in Piping Systems: A Case Study on Surge Analysis andAnti-Surge Device Recommendations

M.S.R. Naidu[1*], A. Jyothi Prakash[1], P.M. Abdul Rahiman[1], T.K. Sahu[1] & G.C. Sahoo[1]
[1]Central Water and Power Research Station, Department of Water Resources, River Development & GangaRejuvenation, Ministry of Jal Shakti, Khadakwasla, Pune, India
*seetaramimalla@gmail.com

Abstract

Hydraulic transients, such as surge events and water hammer, can pose significant risks to the reliability and safety of piping systems. This research paper presents a comprehensive case study on surge analysis and provides practical recommendations for implementing anti-surge devices to mitigate these hydraulic transients. The study aims to enhance the performance and integrity of piping systems by offering valuable insights into surge analysis techniques and the selection of effective anti-surge measures. Hydraulic transients can subject pipes, valves, pumps, and other system components to excessive pressure, resulting in structural damage, leaks, and even catastrophic failures. These incidents not only require costly repairs but also lead to extended downtime and disruption of operations. To mitigate these detrimental effects, transient analysis is crucial. It helps identify surge-prone areas, determine surge pressures, and evaluate potential consequences. Transient analysis provides critical information for designing and implementing appropriate anti-surge measures. This paper illustrates the surge analysis and recommended anti-surge devices for rising mains of lift irrigation schemes NER I having a 0.46 Km long pipeline and NER II having a 1.15 Km long pipeline located at Jihe, Kathapur- Koregaon, Satara, Maharashtra. In case of power failure of the pumps, the pressure is analysed to check column separation, pressure surges, and the necessity of providing anti-surge devices such as air vessels, air valves, etc. After detailed analysis, suitable anti-surge devices to suppress the surge pressures to a permissible limit on the rising mains of NER Lift Irrigation Schemes I and II are recommended.

Keywords: Surge Analysis, Hydraulic transients, Anti-surge devices.

Operation of cascade hydropower stations considering lag time for minimizing power deficit using Genetic Algorithm

A. Karki[1], U. D. Bhatta[1] and B. N. S. Ghimire[1]
[1] Pulchowk Campus, Institute of Engineering, Kathmandu, Nepal
*karkiaavas5@gmail.com

Abstract

The current power supply situation in Nepal experiences a surplus of power during the rainy season, from June to September, while from December to May, there is a power deficit. Storage hydropower projects can help to minimize the power deficit, especially in the dry season. Cascade hydropower stations can increase the generation of storage projects, but they can also increase the complexity of reservoir operation. In this paper, a Genetic Algorithm (GA) optimization model with the objective of minimizing power deficit is proposed to determine the optimal hourly releases from the reservoir with cascade hydropower stations. The model was developed considering the Kulekhani reservoir, which feeds Kulekhani I, Kulekhani II, and Kulekhani III hydropower stations located in Makawanpur district of Bagmati Province in Central Nepal. The results obtained from the optimization model showed a significant increase in energy generation compared to the actual generation during the dry period. The obtained results were also able to suggest the reservoir levels at different stages of the year for optimal operation of the reservoir. Also, this study demonstrates the usefulness of GA for solving complex reservoir optimization problems.

Keywords: Cascade hydropower stations, Power Deficit, Reservoir Operation, Kulekhani Reservoir, Genetic Algorithm

Computational Study of a Low head Francis Turbine with Varying Runner Blade Numbers

Prashant Kumar [1*], S.K. Singal [1] & Pankaj P. Gohil [2]
[1] Department of Hydro and Renewable Energy, Indian Institute of Technology Roorkee, 247667, India
[2] Mechanical Engineering Department, Sarvajanik College of Engineering and Technology, Surat, 395001, India
*erprashant028@gmail.com

Abstract

In this paper, a numerical analysis is presented on the Francis turbine, based on computational fluid dynamics (CFD). The aim of this study is to evaluate the hydraulic efficiency and performance of the Francis turbine by varying the mass flow rate and the number of runner blades using commercially available CFX code. The turbulent nature of water flow through the turbine passages is accurately captured by SST turbulent model. The numerical simulation has been conducted under three loading conditions: part load, rated load, and overload with varying the number of runner blades: 13, 15, and 17. Based on the numerical results, it is observed that the hydraulic efficiency is maximum at the rated load condition. The results obtained from the CFD analysis were validated by comparing them with turbine manufacturer data available in the literature. The efficiency of turbine has been found to be maxima with 15 runner blades, compared to 13 and 17 runner blades. Additionally, the fluctuation in pressure distribution was lower with 15 runner blades. In terms of velocity streamline, the most stable fluid flow condition is observed with 15 runner blades at the rated load condition, in comparison to the other blade configurations. The findings of this numerical simulation study can be valuable for researchers interested in investigating the effects of different parameters on the performance characteristics of the Francis turbine.

Keywords: Francis turbine, 3-D modelling, Blade number, Numerical simulation, Best efficiency point (BEP).

International standard based erosion prediction in Kaplan turbine of a low head hydropower plant

Naman Arora[1*], Arun Kumar[1], Sunil Kumar Singal[1]
[1]Department of Hydro and Renewable Energy,
Indian Institute of Technology Roorkee
*narora@ah.iitr.ac.in

Abstract

Sediments in the flowing water are normally considered an obstacle for the hydropower plants. It can impact hydropower generation due to loss of reservoir capacity and/or damage to the generating equipment. During monsoon season, high SSC with substantial quantity of hard minerals causes sediment erosion in hydraulic turbines. Numerous attempts have been made to study erosion mainly in Pelton and Francis turbines; however, erosion study for Kaplan turbines is limited. The outer trailing edges of the turbine blade and upper runner chamber are most erosion prone zones in the Kaplan turbine. International Electro Technical Commission (IEC) prescribed standard and guidelines (IEC 62364: 2019) for predicting erosion in different hydraulic turbines. In the present study, this standard has been applied for predicting the erosion in the Kaplan turbine of a low head hydropower plant across the Ganga River located in the foothills of Himalayas. The suspended sediment and hydraulic turbine details, made available from the plant operators, were used to predict the erosion through the international standard. Further, the financial implications associated with the sediment erosion i.e., downtime cost, transportation cost, welding and repair cost, grinding cost etc. were estimated based on the predicted erosion in the Kaplan turbine.

Enhancing the Hydraulic Efficiency of the Spillway by Optimising the Design of Various Components using Physical Modelling

Gadge Prajakta[1*], Bhate R. R.[2]
[1]Dr., Scientist 'C', Central Water & Power Research Station, Pune - 411024, INDIA
[2]Scientist 'C', Central Water & Power Research Station, Pune - 411024, INDIA
*prajaktagadge@gmail.com

Abstract

Spillways are protection structures in a dam-reservoir system. A typical spillway for any type of dam project consists of several components consisting of the approach channel, inlet & control structure, conveyance structure and terminal structure phasing from the reservoir to the river channel. The design of each component affects the overall performance of the structure. The present paper discusses the case studies describing the role of the crest profile in determining the discharging capacity and the role of the divide walls in the stilling basin (terminal structure) in enhancing the performance of the energy dissipator. For the project proposed on the tributary of Chenab River (Case 1), the spillway was designed to surplus the design discharge of 4000 m^3/s through 2 spans equipped with radial gates of size 12 m wide x 16 m high. In this case, modification in the crest profile resulted in an increase in discharging capacity of the spillway by 13.6% ensuring the safety of the dam. For the other project constructed on the Narmada River (Case 2), physical model studies indicated a need for the provision of divide walls in the stilling basin to separate a large number of spans into a number of bays. This helped in flexibility in operation, reducing the extent of return eddies formed in the basin, thereby eliminating or minimizing the tendency of deposition of material into stilling basin and consequent damage due to abrasion. Physical model studies played a very important role in optimizing the design of various components of the spillway and ensuring the safety of the structure.

Keywords: Physical Model, Spillway, Discharging Capacity, Divide wall, Crest profile

Qualitative Non-Destructive Evaluation (QNDE) of Hydraulic Structures by Ultrasonic Pulse Velocity Testing – Case Studies

S. Santhosh Kumar[1*], V. K. Ghodake[1], Prakash K. Palei[1]&Rizwan Ali[2]
[1]Central Water and Power Research Station, Pune, India
*santhosh.sk@cwprs.gov.in

Abstract

This paper presents an overview of multiple non-destructive testing methods based on elastic wave propagation which can be used to assess the in-situ quality of hydraulic structures viz. concrete/masonry structures such as dams, powerhouses, weirs, aqueducts and foundations. In the absence of non-destructive testing the subject of qualitative assessment of hydraulic or any other structures would have been a laborious, time-taking and an expensive affair. The non-destructive testing methods serve a novel purpose of qualitative assessment of the concrete/ masonry making up the massive hydraulic structures in a quick and efficient manner besides providing platform for periodic monitoring of the growth of defects, anomalies, voids, delamination etc. over a time scale. This methodology would further enable development of time history of such defects/ damage and extrapolation of the same can serve as a tool to schedule/ conduct appropriate maintenance to the hydraulic structures under investigation. Thus periodic monitoring of hydraulic structures by non-destructive testing methods can serve as an important tool to predict, prevent/ arrest damage augmentation and enhance the service life of the structures. Out of the several non-destructive testing methods available for field investigations, emphasis is laid on the application of Ultrasonic Pulse Velocity Testing (UPV Testing) owing to its popularity as a rapid, accurate and cost-effective technique. This methodology is a true reflection of the soundness of a structure as it is dependent on the elastic properties of the medium. The technique generates 2-dimensional contour maps of walls, beams, columns and foundations of concrete structures. Included in this paper are summary case histories of the application of UPV Testing method to real-world problems. Case histories presented include the evaluation of the Rengali Dam's Power House structure for overall concrete condition; Kolhapur Type (K.T.) Weir blocks across river Nira and Protection Wall for quality assurance; aqueduct structures of Ujjani left bank canal network for mapping of weak/ defect zones.

Keywords: Non-Destructive Testing; Ultrasonic Pulse Velocity; Qualitative Assessment; Hydraulic Structures.

Flow Investigations in Pelton turbine water jet using Laser Doppler Velocimetry

Firoz Khan[1]* & Arun Kumar[1]
[1]Hydraulic Turbine R&D Laboratory, Hydro & Renewable Energy Department,
Indian Institute of Technology, Roorkee
*fkhan@ah.iitr.ac.in

Abstract

The Pelton turbine is an impulse turbine that is designed to convert high-pressure water energy into kinetic energy in the form of a high-speed free-surface water jet that impinges on the runner and generates mechanical power. The water is highly accelerated in the nozzle that leads to the production of turbulence kinetic energy in the jet flow. Before impinges to the runner, the surrounding air is entrained into the jet, which causes the jet dispersion. The uniformity of the jet is essential for the quality of the jet and the effective conversion of water energy into mechanical power. However, due to the distribution of turbulence intensity, the jet experiences instabilities, which leads to the dissipation of the energy as turbulence eventually decays in eddies. The deformation of the jet surface and velocity distribution of the jet would be no more symmetric. Investigation of the velocity distribution and turbulence intensities in the jet flow is very important to understand the flow behavior and design improvements. In this study, the experimental investigation of the jet has been carried out using the 2D-LDV (Laser Doppler Velocimetry) system. The turbulent intensity and instantaneous velocity of the jet are analyzed at different locations along the jet flow. Further, the velocity profile of the jet is compared with CFD (Computational Fluid Dynamics) analysis. This research work is being supported by leading turbine manufacturer M/s Flovel Energy Pvt. Ltd.

Keywords: Pelton jet, Turbulence intensity, Laser Doppler Velocimetry, Jet quality, CFD.

Prediction of Discharge Coefficient of Staged Trapezoidal Labyrinth Weir Using Support Vector Machine (SVM) and Non-Linear Regression (NLR)

M. Danish Mustafa[1*], Talib Mansoor[2], Mohammad Muzzammil[3]
[1]Research Scholar, Department of Civil Engineering, Aligarh Muslim University, Aligarh, 202001, India
[2,3]Professor, Department of Civil Engineering, Aligarh Muslim University, Aligarh, 202001, India
*dmmustafa786@gmail.com

Abstract

Labyrinth weirs bearing longer crest lengths than linear weirs in the available approach channel width offer significant flow magnification. Triangular, rectangular, and trapezoidal shapes of labyrinth weirs have been studied in the past few decades. A staged labyrinth weir having multiple crest elevations helps modify the outflow hydrograph for extreme storms. Being less efficient at lower heads these structures facilitate the use of reservoir volume and allow flows downstream through staged crests. The discharge coefficient depends on head-to-weir height ratio, crest shape, crest thickness, apex configuration, and sidewall angle. The present study aims to determine the discharge coefficient of a staged trapezoidal labyrinth weir using a Support Vector Machine (SVM) and Non-Linear Regression (NLR) approaches. In the present study, one hundred thirty-three laboratory data from the literature were utilized to generate discharge coefficient prediction models using different combinations of pertinent parameters. Presented herein is a discharge coefficient equation based on the NLR approach and an assessment of its accuracy with earlier reported predictors.

Keywords: Flow measurement, Staged Trapezoidal Labyrinth Weir, Discharge Coefficient, Support Vector Machine (SVM).

Study of Characteristics of Segmental Orifice-Meter

H.L. Tiwari[1*] & Kartikeya Mishra[1]
1MANIT, Bhopal, India
* hltiwari@rediffmail.com

Abstract

An orifice meter is used to measure the discharge through pipelines. The conventional concentric orifice meter is suited for measuring the discharge for clear water flows. However, for sediment laden water, the conventional concentric orifice plate is not suitable as the sediment gets deposited on the upstream side of the plate and there by changing the flow characteristics. To overcome this difficulty, eccentric orifice meter like segmental, sectorial etc. can be used. In the present work, segmental orifice plates with different area ratios varying from 0.143 to 0.625 have been used. First the work has been carried out with clear water and then solid water mixture at different concentration of solids by weight have been done. The concentration used are 1.65%, 3.58% and 4.85% by weight. The upstream and downstream tapings have been provided at a distance. of 1.5D and 1.25D respectively from the orifice plate. Here D is the diameter of pipe used. From the results obtained, it has been found that the discharge coefficient is a function of Reynolds number (Re) and area ratio (a/A). But after certain range of Reynolds number (2x105 to 4x105), coefficient of discharge (Cd) is function of area ratio (a/A) only. Coefficient of discharge (Cd) increases with increase in area ratio (a/A) and for mixture, the coefficient of discharge decreases with increase in concentration of solids.

Keywords: Coefficient of Discharge, Orifice meter, Sediment laden water.

An introspective study of the riparian vegetated riverine hydraulics in the context of seven major rivers of Tripura, India

Ankhi Das[1*], Sushant Kumar Biswal[2] & Amlan Das[3]
[1]Ex- M. Tech student, National Institute of Technology Agartala, Jirania, West Tripura, PIN-799046, India
[2]Assistant Professor, National Institute of Technology Agartala, Jirania, West Tripura, PIN-799046, India
[3]Professor, National Institute of Technology Durgapur, Durgapur, West Bengal, PIN-713209, India
*adas.ce@nitdgp.ac.in

Abstract

The term riparian vegetation is used to denote the green covers including any kind of vegetation, be it an agricultural field or grassland that grows in the river banks and flood plains. The rivers in Tripura flow through vegetated flood plains. A proper hydraulic analysis of the rivers flows of Tripura needs to consider the riparian vegetation conditions. This introspection attempts to revisit some of the studies on riparian vegetation effected river hydraulics in the context of seven major rivers of Tripura state. The major rivers of Tripura that draw the attention of researchers are Gumti, Manu-Deo, Khowai, Muhuri, Dhalai, Juri, and Haora. These rivers are the lifeline of the state. Majority of the demographic settlements are found surrounding these rivers, giving rise to different cities/towns, villages and districts. We introspect into the physical description of these seven major rivers of the state and some of the related available important research covering hydraulic and hydrologic aspects. The earlier studies on modelling of riparian vegetated riverine hydraulics are introspected next. All riparian vegetated rivers flow as composite compound open channels. Therefore, the hydraulics of flow in composite compound open channels is introspected next. A summary of this introspective work is also provided.

Keywords: Riparian vegetation, riparian vegetated riverine hydraulics, seven major rivers, Tripura state, composite compound channel.

CFD Simulation of Confluence of Flow using Different Turbulence Models

S. S. Sandilya[1*], B. S. Das[1], K. Devi[2], J. R. Khuntia[2] and M. P. Mohanty[3]
[1] Ph.D. Research Scholar, Department of Civil Engineering, National Institute of Technology Patna, Patna, India– 800005
[1]Assistant Professor, Department of Civil Engineering, National Institute of Technology Patna, Patna, India – 800005
[2]Assistant Professor, Department of Civil Engineering, Chaitanya Bharathi Institute of Technology, Hyderabad, India
[2]Assistant Professor, Department of Civil Engineering, Chaitanya Bharathi Institute of Technology, Hyderabad, India
[3]Assistant Professor, Department of Water Resources Development and Management, IIT Roorkee, Roorkee, India
*sss.nitp@gmail.com

Abstract

Confluences are often observed in natural and artificial channels. The hydrodynamics of open channel confluences are highly complex due to the development of flow separation, mixing, and secondary currents. Numerical modeling of flows is an important tool used for understanding the behavior of complex flow patterns near the confluence. When the construction of physical models is not economically feasible, numerical models are used to directly evaluate and predict the performance. In the last three decades, a large variety of numerical methods and turbulence models have been developed in order to represent the enormous range of flows existing in nature or in industry. This study attempts to address this issue through numerical simulation of the flow behavior in an open channel confluence in OpenFOAM. A three-dimensional numerical model is set up to evaluate the accuracy of different turbulence models for reproducing the flow characteristics of a 90º open channel confluence, which consists of a common and simple geometry. The flow behavior is simulated by the finite volume method (FVM). The Reynolds-averaged Navier– Stokes equation system was utilized as the governing equations and three different turbulence models were employed in this study the standard k-ε model, the realizable k–ε model, and k-ω. The accuracy of simulation results from three different turbulence models (the standard k-ε model, the realizable k–ε model, and k-ω) has been evaluated by comparing velocity fields. The water surface was treated by a rigid lid approach. The general flow behavior generated by the numerical models was in good agreement with the experimental results, regardless of the rigid lid approach's natural inability to model the free surface. However, none of the turbulence models could reproduce properly the secondary current or the helicoidal current downstream of the junction. There is no appreciable difference has been found in the performance of the standard k-ε model, the realizable k–ε model, and the k-ω model. However, Statical analysis recommends that the realizable k– Epsilon turbulence model is more reliable in predicting complex flow geometries such as in the case of the confluence of flow than the k-Omega turbulence model and the standard k- Epsilon turbulence model.

Keywords: OpenFOAM, FVM, Realizable k–ε model, Standard k-ε model, k-ω, Rigid lid approach

Temporal optimization of single reservoir operation constraining downstream water quality

Selvakumar P[1*]. Ramsundram N.[2]
[1] Research Scholar, Kumaraguru College of Technology, Coimbatore - 641035, INDIA
[2] Associate Professor, Kumaraguru College of Technology, Coimbatore - 641035, INDIA
*selva.becivil@gmail.com

Abstract

Reservoirs are operated for stakeholders' requirements based on the inflow and initial storage volume/level. Operation rule curves are determined to resolve the conflict interesting of the stakeholders, in terms of the quantity of water discharged. In the current scenario of urbanization, the upstream scenarios can be used to dilute the downstream water quality with a controlled operation. Few research works addressed the operation of the reservoir to achieve the desired water quality in a particular space. In real life scenario, the reservoir downstream river passing through an urban environment may have multiple effluent discharge points, whether it is possible to maintain the river water quality. To understand the behaviour of the river for regulated release from the reservoir, a simulation-optimization algorithm is proposed. In this study, three major assumptions are considered to develop the framework, i) the reservoir water is pure/water quality parameters are within acceptable limits of drinking standard, and ii) the downstream river receives domestic load with organic pollutants at assumed points. The simulation-optimization framework simulates the downstream dissolved oxygen and efficacy of the Genetic Algorithm (GA), Bat algorithm (BA), and Whale algorithm (WA) with a minimum penalty on the water quantity requirements. From the results two key inferences are made; i) irrespective of the algorithm, stringent water quality constraints penalize the convergence of the algorithm towards achieving optimality, and ii) release from the reservoir increases by 150 % to maintain the downstream river water quality and thereby increasing the no release months during low inflow months.

Keywords: water quality, reservoir operation, optimization, dissolved oxygen.

Investigation of Propeller-Induced Flow with Influence of Under-Water Vegetated Field

Heba Mals[1], Dr Jaan Pu[2*] & Dr Amir Khan[3]
[1,2,3] Bradford University, Bradford, The UK
*j.h.pu1@bradford.ac.uk

Abstract

This paper presents an investigation into the effect of propeller-induced flow on axial velocity under static and dynamic conditions, as well as the axial mean velocity of propeller-induced flow influenced by underwater vegetation. The study utilised both side-look and down-look probes for Acoustic Doppler Velocimeter (ADV) measurements. The results revealed that the axial velocity profile can be characterised by a Gaussian normal probability function. The flow pattern behind a submerged jet can be divided into two zones: the zone of flow establishment (ZFE), immediately downstream of a propeller orifice, and the zone of established flow (ZEF). The length of the ZFE was found to be X/Dp = 2.14 in both tests, where X is the axial distance from the propeller to the downstream and Dp is the diameter of the propeller. M Fuehrer and Romisch (1977)'s equation for efflux velocity (Uo) was applied for both conditions with a difference from the measured value of no more than 0.5%. In investigating vegetation's effect, the static condition revealed a negligible effect on vegetation for both the above and crossed propeller positions at 300 and 1000 rpm. However, under dynamic conditions, the vegetation effect was evident in both positions. It revealed that the water flow from the propeller, shaped conically, is not significantly affected by vegetation, whereas the straight water flow in the flume is influenced by vegetation. To advance this investigation further, my research will analyse transverse and radial velocity, turbulent intensity, and Reynolds stress. Quadrant analysis will also be employed to achieve a better understanding of flow characteristics. Keywords: Turbulence flow, Propeller, Vegetation, Axial mean velocity.

Comparative Analysis of Digital Elevation Models for Assessing Watershed Characteristics and Stream Networks in a Watershed of Aandhi Village, Rajasthan, India

Rakesh Choudhary, Dr. Priyamitra Munoth & Prof. Rohit Goyal
Malaviya National Institute of Technology, Jaipur, India
*2021pcw5481@mnit.ac.in

Abstract

Digital Elevation Model (DEM) is a digital representation of the Earth's surface topography. It provides information about the elevation or height of the terrain at various locations. DEMs are extensively used in various fields such as geography, environmental studies for slope analysis, watershed delineation, and visualization of landscape feature. There are various open-source DEMs available, providing access to elevation data for different regions across the globe. This study presents a detailed analysis of DEMs to assess catchment characteristics and stream networks in a watershed of Aandhi village, Rajasthan, India. Four DEMs (ASTER, ALOS PALSAR, CARTOSAT, SRTM) from different sources were used with a constant threshold of flow accumulation to generate watershed and stream network data. Comparative analysis of calculated catchment areas, stream orders and morphological parameters revealed significant impacts of DEM source and resolution on the resulting watershed and stream network. The results of this study shows that ALOS PALSAR with 12.5m resolution, provided the most detailed outcomes for study area watershed. The findings emphasize the importance of selecting appropriate DEMs to accurately represent flow patterns, drainage characteristics, and catchment areas of surrounding streams. Consideration of DEM resolution and accuracy is crucial for similar type of watershed for detailed hydrological and water resource management studies.

Keywords: DEM, Resolution, Stream Network and Watershed.

Attention Based Machine Learning Model for Streamflow Modelling in Peninsular India

Ashutosh Sharma[1*], Radhika Sharma[2]
[1] Independent Researcher, Chandigarh, India
[2] Independent Researcher, Chandigarh, India
*ashutoshpec20@gmail.com

Abstract

This study presents an exploration into the application of advanced machine learning attention-based model Temporal Fusion Transformer for modelling streamflow in peninsular India. Leveraging the abundance of historical meteorological and hydrological data, the study examines the utility of machine learning models for streamflow modelling using multiple strategies. Through comprehensive evaluations, the study analyzes the efficacy of the Mixture of Expert models under different conditions. The findings provide valuable insights into the potential of extensible machine learning models for streamflow modelling, shedding light on their applicability in hydrological studies. The results contribute to advancing our understanding of using large-scale machine learning models for analyzing streamflow.

Keywords: Temporal Fusion Transformer, Mixture of Experts, streamflow modelling, runoff estimation, peninsular India, time series

Assessing the Accuracy and Suitability of Digital Elevation Models through Integrated GNSS System: A Comparative Analysis for Terrain characteristic in Aandhi Village, Rajasthan, India

Rakesh Choudhary*, Dr. Priyamitra Munoth & Prof. Rohit Goyal
Malaviya National Institute of Technology, Jaipur, India
*2021pcw5481@mnit.ac.in

Abstract

Digital Elevation Models (DEMs) are often used for terrain analysis and hydrological modelling. The accuracy of the DEM used play a vital role in terrain and hydrological analysis. Therefore, this study presents a comprehensive assessment of different DEMs using an Integrated GNSS system approach. The study was conducted on Aandhi village, Rajasthan, India by evaluating the accuracy and performance of DEMs to determine the most accurate DEM among ALOS PALSAR (12.5m), ASTER (30m), CARTOSAT (10m), CARTOSAT (30m) and SRTM (30m) for the study area and assess its suitability for further analysis and water resource development planning. The methodology involves utilizing an integrated GNSS system to collect high-precision elevation data points. The accuracy assessment was conducted by calculating the various statistical parameters like Root Mean Square Error (RMSE), Mean Absolute Error (MAE), Standard Deviation (SD) and Pearson Correlation Coefficient (R) values of the DEMs based on these points. The study found that CARTOSAT (10m) DEM had the lowest RMSE value of 2.72, MAE of 2.17 and Standard Deviation of 2.30 indicating its superior accuracy compared to other evaluated DEMs. The results from this study indicate that CARTOSAT with 10m spatial resolution provides the most accurate representation of the terrain characteristics in Aandhi village. Also, this DEM stands out with more variation values for elevation, slope, and contour, indicating its ability to capture more detailed and varied terrain characteristics. Based on the evaluation of the comparative analysis, the study highlights the suitability of the CARTOSAT (10m) DEM for further studies in Aandhi village. Overall, this research enhances understanding of different DEMs and their accuracy, contributing to improved geospatial analysis for terrain characteristics and decision-making processes in similar contexts.

Keywords: ALOS PALSAR, ASTER, CARTOSAT, DEM, GNSS, and SRTM.

3D Numerical Modelling of Flow Field Induced by a Group of Submerged Vegetations

C.K. John[1], J.H. Pu[1*], Y. Guo[1], M. Keating[2] & M. Pandish[3]
1Faculty of Engineering and Informatics, University of Bradford, Bradford, United Kingdom.
2Director & Principal CFD Engineer, Flow Science, United Kingdom.
3National Institute of Technology (NIT), Warangal, Telangana 506004, India.
* j.h.pu1@bradford.ac.uk

Abstract

The 3-Dimensional (3D) numerical modelling in an open channel flow field of a group of submerged vegetations using computational fluid dynamics (CFD) platform (i.e. FLOW-3D HYDRO) was performed in this study. A set of acoustic Doppler velocimetry (ADV) measurements have been conducted to be considered as benchmark to validate the numerical approach. A quantitative comparison was performed on several hydrodynamic variables that impact vegetated open channel flow, such as flow depths, streamwise water velocity, turbulent intensity, and Reynolds shear stress. In the numerical analysis, turbulence was treated using RANS approach (within RNG k-ε); while a Volume Of Fluid (VOF) method was used to track the air-water interface. Structured meshes with hexahedral elements were used to discretise the channel geometry. In the findings, the numerical model accurately reproduced the flow field, and presented good agreement with the experimental data for the analysed variables. The need to perform a numerical model validation for all the analysed variables were also highlighted. This study showed that the difference between both analyses were within acceptable range (less than 10%). This study concludes that the presented numerical approach can be utilised as an acceptable and efficient tool for simulations of the flow field through vegetation patch.

Keywords: Simulations, vegetation, FLOW-3D HYDRO, computational fluid dynamics (CFD), numerical model.

Characterizing Flood Frequency and Magnitude in the Godavari Basin: Insights from Local and Regional Flood Frequency Analysis

Vaishnavi.G[1], Ray, Litan Kumar Ray[1*] & VM Reddy[1]
1National Institute of technology Warangal, Warangal, India
*litan@nitw.ac.in

Abstract

Flood frequency analysis is a technique utilized to evaluate the probability and magnitude of flood occurrences at specific river locations. In the present study, 50 gauging stations were carefully selected across the Godavari river basin to perform flood frequency analyses. In the present study, flood frequency analysis incorporates two distinct approaches: local flood frequency analysis (LFFA) and regional flood frequency analysis (RFFA). These approaches are applied to analyse two types of data series: annual maximum (AM) series and peaks over threshold (POT) series. LFFA focuses on a specific location or site along a river. On the other hand, regional flood frequency analysis takes a broader perspective and considers multiple locations or sites within a homogeneous region. In the case of the AM series, LFFA and RFFA parameters were estimated using the Bayesian method. For the POT series, the maximum likelihood approach was employed to estimate shape, scale, and local parameters. In the RFFA, parameters estimated from multiple stations within the region were pooled together using the Index flood method. These pooled parameters were then used to determine flood quantiles at ungauged locations within the region. The analysis of the AM series revealed a combination of significant positive and negative trends at various stations, reflecting intricate flow pattern variations. On the other hand, the POT approach displayed fewer notable trends, primarily leaning towards negative changes. Interestingly, stations located in the middle of the basin demonstrated increasing flow rates over time, suggesting potential shifts in hydrological dynamics. The results showed RFFA consistently yielded higher quantile estimates compared to LFFA, signifying the importance of considering regional perspectives. The findings of this study provides valuable insights for effective flood management and mitigation strategies in Godavari Basin.

Keywords: Flood frequency analysis, Local Flood Frequency, Regionalization, Index flood method, Godavari Basin.

Mapping the dynamic changes of LULC around the lake systems using machine learning approaches for Hanamkonda district.

Vangala Tejaswi[1*], Venkata Reddy Keesara[1]
[1]NIT Warangal, Warangal, India
*vtejaswi369@gmail.com

Abstract

Land use and land cover change refer to the loss of natural areas, particularly forests, agricultural areas, or water bodies, to urban or exurban development. It is important to know how land use and land cover (LULC) will affect the availability of water resources across the Hanamkonda district. The identification of land cover establishes baseline information for activities like thematic mapping and change detection analysis. Expanding urban areas affects natural resources and makes them vulnerable. As it is observed that rapid changes are occurring in LULC around the water bodies, this will badly affect the quantity and quality of water resources, increasing the pressure on water availability in urban areas. It also creates flood hazards in the surrounding areas of the water bodies due to not protecting the boundaries of the water bodies. Any loss in the water surface area will also impact the groundwater resources in the region. The Hanamkonda district of Telangana state, India, has many water bodies. Over the period, the surroundings of some of the water bodies are highly urbanised, causing stress on water resource availability and flood-related problems during monsoon season. In this paper, the land use and land cover changes over the period of ten years from 2013 to 2022 for the four lake systems in the Hanamkonda district using machine learning algorithms in the Google Earth Engine platform are presented. The two machine learning algorithms, namely, Random Forest and Support Vector Machine, are used to classify LULC, and their performance is compared using accuracy assessment. For the years 2013, 2016, 2019, and 2022, Landsat-8 data is used, and the major LULC classes are ‘water bodies’, ‘urban’, ‘vegetation’, and ‘barren’. The average overall accuracy of RF and SVM classifiers is 88.47% and 91.92%, respectively. The results suggest that the support vector machine classifier outperforms the random forest classifier in terms of accuracy. The findings revealed that from 2013 to 2022, water bodies (-2.387 sq. km) had a decreasing trend, whereas urban areas (1.4925 sq. km), vegetation (0.022 sq. km), and barren areas (0.874 sq. km) had an increasing trend. The urban area for the Bhadrakali, Dharmasagar, and Waddepalli lake systems has seen an almost 50% increase. The water bodies are mostly affected for Dharmasagar and Chinna Vaddepalli lake systems. This study helps to analyse the lake systems and is used for better management of water resources.

Keywords: LULC, Google earth engine, Machine learning algorithms, Random forest, Support vector machine, Accuracy assessment.om forest, Support vector machine, Accuracy assessment.

Discharge Prediction in Meandering Compound Channel using XGBoost and CATBoost

Suraj Prakash[1*], Shashank Shekhar Sandilaya [2], Dr. B. S. Das [3]

[1]M. Tech Research Scholar, Department of Civil Engineering, National Institute of Technology Patna, Patna, India– 800005

[2]Ph.D. Research Scholar, Department of Civil Engineering, National Institute of Technology Patna, Patna, India– 800005

[3]Assistant Professor, Department of Civil Engineering, National Institute of Technology Patna, Patna, India – 800005

*surajprakash1244@gmail.com

Abstract

River meandering is a complicated process involving the interaction of flow through channel bends, bank erosion, and sediment transport. When a stream is very crooked in the plan, a stream having a winding course and either a regular sinuous pattern or irregular pattern is known as a meandering stream. River sinuosity is defined as the ratio of the length of the thalweg (path of deepest flow) to the length of the valley. Sinuosity is less than 1.05 then the river is classified as straight otherwise classified as a sinuous and meandering river. In a compound channel, one or more floodplains are located next to the main channel, which is often deeper and narrower. In order to expand the capacity of the conveyance system and for better flood management, the flow is divided between the main channel and the floodplains. During floods, the river discharge overtops its bank and spreads to its adjoining floodplains that carry part of the flood load. The relationship between the flow in the main channel and the floodplains has a significant impact on the discharge in a compound meandering channel. The magnitude of flood prediction is fundamental for flood warning, determining the development of the present flood risk, and the long-term management of rivers. This paper attempts to develop a model to calculate the discharge prediction in the meandering compound channel using Machine Learning techniques such as Extreme Gradient Boosting (XG BOOST) and Categorical Boosting (Cat Boost) by considering the impact of several geometric, flow, and roughness parameters. XGBoost and CATBoost are powerful gradient-boosting algorithms known for their ability to handle structured data and categorical variables. Results show that the both XGBoost and CATBoost predicted the discharge (Qp) satisfactorily with the coefficient of determination (R^2) value greater than 0.85 and mean absolute percentage error (MAPE) less than 10 % for training and testing datasets. However, XGBoost model prediction accuracy is better compared to the CATBoost model.

Keywords: Meandering, Main channel, Flood channel, XGBoost, CATBoost.

Velocity and Shear Distribution in Converging Compound Channel Using Large Eddy Simulation (LES) Turbulence Model

Niranjan Kumar[1*], Shashank Shekhar Sandilaya [2], Dr. B. S. Das [3]
[1]M. Tech Research Scholar, Department of Civil Engineering, National Institute of Technology Patna, Patna, India– 800005
[2]Ph.D. Research Scholar, Department of Civil Engineering, National Institute of Technology Patna, Patna, India– 800005
[3]Assistant Professor, Department of Civil Engineering, National Institute of Technology Patna, Patna, India – 800005
*niranjan4951@gmail.com

Abstract

Compound channel consists of main channel with floodplains on either side or both sides. In converging compound channel, the main channel width decreases gradually downstream, leading to complex flow patterns and significant changes in velocity and shear stress distributions. Despite having significant applications in river management, flood control, and irrigation, the hydraulic properties of open channels with floodplains are challenging to predict because the interaction between the main channel and the floodplain flow is complex. This complex behaviour is numerically modelled using different turbulence models like k-epsilon, k-omega, LES etc. In the large eddy simulation (LES) method, flow characteristics (like velocity and shear stress distributions) is modelled with a computational fluid dynamics (CFD) approach. In this paper 3D models numerical simulation with LES turbulence model is used to model the converging compound channel. Numerical simulation has performed using ANSYS FLUENT software to investigate the changes in velocity profiles, shear stress distribution across various converging sections within a compound channel. This enables the study of how the velocity distribution alters as the channel geometry narrows, providing valuable insights into the flow behaviour. The LES model is employed to solve turbulence equations due to its ability to provide improved large eddy structures. The results obtained from the numerical simulation are found more accurate, when validated with the other sources.

Keywords: Shear Stress, Velocity Distribution, LES, CFD, ANSYS FLUENT.

Effect of Impervious Wall Boundary on the Flow Characteristics of Hydraulic Intake Structures in Group

Muhammed Hashid[1], T. I. Eldho[2]
[1]Post-doctoral fellow, Civil Engineering Department, IIT Bombay, India – 400076
[2]Professor, Civil Engineering Department, IIT Bombay, India – 400076
*mhashid@gmail.com

Abstract

Intake structures are submerged water diversion structures widely used for various purposes like Hydropower, Irrigation, Desalination plants, Pump-Sump intakes, Water distribution etc. Intakes in the group show an enhanced flow withdrawal compared to isolated intakes of the same cross-sectional area. The withdrawal capacity and critical submergence of hydraulic intakes are usually affected by impervious boundaries in the form of bed boundaries, side walls and the intake pipe itself. The distance between the level of the intake centre and the water surface level is called submergence. The submergence of the intake below a certain minimum level causes air to enter the intakes through an air-entraining vortex emerging from the free surface and that particular submergence is termed critical submergence. The air entrainment will adversely affect the efficiency and operation of water intakes. The present paper discusses the effect of impervious boundaries on the critical submergence for multiple lateral intakes under uniform approach flow with the help of a multiphase CFD model. The present study uses the coupled Level Set-Volume of Fluid based multiphase modelling with SST k-omega turbulence model to compute the critical submergence at multiple intakes. The boundary blockage in the form of intake pipe protrusions was found to be causing significant changes in the flow hydrodynamics at the intake vicinity. The interphase of the multiphase (air and water) at the free surface was modelled with a better accurate estimation of interface curvature and surface tension forces caused by the curvature. The vortex structure was found to be exhibiting similar characteristics to those observed during the experimental study. The near-wall treatment adopted in the present model helped properly simulate laminar sublayer flow, especially at the junction of lateral intake and approach flow channel domain. The results of the numerical model are found to be well validated with experimental data with an error of less than ±14%. The numerical model developed in this study will help practicing engineers with the design of multiple intake structures.

Keywords: Critical submergence, Multiphase flow simulation, free surface vortex, Water intakes.

Steady Flow Analysis Performed for Flood Inundation Mapping Using HEC-RAS

Megavath Narahari[1*], Dr. N R Rawal[1], Dr. Pramod Soni[2]
[1]Department of Civil Engineering, Motilal Nehru National Institute of Technology Allahabad, Prayagraj, Uttar Pradesh 211004, India.
[2]Dept. of Civil Engineering, Indian Institute of Technology (BHU), Varanasi, Uttar Pradesh 221005, India.
*naraharimnnit09@gmail.com

Abstract

Every year, floods threaten millions of lives and cause significant property damage. Floods are primarily caused by an extraordinary increase in rainfall, dramatic manmade changes in land-use-land-cover patterns, and the resulting negative hydrological repercussions. The problem of floods is more prominent in the northern parts of India wherein most of the rivers originate. The Sangam region in Prayagraj, India, is prone to flooding during the monsoon season due to complex hydrological conditions. To assist in flood management and prevention, a study flow analysis was conducted using the HECRAS model to produce flood maps for the region. The study identified flood-prone areas and estimated flood risk using a hydraulic model of a small catchment at the conflux of the Ganga and Yamuna Rivers. The study found that the Sangam region is highly susceptible to flooding, with several areas at risk of being inundated during the monsoon season. The study showed that the urban area inundations were found to be 58.575501, 138.263274, 245.246041 sq. km for minimum, average, and very high flood discharges. However, on using a 10% higher maximum flood discharge, the corresponding area increased to 353.690072 Sq.km. The flood maps produced can aid in the development of effective flood management strategies to mitigate the impact of flooding in the region. The study highlights the importance of using advanced tools like the HECRAS model to study complex hydrological conditions, assess flood risk, and determine the extent of inundation.

Keywords: Arc-Map, DEM, HEC-RAS, Flood Mapping, Flood Inundation Modelling, Manning's roughness coefficient.

Impacts of Shrinking East Kolkata Wetlands on Urban Hydrology of Kolkata

Arpita Chaudhury Aich[1*], Dr.Bela Das[2]
[1] Raja N.L Khan Women's College, Vidyasagar University and University of Engineering and Management, Midnapore and Kolkata, India
[2] Raja N.L Khan Women's College, Vidyasagar, Midnapore, India
*arpitachaudhury92@gmail.com

Abstract

The East Kolkata Wetlands (EKW) which has been declared as the one of the two most outstanding wetlands of the world in 2017 is considered as the kidneys of Kolkata. It is a spill basin of the defunct Bidhyadhari River. Draining of storm-water runoff from the city of Kolkata into these wetlands prevents the city of Kolkata, adjoining Salt lake and Newtown Rajarhat areas from the problems of water-logging, floods during the peak monsoon period. The study aims to point out the importance of EKW in flood control through movement of storm-water, runoff and sewage water from the city of Kolkata. The paper also aims to highlight how unregulated peri-urban expansion and illegal infilling towards the wetlands is altering the urban hydrological setup of Kolkata and co-relate the relationship between disappearance of wetlands due to illegal infilling and incidences of recurrent flooding in Kolkata and its adjoining areas of Saltlake, Newtown and Rajarhat during the peak monsoon period. Hydromet data, yearly rainfall and flood data, drainage data, aquifer data pertaining to hydro-geological conditions of last five years will be analysed for further The study aims to analyse not only the hydrological impact but also the sociological impact of infilling of these wetlands wherein forcing the direct stakeholders to forcefully change their livelihood pattern leading to a silent death. Primary interviews will be conducted to understand the perceptions of different stakeholders of EKW over the value of wetland, their response to such change and its impact on human-water resource relationship.

Keywords: East Kolkata Wetlands, Storm-water Runoff, Urban hydrology, Illegal Infilling, Floods, Urbanization, Livelihood loss.

ANN for Urban Flood Flow Modelling Using Real Time Data

Krishna Kumar Tiwari[1*], Prof. R.D. Gupta[2] & Dr. Pramod Soni[3]
[1]Research scholar, Civil Engineering Department, Motilal Nehru National Institute of Technology Allahabad, Prayagraj- 211004, India
[2]Professar, Civil Engineering Department, Motilal Nehru National Institute of Technology Allahabad, Prayagraj- 211004, India
[3]Assistant Professor, Department of Civil Engineering, Indian Institute of Technology (BHU), Varanasi- 221005, India
*krishna.2021rce06@mnnit.ac.in

Abstract

Flood is a frequent and devastating natural disaster that can result in significant damage to property and loss of human life. Accurate flood flow modelling is essential for predicting the effects of floods and developing effective flood management plans. Artificial Neural Networks (ANNs) offer many advantages over the conventional method of flood flow modelling based on Saint-Venant equation which is based on many assumptions such as channel geometry and friction while the ANNs have ability to model the relationship without relying on explicit mathematical equations and assumption. For assessing the impact of climate change, accurate forecasting of rainfall is critical. ANNs have proven to be well-suited to address the varied and dynamic nature of flood data due to their ability to learn from vast datasets. Therefore, there is a need to efficaciously use ANNs for flood flow modelling due to their ability to capture complex correlations between input and output data.

Keeping the above in mind, the present study is undertaken to apply feed forward neural network and recurrent neural network (RNNs) to predict the discharge of the river in urban area using meteorological data ensuring minimal computational errors. The study is conducted on the Annapurna ghat gauging station of Barak River in the Cachar district near railway station of Silchar, using data collected from the water resource department of Cachar district, Silchar. The results demonstrate that both the feed forward neural network and recurrent neural network models provide better accuracy than traditional regression models such as polynomial, logarithmic, and exponential regression models. The models' performance was assessed using RMSE (root mean square error) and R^2 (coefficient of determination). The findings indicate that using precipitation, maximum and minimum monthly head as input to ANNs, feed forward neural network (with R^2=0.9428 and RMSE=0.1113 m^3s^{-1}) and recurrent neural network (with R^2=0.8858 and RMSE=0.1347 m^3s^{-1}) are the most accurate models.

For large and complex datasets, RNNs are best suited while for small datasets, feed forward networks provide better and accurate forecasting. The use of ANNs in urban flood flow modelling is therefore recommended for better accuracy and efficiency which is critical in the face of the increasing frequency and severity of floods caused by climate change.

Flood Forecasting Using ANN with Improved Higher Lead Time

Ayushi Panchal[1*] & Dr. S. M. Yadav[2]
[1,2]Sardar Vallabhbhai National Institute of Technology (SVNIT), Surat, India
*ayushipanchal44@gmail.com

Abstract

Water stands as one of the most indispensable natural resources on our planet. However, effectively managing this vital resource presents a global challenge. The concept of Artificial Neural Networks draws inspiration from the intricate design of the biological nervous system, comprised of billions of interconnected neurons. This approach, rooted in machine learning, seeks to replicate the human brain's functionality. In the context of this study, three distinct models have been formulated, each utilizing lead times of 3, 6, and 9 hours respectively. These models take input in the form of rainfall data from three specific stations, while the target data constitutes discharge information from a designated station. Following the construction of these models, an array of performance metrics, including RMSE (Root Mean Square Error), MAE (Mean Absolute Error), R-squared correlation coefficient, and NRMSE (Normalized Root Mean Square Error), were employed to assess their efficacy. Notably, the simulated discharge for the 9-hour lead time aligns remarkably well with observed discharge levels, demonstrating strong agreement. Furthermore, the errors exhibited by the statistical indicators are notably minimal. The prowess of the ANN-driven model is evident, displaying proficient capabilities in accurate flood forecasting. This proficiency positions it as a valuable asset in the realm of water resources engineering and management, offering a reliable tool to address these critical tasks.

Keywords: Soft computing technique, Artificial neural network, prediction, flood forecasting.

Evaluating the Performance of Integrated Storm Water Drains (ISWD) in a Residential Zone of Chennai City for Various Hydro-meteorological Conditions

Pravas Ranjan Pradhan[1] , Nithila Devi[2] , B. Sridharan[3] , B. Narasimhan[4] and S. N. Kuiry[5] *
[1,2,3]Research Scholar, Department of Civil Engineering, IIT Madras, Chennai, India [4]Professor, Department of Civil Engineering, IIT Madras, Chennai, India
[5]Associate Professor, Department of Civil Engineering, IIT Madras, Chennai, India,
*pravaspradhan1998@gmail.com

Abstract

Urban flooding is a significant challenge that has become more frequent globally in the last two decades. It occurs when rainwater reaches an urban area more quickly than it can be transported to a water body, such as a river or lake, due to a prolonged absorption rate to the soil. In urban areas like Chennai, which have a greater degree of impervious regions and disconnected flood pathways, flood waters struggle to follow the natural flow path of the bare terrain. An efficient drainage system is key to draining artificially induced flooding. This study assesses the performance of the existing stormwater drainage system in a residential zone of Chennai between the Adyar and Cooum Rivers. The assessment employs the MIKE+ model to evaluate the performance of the stormwater networks. This model calculates runoff from the watershed using the hydrological component. Subsequently, the computed runoff is fed as input into the 1D stormwater model. The 1D stormwater model is coupled with the 2D hydrodynamic routing model to manage junction overflows onto the urbanized floodplains and overland flows from the floodplains into the junctions. The developed model setup is validated for the 2021 Chennai flooding event. The validated model setup is further used to evaluate the effectiveness of the existing integrated stormwater drains (ISWD) under different rainfall durations. This comprehensive investigation not only aids in understanding the effectiveness of the ISWD but also informs the decision regarding resizing or extending the existing ISWD. Ultimately, this contributes to improved flood preparedness in the city.

Keywords: ISWD, urban flooding, MIKE+, stormwater model.

Evaluation of Astol Water Supply Scheme in Zone 2 of Dharampur Taluka Using Jaltantra

Vini Patel[1*], V. M. Rana[2], Dr. H. M. Patel[3]
[1,2,3]Faculty of Technology & Engineering, The Maharaja Sayajirao University of Baroda, Vadodara, India
E-mail: [1]vinipatel1998@gmail.com, [2]vijayrana-ced@msubaroda.ac.in, [3]hmpatel-*ced@msubaroda.ac.in

Abstract

Water is boon for the Earth and its importance cannot be overstand. The distribution of clean and sufficient water to each consumer is the major concern of the authority. Nowadays fulfilling the needs of safe drinking water for the entire population has become a challenging task for the authorities. The state water authorities in India is striving hard to supply pipe water to each and every household by the year 2024. The main challenge of rural water supply is the distributed cluster of service area extending difficult terrain and remote source locations. To ensure the water supply with limited ground elevation data, advance technologies are required to plan and design regional rural water supply schemes consists of a primary network or feeder network up to village and secondary network to further distribute the water to each household. JalTantra has evolved as promising tools to decides the pipes and pump configuration at minimum cost.

In this paper, the optimum design alternatives of rural water supply component are obtained for a very typical hilly terrain using JalTantra. The main objective of the study is to design the water distribution system (WDS) economically and to ensure water supply of desired quantity and pressure to the community in accordance with their requirements. JalTantra tool has been used to develop the topology of pipeline system and for obtaining a cost estimate while designing the optimum size of pipes. The solution obtained reveals that it fulfils demands with the most economical dimeter and with a choice of pumps by satisfying the constraints of residual pressure. Jaltantra provides very useful tool for fast and easy design process.

Keywords: Water Distribution, Hilly area, Optimization, Pipe diameter selection, Cost Analysis, Jaltantra, PRV.

Assessment of Flood Hazard and Vulnerability Zones using GIS and MCDM Techniques in Banda and Hamirpur District, Uttar Pradesh, India

S. Raaj[1*], S. Yadav[1], D. P. Shukla[1] & V. Gupta[1]
[1] Indian Institute of Technology Mandi, Mandi, India
*saran29raaj@gmail.com

Abstract

One of the most frequent and destructive natural disasters that threatens infrastructure and human life globally is flood. The complimentary impacts of GIS and multi-criteria decision making (MCDM) enhance the efficacy and results of flood analysis. Ten thematic layers, including slope, elevation, geomorphology, rainfall, Topographic Wetness Index (TWI), land use land cover (LULC), flow accumulation, population density, drainage density, and number of households, were developed for study area to determine a suitable location. All the maps were generated and standardized by reclassifying each thematic map into five classes which were further used as input for both MCDM methods. Each parameter had been assigned the weightage on a scale of one to nine based on importance to a potential flood zonation. Based upon AHP and TOPSIS approximately 5% of the total region falls under very high flood hazard zones. By comparing models, flood hazard map shows that multiple river confluence point of both the districts are mostly falling under very high flood hazard zone. The flood data collected from National Remote Sensing Centre (NRSC) was used for validation. The Area Under the Curve" of the "Receiver Operating Characteristic" curve (AUC-ROC), the Analytic Hierarchy Process (AHP) and Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS) Techniques observed the accuracy of 0.835 (83.5%) and 0.752 (75.2%), respectively. This study demonstrated that both models performed well for mapping the flood hazards in the study area, although the AHP model performed better overall.

Keywords: AHP, TOPSIS, Flood hazard, Flood vulnerability, ROC.

Study of Drought Severity and Agricultural Water Demand near Godavari Basin

Vikesh, P[1*], Harshitha, S[2],Sharanya, P[3], Devi, K[4], Khuntia, J.R[5], Bhabani Shankar Das[6]
[1,2,3]UG Student, Department of Civil Engineering, Vidya Jyothi Institute of Technology, Aziz Nagar Gate, C.B Post, Hyderabad, India – 500075
[4,5]Assistant Professor, Dept. of Civil Engineering, Chaitanya Bharathi Institute of Technology, Hyderabad-500075, INDIA
[6]Assistant Professor, Dept. of Civil Engineering, National Institute of Technology, Patna, INDIA
*pulivikeshyadav@gmail.com

Abstract

For crop management and agricultural water demand in the Godavari River basin, the largest river system in peninsular India. In the present research, Polavaram gauge station of Godavari River in Andhra Pradesh, specifically in Polavaram village, Eluru district is considered as study area. The study area is accurately extracted using remote sensing technology with Google Earth Pro and ArcGIS software, enabling precise spatial mapping and visualization. The primary objective is to investigate the prevalence of drought and flood events within the Godavari basin, crucial for effective water resource management and agricultural planning. The study incorporates an index value (Standardized Precipitation Evapotranspiration Index (SPEI) of the river Godavari's cross-section and sediment data, collected from the central water commission (CWC) in Hyderabad. Different types of droughts, including meteorological, agricultural, hydrological, and ecological are analysed to assess meteorological drought impact, hydrological droughts impact the researchers utilize the Standardized Precipitation Evapotranspiration Index (SPEI) over various time periods (1 month,3 months, 6 months, 9 months and 12 months). The variations in the cross section of the Godavari River across different time scales are analysed. Additionally, hydrological drought is examined using the Standardized Water-level Index (SWI). These indices are served as essential input for developing the model, monitored at different time scales. Furthermore, the project investigates how changes in the cross-sectional area impact the discharge of the river. Conveyance estimation system (CES) is used to calculate flow rate of given cross-section. Finally, the present study provides valuable insights into the flow dynamics of the Godavari River, crucial for effective agricultural water demand management and sustainable crop practices in the region.

Keywords: Standardized Precipitation Evapotranspiration index (SPEI), Standardized water-level (SWI), conveyance estimation system (CES), Google earth pro, ArcGIS software.

Predicting Monthly River Discharge using Bayesian Optimisation-Based SVR Model

Sanjay Sharma[1*], Sangeeta Kumari[2], Abhilash Gogineni[3]
[1]Department of Civil Engineering, NIT Jamshedpur, Jamshedpur, 831014, India
[2]Department of Civil Engineering, NIT Jamshedpur, Jamshedpur, 831014, India
[3]Department of Civil Engineering, NIT Jamshedpur, Jamshedpur, 831014, India
*jr.sanjaysharma@gmail.com

Abstract

This study consists of monthly river discharge prediction at Adityapur station in the Subarnarekha River basin. Support vector regression (SVR) is used for prediction in combination with the Bayesian optimization technique which is used to optimize the hyperparameters of the SVR model. This model is also compared with simple SVR model. The inputs for the model are the last 10 years' average discharge of month, last year's discharge of month and the water level of the station. Based on this data, monthly discharge is predicted. Root means square error (RMSE), R2 and Nash-Sutcliffe efficiency (NSE) are used as evaluation methods for models' evaluation and comparison. Results show that the accuracy of the Bayesian optimisation-based SVR model is high and better than the SVR model. The R2 values for Bayesian optimization-based SVR and SVR models are 0.9358 and 0.8859 respectively. Similarly, The RMSE values for Bayesian optimization-based SVR and SVR models are 50.106 m3/s and 66.84 m3/s and NSE values are 0.9238 and 0.7772 respectively. Based on the results, it is concluded that the model's efficiency can be increased by optimizing the SVR model's hyperparameters using Bayesian optimization.

Keywords: Bayesian; SVR; Prediction; Discharge; Monthly.

L-moments Method for Flood Frequency Analysis of Stations in Myanmar and India

Yin Yin Htwe[1], Drissia T K[1] and V. Jothiprakash[1*]
[1]Department of Civil Engineering, India Institute of Technology Bombay, Mumbai, 400007, India.
*vprakash@iitb.ac.in

Abstract

Flood frequency analysis using the L-Moments method has been carried out for four stations: two in Myanmar (Shwesayan and Sagaing) and two in India (Badlapur and Pen). The main objective of the study is to determine the best-fit probability distribution model applicable, among various methods available. Three distributions namely: generalized extreme value distribution (GEV), generalized Pareto distribution (GPA) and generalized logistic distribution (GLO) were used. The best fit distribution was selected based on four goodness of fit test namely: root mean square error (RMSE), relative root mean square error (RRMSE), mean absolute deviation index (MADI) and probability plot correlation coefficient (PPCC). In addition, L-moments and L – moment ratios are found to be a useful summary statistics for analysing sample flood data. The results indicate that GEV is best fit distribution model for Shwesayan and Sagaing stations. The selected best-fit model predicted flood quantile magnitudes ranging from 1797 m3 /s for 2 years return period to 3792 m3 /s for 100 years return period at Shwesayan station. At Sagaing station the quantile magnitudes are 25411m3 /s for 2 years return period 31327m3 /s for 100 years return period respectively. The best fit model for Badlapur station is GPA and the predicted flood magnitudes are 2176m3 /s for 2 years return period to 4877m3 /s for 100 years return period while GLO is the best fit model for Pen station and the predicted flood range from 211m3 /s for 2 years return period to 848 m3 /s for 100 years return period. Even though there is variation in magnitude of predicted floods, the results indicated that the pattern of the probability distributions is almost similar at all four stations.

Keywords: Flood Frequency Analysis; L-moments; Probability distribution; Myanmar; India.

Threshold Identification for Regional Precipitation Frequency Analysis in India's Semi-Arid Region

G. Sree Anusha[1*], & R. Maheswaran[1,2]
[1]Department of Climate Change, IIT Hyderabad, India
[2]Department of Civil Engineering, IIT Hyderabad, India
*cc22resch11003@itth.ac.in

Abstract

The peak-over-threshold model is the most extensively used in regional precipitation frequency analysis (RPFA) for estimating extreme precipitation events and is an essential tool for watershed management and infrastructure design. However, choosing proper threshold values is critical and challenging while estimating rainfall quantiles, particularly in semi-arid regions with high peak-value variability. Here, various threshold methodologies, including graphical, automated threshold selection, and multiple threshold methods, were investigated, and an appropriate threshold selection approach was selected for identifying peaks in daily gridded rainfall data. These extracted extreme events with high thresholds generally follow the generalized Pareto distribution (GPD), whose shape and scale parameters remain constant with increased threshold values. Therefore, the POT-GPD model was employed in the current work, and the parameters were estimated using L-moments to explore and quantify the heavy tail behavior, respectively. Non-parametric tests were performed to shed light on the regional variability and homogeneity. Moreover, the combined effect of threshold, shape, and modified scale parameters was also analyzed to assess the associated uncertainty in the proposed model. The proposed approach will help to improve understanding of the intensity and frequency of severe precipitation events in steppe climatic zones, allowing for more focused mitigation actions and disaster risk reduction.

Rainfall prediction using wavelet neural network based on meteorological signals

Pritee Krishna Das A[1], Dr Bibhuti Bhusan Mukharjee B[2] and Prof. Prakash Chandra Swain C[3*]
[1]PhD Research Scholar, Department of Civil Engineering, Veer Surendra Sai University of Technology (VSSUT) Odisha, India – 768018; Email: priteekerishnad@gmail.com
[2]Assosiate Professor, Department of Civil Engineering, CAPGS, BPUT Rourkela – 769015; Email: capgs.bbmukharjee@bput.ac.in
[3]Professor, Department of Civil Engineering, Veer Surendra Sai University of Technology (VSSUT) Odisha, India – 768018;
*pcswain.vssut@hotmail.com

Abstract

Rainfall prediction is a challenging task due to its high variability and uncertainty. Artificial intelligence techniques like wavelet neural networks (WNN) have been used to predict precise rainfall timing using wavelet activation functions. This study focuses on predicting rainfall using WNN based on meteorological inputs. The experimental findings show that both DWT-based ANN and Haar wavelet-based WNN models are excellent at predicting rainfall, representing connections and temporal dependencies between meteorological signals and rainfall patterns. The achieved RMSE values show accurate forecasts, suggesting that these models could be useful tools for tasks involving rainfall prediction. The combined use of artificial neural networks and wavelet analysis presents a possible approach for rainfall prediction based on meteorological signals, allowing for flexibility in capturing temporal dependencies and increasing precision. These models could help better understand and predict rainfall patterns, potentially impacting various applications in agriculture and water resource management.

Keywords: WNN, DWT, RMSE, ANN, Haar wavelet function, AI

Development of Rainfall Intensity- Duration-Frequency Curves for a Site in Kolkata City, India

Malti Mardi[1*], Sunil Kumar Murmu[1]
National Institute of Technology Patna[1]
*maltim.ph21.ce@nitp.ac.in

Abstract

One of India's significant metropolitan areas is the city of Calcutta (now known as Kolkata). The extensive network of historic sewer networks is one of the key reasons why the city is particularly susceptible to flooding. In order to focus on flood control, the current study's goal is to create the intensity-duration-frequency (IDF) curve from 1980 to 2014 using 35 years' worth of hourly rainfall data gathered from IMD, India for the rain gauge station Dumdum. Using an empirical equation provided by Gumbel's theory of distribution for hourly rainfall intensity data for return periods of 2, 5, 10, 25, 50, and 100 years, the technique offered for intensity duration frequency curve is constructed. For each length (1, 2, 3, 6, 12, 18, and 24 hours), the maximum precipitation and mathematical variables (mean and standard deviation) were used from the underdone data. All of these trustworthy 35-year rainfall intensity data are based on SRRG (self recording rain gauge) data series that have been digitally transformed into hourly rainfall data. It is possible to look over the flood inundation and sewer design using the IDF curve by probability distribution for hourly annual maximum rainfall analysis for various periods.

Keywords: Rainfall, IDF curve, Rainfall intensity, Rainfall frequency relationship, Sewer, flood management, Rain Gauge station

Direct and Indirect Coupling of Evapotranspiration with Energy Fluxes over the Indian Subcontinent

Riya Dutta[1*]; Rajib Maity[2]; Yannis Markonis[3]
[1]IIT ISM Dhanbad
[2]IIT Kharagpur
[3]Czech University of Life Science Prague
*dr.riyadutta@gmail.com

Abstract

Evapotranspiration is a vital component of the hydrologic cycle associated with multiple water and energy fluxes in complex ways. Changing climate has altered the hydrologic cycle leading to changes in the spatio-temporal pattern of evapotranspiration which future impacts water availability across the globe. Understanding the factors (water and energy fluxes) which contribute to such changes is vital to assess future water availability. This study identifies the direct and indirect coupling of evapotranspiration with different energy fluxes over the Indian Subcontinent for a period of 30 years considering four seasons (DJF, MAM, JJA, SON). To achieve this, we use the evaporative stress index, defined as one minus the ratio of actual to potential evapotranspiration, to identify the regions with energy- and water-limited evapotranspiration. Furthermore, networks or conditional independence structures are used to identify the energy and water fluxes (e.g., net radiation) that are directly influencing evapotranspiration. Results indicate significant differences in the direct and indirect coupling of evapotranspiration with the energy fluxes based on the region and season of analysis. Given the uncertainty associated with the future projections of evapotranspiration, identifying energy fluxes primarily associated with evapotranspiration and future alterations in such energy fluxes will provide a better insight into future water availability.

Calibration of TIGGE Ensemble Precipitation Forecasts using Bayesian Model Averaging for Vishwamitri River Basin

Rashmi Yadav[1*], Sanjaykumar M. Yadav[1]
[1]Sardar Vallabhbhai National Institute of Technology, Surat, Gujarat
*rashmiy276@gmail.com

Abstract

The ensemble precipitation forecasts exhibit uncertainty due to the perturbations in the initial condition. A forecast is accurate if there is a very good match between the forecast field and the true state of the system. The raw ensemble precipitation forecasts often contain systematic biases and spread deficiencies, as well as coarse spatial resolutions, which cannot directly drive hydrological models for ensemble streamflow forecasts. Therefore, statistical postprocessing is a requisite to reduce biases and correct dispersion errors for raw ensemble precipitation forecasts. The Bayesian Model Averaging (BMA) is employed for the postprocessing of the short-range ensemble precipitation forecasts by the European Centre for Medium-Range Weather Forecasts (ECMWF), TIGGE for the Vishwamitri River basin. Vishwamitri is a semi-arid river basin with an area of 1200 km^2 and an average annual rainfall of 806 mm. In BMA, the component distributions are mixtures of gamma distributions and point masses at zero instead of the Gaussian distribution. The verification of the post-processed ensemble shows the reduction of the Area under the Curve (AUC) of Receiver Operator Characteristics (ROC) plots with the increase of the lead time. The variation of the AUC plots shows the declination in the performance of the post-processed ensemble with the increase in the lead time. The evaluation of the raw and post-processed ensemble is carried out using Brier score metrics. The postprocessing thus calibrates the ensemble precipitation forecasts with the observed precipitation and reduces the systematic biases.

Keywords: Ensemble, BMA, ECMWF, TIGGE

A Self-Adaptive Elite Population Rao Algorithm for Civil Engineering Benchmarks Problems

K. B. Baladaniya[1*], P. L. Patel[2], P. V. Timbadiya[3]
[1]Ph.D. Research Scholar, Department of Civil Engineering, Sardar Vallabhbhai National Institute of Technology, Surat 395007, India
[2]Professor, Department of Civil Engineering, Sardar Vallabhbhai National Institute of Technology, Surat 395007, India
[3]Associate Professor, Department of Civil Engineering, Sardar Vallabhbhai National Institute of Technology, Surat 395007, India
*kalpeshb1701@gmail.com

Abstract

The present study proposed algorithm-specific parameters less and metaphor-less, named self-adaptive elite population Rao algorithm, for solving optimization problems. The proposed algorithm adapts the elite population based on improving fitness function value. The population is separated into three sub-groups, with a unique perturbation equation randomly allocated for each sub-group. Each perturbation equation guides the solutions towards the different search spaces. The performance of the proposed algorithm is tested using the standard benchmark problems known as discrete-time four-reservoir problem (DFRP), optimal designs of a 3-bar truss, and optimal designs of a cantilever beam. The results of the proposed algorithm are compared with those obtained by the latest advanced optimization algorithms. The study revealed that the results obtained by the proposed algorithm are matchable to the other advanced optimization algorithms. The proposed optimization algorithm is more robust and easily extended to solve any real optimization problems of different engineering disciplines.

Keywords: SAEP-Rao algorithm, benchmark problems, civil engineering.

Coupled Computational Model for Channel-Floodplain Interaction

Ravi Shukla[1*], Gourabananda Pahar[2]
[1,2]Indian Institute of Technology Kanpur, India
*shravi@iitk.ac.in

Abstract

Flood events can be caused by heavy rainfall, dam breaks, incapable or limited drainage, levee breaches, river overflow, individually or due to a combination of them. There is one more factor that greatly affects the intensity of flood, which is infiltration. Rural and urban areas, due to land cover, stand opposite in the infiltration aspect. This paper presents initial development for exploring the urban flooding challenges. Firstly, a 2D Zero Inertia model is tested with cases involving two-dimensional flows and results are presented. Next, Saint Venant's equation with the TVD-MacCormack scheme is tested for dam-break flow. By coupling these two developed models, an interaction between channel & floodplain is modeled to predict flooding scenarios under similar situations. To model the floodplain, the 2D Zero Inertia (Shallow water equation) equation and 1D Saint Venant's equation for the channel are used. The interaction is modeled through a discharge linking equation. This developed coupled computational model is finally tested with a hypothetical test case, and shows a satisfactory result. This model still needs more validation for its further development.

Keywords: Zero Inertia, Shallow Water Equation, SWE, Overland, Interaction

Future Forecasting of Rainfall Data by ARIMA Modelling

Anant Kumar Nagar [1*], & Gunwant Sharma[2]
[1] M. Tech. Malaviya National Institute of Technology Jaipur, Jaipur, India
[2]Professor (HAG) Malaviya National institute of Technology Jaipur, Jaipur, India
*2020pcw5640@mnit.ac.in

Abstract

As we all know that day by day population and water requirements are increasing. so, it will create a lot of shortage of water in upcoming years mainly in Rajasthan. This study consists of probability and general scenarios of rainfall in rajasthan for future years. Data consists of rainfall based on the monthly monsoon season (June, July, August, and September) resolution for 41 years, in which 30 years are taken in training work and the rest of 11 years for testing work. There are two Districts taken for the prediction of Rainfall based on the previous 41 years of Rainfall data. Rajsamand, Bhilwara, Ajmer and Tonk are the study area of interest. RMSE range is 13.88mm to 51.15mm Arima model based on data observed. Where minimum percentage error is observed 15.17 in August month Rajsamand district. Maximum percentage error is 32.40% which found in Ajmer Jun month Model Generated through Training Data shows pretty much correct results on the testing data set. Every month has a different model for future rainfall predictions like it depends on data collected in that month. There Are six parameters which shows efficiency of model. RMSE, R^2, Standard Deviation, Average mean of predicted and observed dataset. R^2 Correlation coefficient minimum is 0.685 and maximum is 0.881.

Keywords: ARIMA, RMSE, ANN, SARIMA, AIC

A Review of Flood Estimation Methods: Advancements and Challenges

Vishwakarma, V.[1*], Thawait A. K[2]
[1]PG Research Scholar, Centre of Excellence in Water Management, MANIT Bhopal-462003, INDIA
[2]Assisstant Professor, Centre of Excellence in Water Management, MANIT Bhopal-462003, INDIA
*vishwakarmavatsal1699@gmail.com

Abstract

This paper provides a comprehensive review of flood estimation methods, with a focus on recent advancements and persistent challenges in the field. Traditional techniques, such as statistical approaches and regionalization methods, are widely used but often encounter limitations due to assumptions of stationarity and homogeneity in hydrological processes. Data-driven approaches, including machine learning and artificial intelligence techniques, have emerged as promising alternatives. These methods leverage computational algorithms and large datasets to capture complex relationships between meteorological, topographic, and hydrological variables, resulting in improved flood estimations. The integration of remote sensing data and hydrological models for flood estimation is also investigated. Remote sensing technologies, such as satellite imagery and radar measurements, provide valuable information on rainfall, land cover, and terrain characteristics. When combined with hydrological models, they enhance flood forecasting and improve the accuracy of flood estimations. Nevertheless, challenges pertaining to data resolution, temporal variability, and model calibration remain. The impact of climate change on flood estimation is another key aspect of this review. Uncertainty quantification in flood estimation is emphasized as an important consideration. Acknowledging the inherent uncertainties in input data, model parameters, and prediction outcomes is crucial for decision-making, risk assessment, and flood management strategies. In conclusion, this review highlights advancements and challenges in flood estimation methods, emphasizing the need for interdisciplinary research, improved data availability, and robust modeling frameworks. Addressing the identified challenges will contribute to more effective flood risk management in a changing environment.

Keywords: Flood estimation, Data-driven models, Remote sensing, Machine learning, Climate change.

Simulation of Floods During Cyclone Events for A Coastal Basin Using HEC-HMS And Machine Learning Algorithms

Buridi Sravya[1*], Venkata Reddy Keesara[1]
[1]NIT Warangal, Warangal, India
*sravyaburidi92964@gmail.com

Abstract

Persistent and intense rainfall resulting from cyclones leads to flooding and inundation of low-lying regions, resulting in fatalities and damage to assets. Precise modelling of rainfall and runoff during cyclones is crucial to mitigating the impact of natural disasters. The main objective of this study was to develop a hybrid model for the Nagavali River Basin which integrates physically based hydrologic modelling system (HEC-HMS) into machine learning models (SVM, ANN, RF) to predict daily runoff discharges in the Nagavali Basin, Andhra Pradesh. In the past 10 years, the river basin has been more vulnerable to cyclones. Five flood events that are caused by cyclones (with a total of 70 data sets) are used for model calibration and validation. Five statistical indices (mean absolute error, root mean square error, correlation coefficient, error of peak discharge and R2) are employed to assess prediction performance. The overall superiority of the present approach is revealed through systemic comparison among physically based hydrologic model (HEC-HMS) and three hybrid combinations (HEC-ANN, HEC-SVR, HEC-RF). Overall results show hybrid models give better results as they reduce the uncertainties that occur in physical- based model and improve their predicting capability. For this basin there is an overall improvement of 16-79% of mean absolute error,36-86% of root mean square error, and 7–42% of r2 from physical based model to hybrid models. Out of three hybrid models, the results obtained from the HEC-SVR model are much better and provides the most accurate runoff discharge predictions.

Keywords: Rainfall-runoff, Hydrologic modelling system (HEC-HMS), Hybrid approach, Support Vector Regression (SVR), Artificial Neural Network (ANN), Random Forest (RF).

Hydrological Modelling of the Chaliyar River Basin using the VIC Model

Geethika Moorthy[1*]; Chithra N R[1]; Agilan V[1]
[1]NIT Calicut
*geethikamoorthy48@gmail.com

Abstract

Streamflow has a key role in hydraulic and hydrological applications. Hence, the selection of reliable inputs and calibration methods is essential to obtain a satisfactory streamflow forecast from the model. For the current study, the physically based Variable Infiltration Capacity (VIC) model is used for streamflow simulation of the Chaliyar basin in India. Shuttle Radar Topography Mission (SRTM) digital elevation model was used to perform watershed delineation and for obtaining derived products like elevation and slope gradient. The meteorological datasets were obtained from European Centre for Medium-Range Weather Forecasts (ECMWF) Re-Analysis (ERA) and India Meteorological Department (IMD) for the period from 1995-2015. The discharge data were obtained from the Central Water Commission observation at the Kuniyil gauging station. The modified Green-Ampt method is employed in the implementation of the infiltration model which requires soil properties and vegetation cover derived from the Food and Agriculture Organization (FAO) map and Land Use Land Cover (LULC) obtained from Oak Ridge National Laboratory (ORNL) Distributed Active Archive Center (DAAC) respectively. Since VIC requires calibration of many parameters, the auto-calibration was done employing the Non-Dominated Sorting Genetic Algorithm II (NSGAII) from 1995 - 2010. NSGAII can encompass multiple objectives such as Nash-Sutcliffe Efficiency (NSE), Time Root Mean Square Error (TRMSE), Mean Squared Deviation Error (MSDE), and Runoff Coefficient Error (ROCE). The validation was done from 2010- 2015 for which the model showed a good performance with the given algorithm.

Keywords: Streamflow, Hydrological Modelling, VIC, NSGA-II, SCE-UA

Peak Flows in Seven Major Rivers of Tripura, India

Ankhi Das[1], Sushant Kumar Biswal[2] & Amlan Das[3*]
[1]Ex- M. Tech student, National Institute of Technology Agartala, Jirania, West Tripura, PIN-799046, India
[2]Assistant Professor, National Institute of Technology Agartala, Jirania, West Tripura, PIN-799046, India
[3] Professor, National Institute of Technology Durgapur, Durgapur, West Bengal, PIN-713209, India
*amlan.das@ce.nitdgp.ac.in

Abstract

Tripura, a Northeastern state of India, belongs to Brahmaputra subzone 2c from hydrologic point of view. The present work focuses on the estimation of peak flows in Gumti, Manu-Deo, Khowai, Muhuri, Dhalai, Juri, and Haora rivers of Tripura, India. Use of synthetic unit hydrograph formulations applicable for adjacent hydrologic locations is attempted to determine the synthetic unit hydrographs for these seven major rivers of Tripura. A 72-hour rainfall event that produces varying total rainfall in three particular river zones are chosen and used to determine the peak flows in these seven major rivers considering zonal spread uniformity. The rainfall runoff coefficient for Gumti river is assumed to remain valid for all rivers because of hydro-geo-morphologic similarity of the state. The peak discharges are obtained by convolution of the derived 1-hr unit hydrograph. The derived unit hydrographs and peak discharges can be used further to study the hydraulic characteristics of these seven major rivers of Tripura by future researchers.

Keywords: Major rivers of Tripura, ungauged catchment, synthetic unit hydrograph, rainfall event, runoff coefficient, peak flows.

Socio-Hydrological Modeling

Mahesh R Tapas[1], Randall Etheridge[1] & Gregory Howard[1]
[1]East Carolina University, Greenville, NC, USA
*tapasm21@students.ecu.edu

Abstract

Climate change has varying effects on different parts of the world depending on geographical location. Countries with longer coastlines typically face greater climate change impacts. Human actions have changed watershed characteristics by altering drainage, soil cover, groundwater, and surface water quality. One potential solution to mitigate degrading ecosystem health is to implement better or updated policies with the goal of altering farmers' land use and land management (LULM) decisions. The changes in LULM decisions and agricultural practices have the potential to improve ecosystem health. This study will investigate how SLR and increased eutrophication, along with farmers' LULM decisions, interact under different policies to affect downstream ecosystem health. These predictions will be helpful for policymakers to understand the effects of different policies on the ecosystem and implement resilient mitigation strategies.

Making such predictions requires an integrative approach to thoroughly understand the interactions of farmers' LULM decisions, water quality, and water quantity in eastern North Carolina. I will do this through a novel socio-hydrological model. Hydrological modeling via the Soil Water Assessment Tool Plus (SWAT+) will be used to create projections of how LULM alters downstream ecosystems. This study will simulate several policy change scenarios to understand how the catchment's hydrological conditions will change and what impacts these changes will have on agriculture and nutrient transport in the Tar-Pamlico River basin. This socio-hydrological model will enable us to model the spatial and temporal changes in nitrate concentration in the Tar-Pamlico watershed.

Keywords: SWAT+, Hydrological Modeling, Policy Testing, Nitrate.

Assessment of Water availability in the Khapri Watershed of the Dangs District using Land Use Land Cover, Agriculture and Groundwater Scenario

A.L. Guruji[1*], P.G. Agnihotri[2]
[1]Sardar Vallabhbhai National Institute of Technology, Surat, India
[2]Sardar Vallabhbhai National Institute of Technology, Surat, India
*ashish.guruji-polyced@msubaroda.ac.in

Abstract

The Khapri watershed in the Dangs district of Gujarat state gets an average annual rainfall of 2140 mm from the Southwest monsoon in the period of Jun to October every year, which is highest in Gujarat, but still, it suffers acute drinking water problem in last two months of the hydrological cycle. To assess the water availability of the region the inter-relationship between Land Use Land Cover, Agricultural, Ground Water assessment, and Site visits has been carried out. Ground truthing has been carried out using GPS instrument. From satellite image analysis of 2018 and 1997, it is found that the agriculture area increases by 21 %. Dense Forests decrease continuously but Sparse Forests increase steadily. The study of cropping patterns from 1995 to 2018 in the region shows that there was an increase in rabi crop growth from the year 2012 onwards, which means people can manage water either from a check dam, tube well, open well, or pond. From the study of maps on Groundwater level in the Khapri watershed, the water table is ranging from 5 to 30 m in the post-monsoon of 2012. While in November 2020 water table in the open well ranged from 0 to 2 m. This depicts that people had the option of utilizing groundwater for the growth of agriculture from 2012 onwards. Site visit for assessing the water table in the observation well shows water table was less than 10 meters during the last phase of the hydrological cycle in 2022.

Keywords: Land Use Land Cover, Cropping Pattern, Ground Water, RS-GIS (Remote Sensing-Geographical Information System) GPS (Global Positioning System) Instrument.

Morphometric Analysis of the Tel River Basin: Understanding Hydro-Geomorphological Characteristics for Watershed Prioritization and Management.

Debarghya De[1*], Priya Khanda[2], Bibhuti B Sahoo[3]
[1,2]B Tech Student, Department of Agricultural Engineering, Centurion University of Technology and Management, 761211, Odisha, India
[3]Assistant Professor, Department of Agricultural Engineering, Centurion University of Technology and Management, 761211, Odisha, India
*203001170001@cutm.ac.in

Abstract

The drainage basin dynamics of rivers are controlled by various characteristics of a basin. To understand the drainage basin dynamics and their usefulness in watershed prioritization and management in terms of soil erosion studies and groundwater potential assessment and flood hazard risk reduction in mountainous rivers, morphometric analysis of the Tel River basin has been taken as a case study. The entire Tel River basin has been subdivided into sub-watersheds and various morphometric parameters have been calculated under four broad categories: drainage network, basin geometry, drainage texture, and relief characteristics, each of which is further grouped into different clusters having similar morphometric properties. The result thus generated provides an adequate knowledge base required for decision-making during strategic planning and delineation of prioritized hazard management zones in mountainous terrains.

Keywords: Morphometric Analysis, Tel River basin, watershed prioritization, stream order

Comparison of Random Forest and Support Vector Machine Classification Algorithms for Crop Mapping in Fragmented Landscapes by using Cartosat-2 Imagery

Sravani Duvvuri [a,b] *, B.V.N. P. Kambhammettu [b]
[a] Department of Civil Engineering, RGUKT Nuzvid, Andhra Pradesh, India
[b] Department of Civil Engineering, Indian Institute of Technology Hyderabad, Telangana, India.
*sravanidvr@gmail.com

Abstract

Small to marginal farms with a diversity of crops and management practices pose a formidable challenge to the implementation of crop classification algorithms. Coarse-resolution satellite imagery cannot accurately represent fragmented land parcels. The Indian agro-climatic environment is especially suited to this. The goal of this study is to classify the crops based on satellite images with very high-resolution using machine learning algorithms. The Cartosat–2E satellites has a spatial resolution of 1.6 m to classify crops in marginal/fragmented land systems. It is widely used to classify the croplands more efficiently and accurately from the data obtained by the field studies in conjunction with data obtained from remote sensing techniques, and using artificial intelligence and machine learning methodologies. This study was carried out in Nandikandi, Sanga reddy district, Telangana state, India using Cartosat-2E imagery to classify croplands in a fragmented system. The accuracy metrics of both pixel-based and object-based approaches to classifying the fragmented landscapes were compared using Random Forest (RF) and Support Vector Machine (SVM) classification algorithms. It was observed that parcel-based classification using SVM and RF techniques yielded better results with an overall accuracy of 90.74% (F-1 Score of 0.8) and 86.89% (F-1 Score of 0.78), respectively. Our results conclude that SVM outer performed the RF classifier with a parcel-based approach, which can effectively differentiate cropland for crop productivity and damage assessment models.

Keywords: Crop Classification, Random Forest, Support Vector Machine, Cartosat-2

Rainfall Threshold Analysis of Lothal Village, H.P., India Landslide

Saurabh Raj[1*], Aman Chauhan[2] & Virender Kumar[3]
[1]Department of Civil Engineering, NIT Hamirpur, Himachal Pradesh, India,
[2]Department of Civil Engineering, NIT Hamirpur, Himachal Pradesh, India.
[3]Department of Civil Engineering, NIT Hamirpur, Himachal Pradesh, India.
*saurabh_phdce@nith.ac.in

Abstract

Being a tectonically active zone with fragile geological condition, Himalaya possesses high potentiality of both rainfall and earthquake induced landslide occurrence in Himachal Pradesh, India. These landslides every year causes many problems to mankind as well as huge damage to property. On 5th August of 2013, torrential rainfall induced landslide in the form of debris flow at Lothal Village, Chamba district in the lap of lesser Himalaya. Present study focuses on this event of Lothal Village landslide. Empirical thresholds were used in this study. Empirical threshold has been considered as collecting rainfall data for sediment related disaster events from 2012 to 2013. The main aim of this study was determination of rainfall thresholds for potential sediment interrelated disaster occurrence in Lothal Village. The results illustrated that the disasters related to sediment occurred in very frequent interval of time (0.5 hours) with high average intensity and extended periods (24 hours) with a lower average intensity in Lothal Village. With the regression value of I = 1.417D-0.334 (I is the rainfall intensity in mm/hr and D is duration in hr), determination of new rainfall thresholds for possible disasters related to sediment were done. It is anticipated that the new rainfall thresholds can be used for development of a warning system in Lothal Village of Chamba District in Himachal Pradesh, India.

Keywords: Lothal Village landslide 2013, Rainfall thresholds, Landslides, Debris flows, Empirical Threshold.

Hydrological Modelling of the Luni River Basin by using SWAT Model

Saran Raaj[1] and G. D. Kale[1*]
[1]Sardar Vallabhbhai National Institute of Technology, Surat, Gujarat- 395007, India
*gdk@ced.svnit.ac.in

Abstract

Runoff is a vital component of the hydrological cycle as it controls the amount of water that runs into streams. Worldwide, hydrological models (HMs) like precipitation-runoff and sediment formation are frequently used to simulate hydrological processes. Semi-distributed HMs can imitate water balance spatially for different soils, land use, topography and climatic conditions. Soil and Water Assessment Tool (SWAT) is one amongst these HMs, which has been evaluated in diverse world climates. None of the reviewed studies have carried out hydrological modelling of the Luni River Basin (LRB), Rajasthan, India in recent years. Thus, in the present study, hydrological modelling of the LRB is carried out by using SWAT model. Using historical streamflow and weather data of the LRB, the SWAT model is calibrated and validated corresponding to a monthly temporal scale. The model parameters are calibrated and validated by using data corresponding to time period 1991 to 2018. The findings of the model calibration and validation revealed coefficients of determination (R^2) values to be 0.82 and 0.95, respectively, which indicated "Very Good" performance of the model. Nash-Sutcliffe (NSE) values are 0.81 and 0.70 corresponding to the calibration and validation, which indicated "Very Good" performance and "Good" performance of the model, respectively. The SWAT model is found to be useful in simulating streamflow in the LRB. The developed SWAT model can be used to investigate the effect of land use alteration and climate change on the future streamflow of the LRB.

Keywords: SWAT, Hydrological model, Luni River Basin

Estimation of Design Flood for Steady Flow using Hydro Meteorological Parameters

Shweta A. Patil[1] & A. R. Kambekar[2*]
[1]Research Scholar, CED, SPCE Mumbai
[2]Associate Professor CED, SPCE Mumbai
*a_kambekar@spce.ac.in

Abstract

Design flood, or inflow design flood, is the flood accepted for design or safety evaluation of the hydraulic structure. High flood levels (HFL) are estimated using design floods of different frequencies. In case of the design of various hydraulic structures, the approximate approach may lead to over-estimation or under-estimation of design flood, that can cause destruction or loss of structure, or it becomes more uneconomical. Therefore, the current study with a hydro-informatics approach integrated with the Geographical information system (GIS) for estimating design flood of the Bhima River basin in Maharashtra, India, is presented in this paper. The methodology of Central Water Commission (CWC), Ministry of Jal Shakti, Department, Government of India (http://www.cwc.gov.in) is used and validated at six catchments using a derivation of the synthetic unit hydrograph (SUH) and flood estimation. The peak flood discharge, i.e., surface runoff is computed for return periods of 25 year and 100 year. Hydrologic Engineering Center's (CEIWR-HEC) River Analysis System) (HEC-RAS) (https://www.hec.usace.army.mil/software/hec-ras/) simulates the estimated designed flood discharge and outcomes are mapped for mitigating flood hazards. Flood inundation maps are developed for 25-years and 100-years recurrence interval. The ultimate characteristics of an estimated maximum flood are more responsive towards storms of different sample. The simulation results will be helpful in flood-risk mitigation and management.

Keywords: Synthetic Unit Hydrograph (SUH), Design flood, Basin delineation, HEC-RAS, GIS.

A Statistical Inverse Methodology for Identifying Bucket Contributions during Recession Flows

Owees Rashid[1*], Tushar Apurv[1]
[1]Indian Institute of Technology Kanpur
*owees20@iitk.ac.in

Abstract

During dry periods, streamflow acts as a critical source of water supply and sustains a wide variety of aquatic plant and animal species. Streamflow in the non-rainy periods, known as recession flow, is the water from previous rainfall events which is released from various subsurface storages into the streams. Accurate modelling of recession flows remains a challenge due to a limited understanding of the mechanisms of water release from subsurface storages and difficulties in the parameterization of these processes in hydrologic models. The spatial variability in subsurface characteristics combined with temporal variability in the water stored in different subsurface storages can contribute to changes in recession flow characteristics across events. In this study, we model the catchment as a set of parallel buckets with different storage discharge relationships. Assuming, a linear storage-discharge relationship for each bucket, we develop an inverse methodology for quantifying the contributions of the buckets during recession events in which inverse Laplace transform is applied to streamflow data during recession periods.

Trend Analysis of Rainfall And Temperature: A Case Study of Amreli District, Gujarat, India

*1Zarna J Chovatiya, 2Dr.Gargi Rajpara, 3Dr. Mohdzuned. M. Shaikh
1Kadi Sarva Vishwavidyalaya, Gandhinagar, India
2L.D.R.P. Institute of Technology & Research, Kadi Sarva Vishwavidyalaya, Gandhinagar, India
3L.D. College of Engineering, Ahmedabad, India.
*zarna@ldce.ac.in

Abstract

The stability of Earth's ecology and temperature is the main consequence of climate change. Climate change is one of the biggest problems around the world. The overall surface temperature has altered as a result of global warming due to an increase in greenhouse gas concentrations. It is directly affecting the environment. The ecology is influenced more to a greater extent when the global temperature rises. As a result, even with great effort, it is hard to turn the process around. The present study is mainly concerned with the changing trend of rainfall of a river basin of Amreli district, Gujarat, India. From the extensive literature review it can be established that the river is facing adverse effects of flood. This is an effort to analyse some of the most important climatic variables, precipitation and temperature for analyzing the trend in the study area. A statistical trend is an important change over time that may be identified using both parametric and non-parametric techniques, and trend analysis of a time series includes the size of the change. The Daily rainfall data of 40 years from 1970 to 2020 has been processed in the study to find out the monthly, seasonal and annual variability of precipitation and for this purpose well established non-parametric test called Mann Kendall test has been used for the determination of trend. From the trend analysis it is found that the trend in precipitation ranges from -0.83 to 3.02 and for temperature it ranges from -3.27 to 3.09.

Keywords: Trend Analysis, Climate change, Shetrunji River Watershed, Amreli

Assessment of Kaleshwaram Lift Irrigation Project (KLIP) Impact on Croplands using Geospatial Technology

Pranay Panjala[1,2*], Murali Krishna Gumma [1], Shashi Mesapam[2]
[1]Geospatial and Big Data Sciences, International Crops Research Institute for Semi-Arid Tropics, Hyderabad, India
[2] RS & GIS, National Institute of Technology, Warangal
*goudapranay@gmail.com

Abstract

Cropland products play a significant role in the evaluation of water and food security. Quantifying the temporal and spatial changes due to interventions is important for assessing the effectiveness of natural resource management practices. Kaleshwaram Project envisioned to provide irrigation in drought-prone areas of Telangana State. In this study, we evaluated the impact of the Kaleshwaram project in terms of crop intensity and identified the areas with high impact using satellite imagery and geospatial techniques. The study found out the cultivation of another crop in the Rabi (winter) season, increased double-crop throughout the command area. This type of study will help the stakeholders and policymakers to locate the areas and help the farmers with better recommendations.

Keywords: Telangana, agriculture, crop, intensity, change detection

Comparison Study of Hybrid Flood Models with Hydraulic Model: A Case Study of Achankovil River Basin

Amina M K[1*] , Chithra N.R[2]
[1]Department of Civil Engineering, National Institute of Technology Calicut, Kerala, India
[2]Department of Civil Engineering, National Institute of Technology Calicut, Kerala, India,
*aminamk98@gmail.com

Abstract

Floods are prevalent and recurring catastrophic natural disasters that disrupt economic and social services. Different measures like inundation modeling, flood forecasting, and flood hazard and risk mapping can be adopted to attenuate the adverse effects and economic losses of floods, thus identifying flood-susceptible zones. One of the most commonly used flood forecasting systems is the physically based model where dynamicity and physical characteristics of watershed will be considered.These models are encountered by complexities in hydrological processes and non-linear characteristics of the input parameters.The reliability of these models is affected by the purpose of modeling, the nature of the watershed, and the quality of input variables like rainfall, land use land cover and spatiotemporal variability of inputs. They also suffer from computational instabilities and long runtime problems, which are particularly important in real-time applications. Machine learning models are becoming a remedy to counteract this issue as the speed of computation of these models is more than the other. In this study, a comparison was done between coupled models based on the HEC-HMS rainfall-run-off and the HEC-RAS hydraulic routing model with two machine learning-based flood models - Hybrid wavelet Artificial Neural Network model (WANN) and Hybrid Wavelet Support Vector Machine model (WSVM) for different lead times in the Achankovil river in Kerala. The hourly water level at the Konni gauging site was simulated with1 hour lead times. The performance of each model structure was evaluated based on standard performance criteria and it was evident that WSVM performed better than WANN and HEC-RAS simulations.

Keywords: Flood forecasting, HEC-RAS, Hybrid wavelet Artificial Neural Network model (WANN), Hybrid Wavelet Support Vector Machine model (WSVM),HEC-HMS, Achankovil Basin.

Spatio-temporal Assessment of Soil Erosion Modeling in the Upper Cauvery River Basin, India

Soumyashree B Tillihal[1], and Anoop Kumar Shukla[1]*
[1]Manipal School of Architecture and Planning, Manipal Academy of Higher Education, Manipal, Karnataka, India.
*anoopgeomatics@gmail.com

Abstract

An issue like soil erosion frequently threatens the environment. Significant changes in the spatiotemporal land use land cover distribution may bring on soil erosion events. Analysing the risk of soil erosion is essential while managing a basin area. Although soil erosion is widespread throughout the basin, it is not feasible economically to adopt conservation measures everywhere. To ascertain the vulnerability to soil erosion, a thorough methodology was adopted that incorporates the Remote Sensing, GIS, and Revised Universal Soil Loss Equation (RUSLE) models. RUSLE has been applied in this study to measure soil erosion in the Upper Cauvery River Basin (UCRB), Karnataka, India. The topographic factor (LS), runoff-rainfall erosivity factor (R), soil erodibility factor (K), crop management factor (C), and support practise factor (P) are the components of this model. We created the K factor map using necessary data from the FAO DSMW and added it to a soil map and the R factor map utilising India Meteorological Department (IMD) monthly rainfall data. The Landsat 8, and digital elevation model (DEM) data was utilised to create the LS-factor map, Landsat 8 satellite images was used to create the LULC, and the NDVI map was used to create the C and P factors. Soil loss was calculated in UCRB, and it was revealed that the trend in soil loss considerably increased. Soil erosion occurs most frequently in and around hilly terrain with steep slopes. This study will help control the erosion process and reduce soil erosion in the watershed.

Keywords: GIS, Soil erosion, DEM, and Revised Universal Soil Loss Equation

ANFIS Based Model for Scour Prediction at Downstream of Bed Sills

Javed Alam[1], Mohammad Muzzammil[2] & Md Atif Raza[3*]
[1]Professor, Department of Civil Engineering, Zakir Hussain College of Engineering and Technology, Aligarh Muslim University
[2] Professor (Rtd), Department of Civil Engineering, Zakir Hussain College of Engineering and Technology, Aligarh Muslim University
[3] M. Tech student (corresponding author), Department of Civil Engineering, Zakir Hussain College of Engineering and Technology, Aligarh Muslim University
*atif07raza@gmail.com

Abstract

Bed degradation is a very extensive problem related to the mountainous streams. To reduce bed degradation, generally bed sills are provided at stream bed. The overflowing water interacts with bed sills which results in modification of the flow pattern and increased bed shear stress that causes scouring around bed sills. Researchers carried out physical modelling to study the scour mechanism and the factors affecting scouring process. They also developed scour depth prediction models based upon regression analysis. Accurate estimation of scour depth is very important for their proper design and planning. Nowadays, soft computing techniques are extensively applied in modelling various hydraulic engineering phenomenon and reported better performance. In this study, a regression model was developed to predict downstream scour depth at bed sill based on the available data in literature. Then a comparison was made with the available regression models. The present study regression model gave better prediction performance. Furthermore, Adaptive Neuro Fuzzy Interference System (ANFIS) soft-computing technique was employed to develop scour depth prediction model. It has been found that the performance of ANFIS model is better than that of regression model. Results showed that the present study models are more effective in modelling scour depth and therefore can be used for designing purpose. Silent features of the study are described in the present paper.

Keywords: Bed sills, Maximum Downstream Scour Depth, Soft-computing, ANFIS.

Remote Sensing-Based Assessment of Surface Water Quality in Chilika Lake, India

Priya Khanda[1*], Debarghya De[2], Bibhuti Bhusan Sahoo[3]
[1,2] Department of Agricultural Engineering, Centurion University of Technology and Management, 761211, Odisha, India
[3]Assistant Professor, Department of Agricultural Engineering, Centurion University of Technology and Management, 761211, Odisha, India
*203001170004@cutm.ac.in

Abstract

The study delivers a detailed water quality assessment at Chilika Lake using remote sensing techniques. We examined critical water quality indicators such as turbidity, total dissolved solids (TDS), and chlorophyll levels using satellite data and in-situ water samples. The assessment confirms its efficiency in delivering significant information into the lake's water quality using remote sensing methods. The findings add to our understanding of Chilika Lake's ecological health and enable informed decision-making for its preservation and long-term management. Furthermore, this study looks into the impact of natural and anthropogenic influences on water quality dynamics within the lake ecosystem. The study provides a foundation for targeted actions and pollution control strategies by identifying potential pollution sources and their spatial distribution. The combination of remote sensing technology and in-depth ecological analysis enhances our ability to address the challenges facing Chilika Lake, promoting the conservation of its unique biodiversity and ensuring the well-being of local communities dependent on its resources.

Keywords: Water Quality Analysis, Remote Sensing, GEE, Total Dissolved Solids, Chlorophyll, Turbidity.

Study of Rotor-Stator Interaction in Variable Speed Reversible Pump-Turbine in Turbine Mode at Low Head Using CFD

B. R. Rode* & A. Kumar
Hydraulic Turbine R&D Laboratory, Department of Hydro and Renewable Energy, Indian Institute of Technology Roorkee, Roorkee, India
*bhushan_rr@hre.iitr.ac.in

Abstract

Pumped storage hydropower (PSH) offers the cost-effective storage of large quantities of energy with high efficiency. Reversible pump-turbines (RPT) are used in PSPs having large head variations and where variable speed operation can enhance its efficiency and grid stability. The RPT may experience higher fatigue and vibrations due to hydraulic instabilities caused by pressure fluctuations in the vaneless space between runner blades and guide vane interaction, known as rotor-stator interaction (RSI). Because of this instability, the local components of the powerhouse vibrate severely. Therefore, there is a need to study the pressure fluctuations caused by RSI in the variable speed RPTs. The present numerical study focuses on the pressure fluctuations due to RSI in turbine mode conditions having low available head. The present study used a reduced scale high-head variable speed RPT model, and the SST k-ω turbulence model was used to carry out numerical calculations. The analysis was performed at the best efficiency point and low head operating conditions having optimized rotational speed. The analysis showed that the main source of pressure fluctuations in the RPT at all operating conditions is the RSI, where the dominant frequency is BPF and its harmonics.

Keywords: Reversible pump-turbine, pumped storage hydropower, rotor-stator interaction, pressure fluctuations, vaneless space, variable speed

Stream Flow Simulation of Wainganga River Basin by using SWAT Model

Meena B L [1*], Patel P L [2], Dr. Prabhat Chandra [3]
[1]Scientist-C, [2]Professor, SVNIT, [3]Additional Director Central Water and Power Research Station, Pune-411024, India
Sardar Vallabhbhai National Institute of Technology, Surat, Gujarat, India
*meena.banwarilal@gmail.com

Abstract

The hydrological modelling is an essential aspect for development, planning, designing, execution and proper management of water resources. Physically based models are capable for simulating stream flows at different spatial and temporal scales. Present study deals with the simulation of stream flow at GDS namely; Asti of Wainganga river basin, a major tributary of Godavari river lying in Madhya Pradesh and Maharshtra states, India. For this study, the QSWAT model has been utilized and calibrated at the outlet point for the Wainganga river basin with watershed area of 51,430 sq km. The rainfall and temperature data used for study was taken as IMD gridded data at 0.25x0.25 degree. Total 19 sub-basins have been delineated and 513 HRUs are created by QSWAT model which contributed in flow up to the outlet point. By observing the land use land cover map, it was found that most of the areas in the basin are agricultural and fallow lands. The classification of soil maps in the basin indicates the predominant presence of clayey soil. After simulation of QSWAT model, the stream flow at outlet (Ashti) was calculated and compared with observed stream flow data. The coefficient of determination (R2) was found of the order 0.97 and Nash-Sutcliff efficiency (NSE) is of order 0.97. For model sensitivity analysis p-factor and r-factor are found to be order of 0.87 and 0.66 respectively during model validation and during calibration period these values found to be 0.94 and 0.89 respectively. The model performance indices show that the hydrological models simulate monthly stream flows quite reliably. The calibrated model can simulate hydrological changes and climate variability in the study area for better water management practices.

Keywords: Hydrological model, SWAT, river basin, Stream flow.

Estimation and Comparison of Spatio- Temporal Variability of Soil Physical Properties Based on Interpolation Techniques

S. Sharma[1*], V. Meena[1], S. Yadav[1] & D. Swami [1]
[1]Indain Institute of Technology Mandi, Mandi, India
*sharmasahilbuce@gmail.com

Abstract

The increasing variability in soil physical characteristics requires understanding subsurface hydrology and addressing variations at both spatial and temporal scales. Therefore, the present study aims to analyse the spatiotemporal variability of soil physical properties of the samples collected from 104 sampling locations in the Suketi watershed of district Mandi, Himachal Pradesh, India. The study compares different interpolation techniques for quantifying the spatial variations in soil moisture and soil organic content. Based on the error estimates of the coefficient of correlation (R), root mean square error (RMSE), bias, and unbiased root mean square error (ubRMSE), the Interpolation techniques, Inverse Distance Weighting (IDW), Radial Basis Function (RBF), Local Polynomial Interpolation (LPI), Simple Kriging (SK), Empirical Bayes Kriging (EBK), Universal Cokriging (UCK), Ordinary Kriging (OK) and Universal Kriging (UK) are compared and validated (cross-validation). UCK and SK were the best-performing geostatistical techniques for soil moisture (RMSE ~ 2.9 and ~ 0.40 correlation values), and the UK was best performing for organic matter (RMSE ~ 2.25 and 2.29 correlation values). The best deterministic approach based on the (RMSE ~ 2.9 for soil moisture and ~ 2.24 for organic content) computation was LPI; however, LPI has a continuous negative bias (~ 0.48) for soil moisture and positive bias (~ 0.1) for organic content. In contrast, RBF provides a balanced approach depicting a smaller bias (~ - 0.19) but a higher R value (~ 2.98). The Kriging methods have better functionality than IDW methods; specifically, the Kriging with external drift provides better prediction results.

Keywords: Soil Moisture, Soil Organic Content, Spatial Interpolation, GIS.

Improving Redundancy in Water Distribution Systems Considering Pressure Deficient Modeling Approaches

Sunny Singh[1]& Shweta Rathi[1*]
[1]NIT Kurukshetra, Kurukshetra, India
*shwetarathi@nitkkr.ac.in

Abstract

Redundancy is an important attribute of a resilient Water Distribution System (WDSs). However, due to lack of knowledge of where and how to increase the redundancy and its contribution to resiliency in branch as well as looped networks i.e. where to add the pipes one by one in case of branch as well as loop networks is a question in case of budget constraints to Water Authorities. The additions of pipelines in the WDSs are suggested based on the results of different Pressure Deficient Analysis (PDA) approaches. Since, the accurate analysis of pressure-dependent behaviors in WDSs is crucial for efficient and reliable network design and operation. There are different ways for modeling of PDA of WDSs i.e., Change in source code, adding artificial Elements, Using Emitter instead of Node. The main aim of the study is to perform PDA modeling approaches on two examples, a single source network, and a case study of a Water Distribution System, Maharashtra State, India. In this study, for PDA modeling used are “adding different artificial elements” suggested by different researchers for an application of two example networks namely, a single source network, and a case study of a Water Distribution Systems, Maharashtra State, India. We considered two methods for PDA analysis to assess the performance of the modeling approaches i.e. Babu and Mohan’s method (2012), Gorev and Kodzhespirova (2013) and Paez et al.(2018). The results of PDA modeling approaches i.e. pipe discharges and nodal demands and pressures are considered for redundancy determination i.e. iteration-wise addition of pipes in the branch and looped network. The pipes are added considering minimization of variance of pipe-flows (VPF), which indicates maximization of flow uniformity in the networks as discussed by Rathi et al. (2018, 2023) and observed that Variance of Pipe-Flows parameters provided better designs which increases more reliability with least cost. Thus, herein VPF are considered as a flow-uniformity parameter and used for network design and reliability evaluation for different PDA modeling approaches. Herein, we have discussed the steps (methodology) for redundancy determination wherein variances of pipe flows are used for flow uniformity only methodology is explained with steps and redundancy will be evaluated for all different PDA approaches and advantages and disadvantages will be the future scope of this study. The future scope of the study is further to compare the redundant based designs

considering all PDA Modeling approaches and to discuss advantages and disadvantages of all PDA modeling approaches in redundancy improvement. The findings of this study is to contribute the improvement in redundancy considering different PDA modeling approaches in WDSs on implementing a real case study over the Demand Dependent Analysis (DDA) approach and offer guidance to the practitioners in performing a single appropriate PDA approach on real case studies considering the ease of adoption and implementation in increasing resiliency of WDSs.

Keywords: EPANET, Modelling, Pressure Deficient Analysis, Redundancy, Variance of Pipe Flows, Water Distribution Systems.

Impact of Choice of Optimization Target in Calibration of Hydrological Models on Model Performance

R. Buragohain[1*], H. Medhi[1] & K.U. Ahamad[1]
[1]Tezpur University, Tezpur, India
*rbgn@tezu.ernet.in

Abstract

A hydrological model needs to be calibrated to obtain the most optimal parameter set and the most common method is the use of optimization algorithms to minimize the error between observed and modelled values. While it can be achieved by minimization of the sum of squared errors or absolute errors, several other target variables are suggested in various literatures. Among those, Nash-Sutcliffe Efficiency and Kling Gupta Efficiency are commonly adopted, both of which are similar and different in their own ways. Further, parameters such as RMSE, percentage bias, RSR (RMSE-observations standard deviation ratio) etc. are also adopted in many studies as model evaluation statistics due to their respective utilities in various situations. In this paper, impact of choosing different parameters as the objective function is examined. For testing, a lumped hydrological model is applied on two mountainous catchments in western USA. The calibrated parameters obtained from using the different performance metrics as the optimization target are used in simulation to examine their relative merits in terms of the other metrics.

Keywords: Optimization, Objective Function, Hydrological Model, Performance statistics.

Atmospheric Rain Water Harvesting

Mohd. Athar[1*], Murtaza Maqbool[2], Mir Mohsin[3], Humaira Athar[3]
[1]Professor, Civil Engineering Department, A.M.U., Aligarh, Uttar Pradesh-202002,
[2]B. Tech. students, Civil Engineering Department, A.M.U., Aligarh, Uttar Pradesh-20200
[3]Scientist, Innovative Building Materials Division, CSIR-CBRI, Roorkee, Uttarakhand 247667
*matharalam58@gmail.com

Abstract

Water is indispensable element in meeting many vital needs, like drinking, cooking and cleaning etc. Unconscious agricultural irrigation, pollution, and population growth cause water scarcity that humanity must cope with. As a result of global warming and climate change, especially the amount of potable water is decreasing, making it difficult to access clean water resources. The occupancy of drinking water sources decreases in high temperature seasons and some of them even disappear. This situation has made it necessary to search for alternative methods to obtain drinking water. One of these methods is to obtain potable water from atmospheric air containing high amounts of water. With the widespread use of this method, the scarcity of drinking water can be alleviated to a certain extent. In this study, the processes of condensing the water in the atmospheric air by using solar energy, which is a renewable energy source, and thus obtaining potable water are discussed. Efforts to increase the efficiency of obtaining potable water by using various absorbents and by various systemic solar still designs have yielded positive results. As a result of this literature review, the limits of the studies and their regional effectiveness were evaluated together. The effect of temperature, velocity, humidity of the atmospheric air and the amount of solar radiation on the process were evaluated. It has been concluded that certain desiccant materials with good water absorbers such as calcium chloride and silica gel can be used effectively in the processes of obtaining potable water from atmospheric air by developing correct designs. It has been demonstrated that high atmospheric air temperature, which is an important cause of water scarcity, can be converted from disadvantage to advantage by utilizing solar energy.

Keywords: Atmospheric Rain water Harvesting, Potable water, Solar radiation, Global warming.

Actual and Potential Evapotranspiration Trend Analysis of Son Beel Wetland Northeast, India

N.R. Devi[1*], B.S. Sil[2]& T. Das[3]
[1,2,3]National Institute of Technology, Silchar, Silchar-788010, India,
*nritadevi21rs@civil.nits.ac.in

Abstract

Evapotranspiration (ET) is a sensitive and integral hydrological and climatic variable in water and energy balance studies. It also holds the second-largest mechanism for precipitation in the hydrological cycle in terms of water quantity and is also a key indicator of climate change and a significant contributing factor to sustainable water resource management as it influences surface water storage; runoff and groundwater recharge. So, environmentalists and researchers have recently paid much attention in detail analysis of its temporal trends. In this study, we explore monthly, seasonal and annual trends of both actual evapotranspiration (AET) and potential evapotranspiration (PET) for the area in Son Beel Wetland, Assam using non-parametric Mann-Kendall test and Sen's slope estimator for the period of 2001 to 2021. Moderate-resolution imaging Spectroradiometer (MODIS) gap-filled evapotranspiration product of mm/8 day data has been used in this study. The result showed significant increasing trends in AET in June, October, and November. A similar trend is observed in seasonal (spring and autumn seasons) and annual analysis also, the reason being the climate changes that leads to an increase in maximum and minimum temperature. But in the case of PET, there are significant decreasing trends in April, May, and the summer season. The annual analysis shows no significant trend for PET. The results of this analysis will help understand the evapotranspiration dynamics of the study area.

Keywords: Evapotranspiration (ET), AET, PET, Mann-Kendall test, Sen's slope, climatic variables.

Design Discharge Estimates from Frequency Analysis of Annual and Summer Maximum Flow Series-River Jehlum

Anbreena Anjum*
NIT Srinagar
*anbreenanjum@gmail.com

Abstract

Floods, one of the most common and destructive natural disasters, have always been a significant part of Earth's history. Extreme flood occurrences can sometimes have an effect on hydrologic systems. Therefore, planning, designing, and managing a variety of facilities require a hydrologic and hydraulic understanding of floods. Hydrologic flood frequency analysis is a method of forecasting future frequencies of floods by utilizing statistics and probability. In this study, the discharge data of River Jehlum was analysed for annual & summer maximum flood peaks and flood frequency analysis was performed on nine gauging stations, using probability distributions. These included gamma distribution, Log Pearson Type-III distribution & Extreme Value Distribution (EV-I). The corresponding PDF, CDF, shape, scale & location parameters were obtained, fitting distributions, calculating flood quantiles and subsequently results were plotted. Corresponding confidence intervals at 95% were also constructed for flood quantiles from the best fitted distribution. The frequency curves obtained were compared with empirical estimates. The 100 year return period flood discharge was obtained at all the gauging stations which is useful in design of hydraulic structures. The delineation of River Jhelum watershed and sub basins was done in ArcGIS software using 30m SRTM Digital Elevation Model-DEM. The seasonality of discharge peaks and the corresponding extreme magnitude variations were studied to relate the seasonality of flood peaks with magnitudes. Rainfall and snowmelt contribute to the flood discharge, and the relative contribution of each changes with the season. The study has completed flood frequency analysis at each gauging station on River Jhelum and obtained the design discharge both for annual and summer data for comparison. After analysing and comparing the flood frequency analysis performed with summer peaks, it can be concluded that 2014 flood can have a return period of 100 years for river Jhelum in Srinagar, which was earlier comprehended to be a 150 year return period flood.

Keywords: Extreme Value Distribution (EV-I), Log Pearson Type-III distribution.

A Study of the Impact of Change in Land Use and Land Cover (LULC) on the Runoff Generation by Soil Conservation Service Curve Number (SCS-CN) Method in the Kidangoor Watershed, Kerala

Ajith A.V[1], Dillip Kumar Barik [2*]
[1]Research Scholar, School of Civil Engineering, Vellore Institute of Technology, Vellore, India
[2]Professor, School of Civil Engineering, Vellore Institute of Technology, Vellore, India
*dkbarik@vit.ac.in

Abstract

One of the factors that affect runoff estimation in the SCS-CN approach is the change in land use and land cover (LULC). Both natural and artificial activities are responsible for the change in LULC. The precise estimation of runoff is very much important to control floods and other natural disasters. The use of GIS and remote sensing techniques are crucial in the SCS-CN method. It has been observed that Kerala's rainfall pattern has undergone significant changes, which may be due to the rise in temperature in the Southeast Arabian Sea. This could be one of the reasons for frequent cloud bursts in Kerala nowadays. Hence, the Kidangoor watershed in Kerala has been considered in this study to estimate the runoff. The geospatial tools have been used in the SCS-CN method to study the impact of changes in LULC in runoff generation from the Kidangoor watershed. The downloaded satellite images for the years 2000, 2011, 2013, and 2017 have been classified into six classes as water bodies, built-up areas, mixed crops, rubber plantations, and teakwood by using the supervised method of classification in ArcGIS 10.5. The Inverse Distance Weighted (IDW) method was used in ArcGIS 10.5 to obtain the spatial distribution map of the rainfall for AMC-I, AMC-II, and AMC-III. By considering these spatially distributed rainfall, LULC, and Hydrological Soil Group (HSG) maps, spatial distribution maps of runoff were created in ArcGIS 10.5 by using the SCS-CN method for the years 2000, 2011, 2013, and 2017. It has been observed that about a 168% increment in the built-up area from 2000 to 2017 whereas other classes decreased in the ranges of 10 to 23%. The increment in runoff generation is only 31% in 2017 as compared to the year 2000. Similarly, the increment of runoff generation is 27% in 2017 as compared to 2000 while LULC kept constant. There is less impact of change in LULC in the Kidangoor watershed on runoff generation in the SCS-CN method. The results were compared with the observed discharge data. The error in annual runoff estimation was below 5% in both cases, which is within the acceptable range (10%). The quantity of rainfall may be the major factor to control runoff generation in this study area.

Keywords: Runoff, land use and land cover (LULC), soil conservation service curve number (SCS-CN), antecedent moisture condition (AMC), GIS and remote sensing, inverse distance weighted (IDW) method.

Estimation of Design Flood for the Ungauged Catchments of River Sutlej Using SUH Approach

Archana S. Shinde[1*], N. Vivekanandan[2], C. Srishailam[3], R.G. Patil[4]
[1]Assistant Research Officer, Central Water and Power Research Station, Pune, Maharashtra
[2,3,4]Scientist-C, Central Water and Power Research Station, Pune, Maharashtra
*archanas226@gmail.com

Abstract

Estimation of design flood for a given return period is of utmost importance for planning and design of hydraulic structures, river protection works and development of water resources projects. For this purpose, Synthetic Unit Hydrograph (SUH) is generally considered for estimation of design flood as well as development of flood hydrograph for ungauged basins have catchment area more than 25 km^2. For ungauged catchments, the observed rainfall data is used for estimation of rainfall by adopting probability distribution, which becomes an important input for computation of design flood. In this paper, the Extreme Value Type-1 (EV1) distribution is applied in estimating the rainfall, which is evaluated by Anderson-Darling Goodness-of-Fit (GoF) test. This paper presents a study on estimation of design flood at three ungauged catchments of river Sutlej viz., (i) Saisso Khad upto Giabong village (ii) Saisso Khad between Giabong and Rushkling villages and (iii) Kannam Nallah up to Kannam by adopting SUH approach as its catchment areas are more than 25 km^2. The annual 1-day maximum rainfall series pertaining to Pooh rain-gauge station is used to estimate the rainfall by adopting EV1 and the results are evaluated through GoF test. The rainfall depth is used for estimation of design flood by applying the procedures as described in Central Water Commission flood estimation report for Western Himalayas-Zone 7. The paper presents that the estimated design flood using SUH approach and the derived flood hydrograph of three ungauged catchments in the tributaries of river Sutlej with 25-year, 50-year, 100-year return period rainfall depth and observed 1-day maximum rainfall could be considered for flood protection and river training works, and development of water resources projects in the region.

Keywords: Design flood, Extreme Value Type-1, Rainfall, Synthetic Unit hydrograph.

Advancements and Challenges in Hydrological Modeling: A Comprehensive Review

S. Singh[1*], K. Mishra[2] & H.L. Tiwari[3]
[1]Centre of Excellence in Water Management, MANIT Bhopal-462003, INDIA
[2]Department of Civil Engineering, MANIT Bhopal-462003, INDIA
[3] Department of Civil Engineering, MANIT Bhopal-462003, INDIA
*shivillarows@gmail.com

Abstract

Hydrological modeling is a potent technique for comprehending and forecasting the behavior of water in a specific area or hydrological system. It plays a crucial role in understanding and managing water resources but is often associated with various uncertainties. This review highlights the development of hydrological models that consider complex interactions between different water cycle components. By systematically analyzing and reviewing a diverse range of studies, this paper provides a clear and detailed explanation of the challenges, limitations, and recent advancements in hydrological modeling. Additionally, it identifies specific areas within the field that require further research and investigation. The importance of uncertainty quantification, model calibration, validation techniques, and the integration of observational data for enhancing the accuracy and reliability of rainfall-runoff modeling is also emphasized. A comprehensive overview of recent advancements in hydrological modeling, their benefits to society, and the challenges and gaps in the field are presented. This review contributes to the improvement of hydrological models by shedding light on existing knowledge gaps and offering new lines of inquiry to better comprehend and predict hydrological processes. These insights hold significant potential for practical applications, empowering water resource managers, engineers, and policymakers to make informed decisions that optimize water management, enhance resource planning, and ensure the sustainable utilization of water systems.

Keywords*:* Hydrological Modelling, Uncertainty, Rainfall-runoff modeling, Water resource management, Water cycle.

Analysis of Flash Droughts across Indian Mainland: A comparison between CMIP6 simulations and ERA5 reanalysis data

Subhra Sekhar Maity[1] & Rajib Maity[1*]
[1]Indian Institute of Technology Kharagpur, Kharagpur - 721302, INDIA
*rajib@civil.iitkgp.ac.in

Abstract

Flash droughts (FDs) are distinguished from conventional droughts by their short duration and rapid onset characteristics. This phenomenon has significant implications for the agricultural sector as it can quickly deplete soil moisture levels, hindering crop growth within a short period. This study aims to examine the representation of FDs across the Indian mainland using the Evaporative Stress Index (ESI) utilizing data from General Circulation Models (GCMs) that are part of the 6th Phase of the Coupled Model Intercomparison Project (CMIP6). Considering the availability of all the variables necessary to calculate Actual Evapotranspiration (AET) and Potential Evapotranspiration (PET), which are essential for the computation of ESI, we have utilized a set of 5 GCMs. In this study, we have considered a historical period spanning from 1950 to 2014, which is divided into two distinct epochs: 1950-1981 and 1982-2014, to investigate the influence of the global climate regime shift on FD events that occurred in the 1980s. The observations from the GCM simulations are also compared with the reanalysis data obtained from 5th generation European Centre for Medium-Range Weather Forecasts (ECMWF) Reanalysis for Land (ERA5-Land) dataset. In summary, this study thoroughly examines the intermodal spread of spatio-temporal features of FD events indicated in CMIP6. Additionally, the study offers a detailed comparison with the representation of FD events in reanalysis dataset. As a future scope of this study, the status of flash droughts in the future across Indian mainland can be investigated to adopt climate-resilient policies.

Keywords: Flash Drought, Evaporative Stress Index, CMIP6; ERA5-Land

Reliability Based Design of Water Distribution Network

Amim A Nabi[1*] & Rajesh Gupta[2]
[1]PG Scholar, Visvesvaraya National Institute of Technology, Nagpur, India
[2]Professor, Visvesvaraya National Institute of Technology, Nagpur, India
*amimaltaf81@gmail.com

Abstract

Consideration of reliability in the design of water distribution networks (WDNs) requires performance evaluation of the network under various conditions that affect reliability, which makes the design methodology tedious. Several surrogate measures of reliability have been suggested, the improvement of which shows improvement in reliability and obviates the tedious performance evaluation step. Variance of pipe flows (VPF) is one amongst the different surrogate measures. The reduction of VPF improves the uniformity of flows in different pipes. Therefore, failure of any pipe and its isolation results in lesser impact as compared to a network in which flows are concentrated in a few major pipes. A two-step methodology was earlier used in which flows in pipe networks were obtained first using Genetic Algorithm to minimize the VPF. Then, in the second step, the network was designed to minimize the cost of the network considering the assigned flows. This article presents a single-step methodology using Non-Dominated Sorting Genetic Algorithm (NSGA) for the optimal design of a WDN considering the VPF as a surrogate reliability measure. The pipe diameters are taken as decision variables and a Pareto front is generated between network cost and VPF. A solution that minimizes both VPF and Network Cost is considered as the best solution. The methodology is illustrated with a simple two-loop network taken from the literature. The obtained solutions are compared with those obtained through a two-step methodology. The relative advantages and limitations are discussed.

Keywords: NSGA, Optimal Design, Reliability, Variance of pipe flows, WDN.

Rainfall -runoff modelling using Numerical Technique for Upper Krishna Basin, India

Aparna M. Deulkar[1*], Dr. Shreenivas. N. Londhe[2], Dr. Rakesh. K. Jain[3] & Dr. Pradnya R. Dixit[4]
[1]PhD Research Scholar, Department of Civil Engineering, JSPM Rajarshri Shahu College of Engineering, Tathwade, Pune-411033, India
[2]Professor, Vishwakarma Institute of Information Technology-Pune University, 411048, India
[3] Professor, Department of Civil Engineering, JSPM Rajarshri Shahu College of Engineering, Tathwade, Pune-411033, India
[4] Associate Professor, Vishwakarma Institute of Information Technology-Pune University, 411048, India
*aparna.deulkar2015@gmail.com

Abstract

Accurate prediction runoff at different lead time intervals is very essential to meet the day by day increasing water demand and also for the effective utilization of limited water resources. Rainfall -Runoff is the natural phenomenon which explains how rainfall interrelates with the surface flow and absorption into the soil (infiltration process). After satisfying of soil moisture capacity, excess amount of rainfall flows on the surface of the earth as a runoff. This whole natural process is known as the rainfall-runoff process. Generation of runoff also depends upon catchment characteristics like the land cover, soil type, slope, intensity of rainfall and climate change within the catchment area. The present study aims to predict runoff one day ahead in time interval using a numerical technique of Hydrologic Engineering Centre's Hydrologic Modelling System (HEC-HMS) at Shivade station in India's Upper Krishna Basin. The Shivade station in the upper Krishna Basin is considered as the study area along with the eight nearby raingauge stations in the same basin for this study. To evaluate the model performance different traditional error measures are used and model results reveal that the HEC-HMS model is reasonable and can be applied for modelling the rainfall -runoff process and to simulate the runoff. Detailed result analysis along with the error measures is presented in the full manuscript of the paper.

Keywords: Rainfall-Runoff, Krishna Basin, HEC-HMS, error measures.

Spatio-Temporal Assessment and Monitoring of Agricultural Drought in Karnataka, India

Chandan Kumar N M[1*], Vasala Saicharan[1] & Shwetha H.R.[2]
[1,2]National Institute of Technology Karnataka, Surathkal, Mangalore, India
*chandankumar2605@gmail.com

Abstract

Agricultural drought monitoring is indispensable as it alters the course of the natural agricultural system, causing severe constraints on achieving the UN SDG of food security. Due to climate change and erratic rainfall patterns, conventional drought indices are unsuitable for addressing intra-monthly rainfall patterns. To address this challenge, the current study employed a methodology for calculating agricultural drought using a standardized net-precipitation distribution Index (SNEPI) from 2000 to 2022 by accounting for rainfall at an intra-monthly scale. This study employed daily gridded rainfall data and monthly potential evapotranspiration obtained from India Meteorological Department (IMD) and NASA's global land data assimilation system (GLDAS), respectively, at $0.25^0*0.25^0$ spatial resolution for the calculation of SNEPI. The SNEPI is estimated for three months, which can be used as a proxy for agricultural drought. Intra-monthly variation of rainfall pattern is addressed by deriving the uniformity coefficient multiplied while calculating mean monthly rainfall values. The results were compared with the widely used drought index, SPEI. Spatial (agroclimatic zones and whole Karnataka level) and temporal (annual and monthly scale) analyses were performed. According to the yearly reports of the Karnataka State Natural Disaster Management Centre (KSNDMC), the highest negative rainfall departure occurred in 2003 and 2016, both of which were termed deficiency periods. The results showed that, even in 2006, the drought was observed; however, the annual rainfall was near normal magnitude. Therefore, this study presented the detailed results of 2003, 2006, and 2016. A higher magnitude (0.98) of the correlation coefficient was observed for October, the monsoon season's termination month. Also, the decreased correlations of 0.88, 0.88, and 0.84 were observed for the months of July, August, and September respectively. This can be interpreted as increased intra-monthly variations, which SNEPI successfully captures, whereas SPEI ignores the variation. Spatio-temporal analysis of SNEPI shows that it is correspondingly sensitive to dry or wet spells. The variations of SNEPI are in good agreement with the rainfall departure magnitudes, representing the near-real dry or wet conditions, whereas SPEI is less sensitive. SNEPI succeeds in the early detection of drought events due to its ability to detect short-term dry spells. SNEPI correlates well with SPEI at all considered months, inferred as SNEPI can be used for drought identification. Therefore, it can be used as an index that accounts for intra-monthly rainfall variations. The results suggest that this index is better for understanding the agricultural drought patterns spatially and temporally across diverse climatic conditions of Karnataka, even in remote and data-scarce regions, and helps the agricultural community and policymakers.

Keywords: Drought, Intra-monthly, Agro-climatic zones, and Generalized extreme value distribution.

Urbanization and its effect on storm water management

S. V. Ighare[1*], V.S Pradhan[2]
[1]MGM University Aurangabad, India[2]MGM University, Aurangabad, India
*sighare@mgmu.an

Abstract

Rapid growth and development of Urbanization leads to surface runoff, which ultimately become storm water. Sometimes draught and flood like situation may arise because of improper drainage system. It affects the rate of infiltration of soil through decades due to various reasons like soil erosion, concrete pavements, less vegetation etc. Urbanization increase through decades 1990,2000,2010,2020 are evaluated from various modern tools as GIS (Geographical Information System). Rate of infiltration in urbanized area has changed drastically from previous decades. The changes are incorporated in SWMM (storm water management software) for analyzing proper drainage system. Application of LID (low impact development) on catchment area can reduce surface runoff and increase the infiltration rate of soil. Proper drainage system of storm water is a necessity in urban areas.

Keywords: SWMM, GIS, LID

Statistical Analysis of the Last 30 Years of Spaceborne Precipitation Data of Uttarakhand by Non-Parametric

K. S. Rawat[1*], N. Bisht[2], S. Kumar[1], N. Garg[1]
[1]Department of Civil Engineering, Graphic Era Deemed to be University, Dehradun, India
[2]Horticulture & Food Processing, Uttarakhand
*ksr.kishan@gmail.com

Abstract

The study here gives a comprehensive analysis of the pattern of precipitation over the state of Uttarakhand. All 13 districts of the state have been studied for the annual precipitation variations. The precipitation data was acquired from CHIRPS (Climate Hazard Infrared Group Precipitation Station) for the last 30 years from 1991 to 2020. From its analysis, it was found that Uttarakhand receives the maximum precipitation from southwest monsoons. Its highly changing topography leads to great changes in precipitation patterns and weather conditions, and in long run the climatic conditions. The annual trend, as well as the seasonal variations of precipitation, were analysed with the help of a non-parametric test, the Mann-Kendall Method, and the trend's magnitude was analysed by Sen's Slope Estimator. There were some significant variations in the trends in different districts due to varying topography. Although the study involved analysis of districts individually meanwhile an analysis of the state suggested that there is a positive trend of precipitation in all four seasons with 1.57 in Winter, 2.11(max) in Pre-monsoon, 1.53 in Monsoon, and 0.57 (minimum) in post-monsoon. The Sen's slope suggested that the maximum magnitude was in Monsoon of 36.21 mm and a minimum in Pre-monsoon of 1.08 mm. the two-tailed Mann Kendall test suggested that in Dehradun and Uttarkashi the increasing trend was significant in pre-monsoon season while one-tailed test showed a significant positive trend in Uttarkashi, Pithoragarh and Bageshwar in Winter Season, Pauri, Uttarkashi, Dehradun, and Almora in Pre-Monsoon Season, and Rudraprayag, Tehri, Dehradun, and Almora in Monsoon season. There was no significant increasing trend in the post-monsoon season in any of the districts and but, there was a less significant decreasing trend in some districts, i.e., Nainital, Champawat, Pithoragarh, Bageshwar, Almora, and Udham Singh Nagar in the post-monsoon season and winter season for Udham Singh Nagar. These variations in the regions of the state are due to the varying topography from Gangetic plains in the south most regions to the greater Himalayas in the Northernmost regions. This study is intended to help the responsible planners specifically working in the water resources management as well as the corresponding infrastructural development work to have better decisions in the present scenario and can also be a guide to the agriculture sector for deciding which crops to be sown for maximum profit.

Keywords: Mann-Kendall Test, Sen's Slope Estimator, precipitation, trend, CHIRPS, Himalaya, south-west monsoons.

Statistical comparison of simple and machine learning based Land use and land cover classification algorithms: A case study

K. S. Rawat[1*], S. Kumar[1] and N. Garg[1]
[1]Department of Civil Engineering, Graphic Era Deemed to be University, Dehradun, India
*ksr.kishan@gmail.com

Abstract

Land Use and Land Cover (LULC) digital maps are invaluable resources for a multitude of applications, ranging from urban planning to environmental monitoring. The extraction of this vital information from Earth observational data has been a focal point of research for many decades. In earlier times, researchers grappled with limited classifier techniques, which cast doubt on the accuracy of LULC mapping. Often, the only metric that mattered in the final classification by any classifier algorithm was the Kappa coefficient. However, the landscape has evolved significantly in recent years, with an expansive array of classifiers and Earth observational data sources available for comparison. In the past, LULC mapping relied heavily on a handful of classifier techniques, leaving researchers somewhat skeptical about the precision of their results. Kappa coefficients served as the ultimate litmus test for accuracy. However, in today's dynamic research environment, the options for classifiers and Earth observational data have grown exponentially. Consequently, before arriving at a final LULC classification, it is imperative to be acutely aware of the potential variations in accuracy across different methods. Indeed, our recent study has clearly demonstrated that utilizing the same dataset and an identical number of training sets or sampling points with different classifiers can yield significantly different results. Even state-of-the-art Machine Learning (ML) techniques, such as Support Vector Machine (SVM) classifiers, are not immune to accuracy issues. For instance, it was found that Random Forest (RF), categorized as a soft classifier, outperforms SVM, a hard classifier, in terms of accuracy. Nevertheless, it is worth noting that advanced SVM classifiers still exhibit superior accuracy when compared to earlier classifiers like Maximum Likelihood Classification (MLC). Such findings are of paramount importance for researchers seeking to identify the most suitable classification algorithm for generating LULC maps in any Area of Interest (AOI). Furthermore, our study underscores the significance of considering temporal variability in datasets. This temporal aspect offers critical insights into metrics such as Land Use Change (LUC) in square kilometers (km^2), Annual Rate of Change (ARC) in km^2 per year, percentage change (PC), and percentage ARC for specific LULC classes over defined time intervals. However, it raises another intriguing avenue of research: determining which classifier is best suited for classifying specific LULC categories. Within our investigation, we observed that urbanization exerts a notable influence on agriculture, green cover, and even minor water bodies. Our analysis revealed a continuous expansion of built-up lands from 2005 to 2020, underscoring the significance of monitoring and understanding land-use changes in rapidly urbanizing regions.

Keywords: Support Vector Machine; Random Forest Machine; Maximum Likelihood; Image Processing; Remote Sensing; Land Use and Land Cover Classification.

Assessment of Standard Anomaly Index)SAI(of Last 30 Years Spaceborne Precipitation Data of Uttarakhand

K. S. Rawat[1*], N. Bisht[2], S. Kumar[1], N. Garg[1]
[1]Graphic Era Deemed to be University, Dehradun, Uttarakhand
[2]Horticulture & Food Processing, Uttarakhand
*ksr.kishan@gmail.com

Abstract

Drought indices are simple mathematical tools formulated to indicate the magnitude of change in precipitation from the standard values. Many indices are being used for this purpose but have a common idea about the deflection of average data values from the standard deviation. The standardized Anomaly Index (SAI) is one such index that helps to understand the pattern of precipitation. In this present study, SAI was computed using CHIRPS (Climate Hazard Infrared Group Precipitation Station), daily precipitation data for the entire state for a period from 1991 to 2020. This will bring out the anomaly of precipitation in various parts of Uttarakhand from plainer regions to highly mountainous terrains. The Standard Anomaly Index (SAI) analysed the decadal, annual, seasonal, and monthly average precipitation. One interesting thing that the indices showed (negative values) is that there is a decrease in precipitation between 1998 to 2008 and then back to normal as was before 1998. The seasonal index showed a similar kind of thing and the monsoon months which we have taken as June, July, and August. Meanwhile, we can conclude that the recent decade has shown a positive indication of precipitation and show there are fewer chances of droughts in near future. Also, the SAI has been used to find the drought as well as humid years. The results suggest that recent years have seen an increase in precipitation, so, a new plan should be made to effectively handle the landslides and other disasters during monsoonal months and probable drought conditions in non-monsoonal months. The government should encourage new agricultural practices after a thorough analysis of new arising situations to obtain maximum benefit with available resources.

Keywords: Standardised Anomaly Index, precipitation, trend, CHIRPS, Himalaya, droughts, humid years, El Nino.

Statistical Analysis of Last 30 Years Spaceborne Precipitation Data of Uttarakhand by Parametric Tests

A Sati[1], K S Rawat[2*], Sanjeev Kumar[2], N. Garg[2]
[1] Indian Institute of Technology, Delhi
[2] Graphic Era University, Dehradun, Uttrakhand
*ksr.kishan@gmail.com

Abstract

Using mathematical tools for statistical analysis has always been an integral part of research work. To study the climatic characteristics of a region we need certain data coherent to climatic parameters like temperature and precipitation. In this study, CHIRPS (Climate Hazards Group InfraRed Precipitation with Station data) datasets were used to retrieve the three decadal (1991-2020) daily precipitation data for the Uttarakhand state. As the topography of the state represents the areal territory from plains to hilly terrain from its south to north belonging high altitude northern Greater Himalayan peaks to the synclinal foreland basin as Shivalik to its southern end thus, to make the analysis useful it is important to process the data district wise, giving a complete range of climatic behaviours in different regions. The study emphasized the decadal, annual, seasonal, and monthly statistical parameters. It was found that there is a decrease in precipitation between 1998 to 2008 and then back to normal as was before 1998. The maximum precipitation was received in the months of July and August, and more than half from June to August. The plainer regions of Udham Singh Nagar, Dehradun, Haridwar, Nainital, Pauri, and Bageshwar districts, typically the southern part of the state receive more than 80% of annual precipitation in the SW monsoon (June, July, August, and September) season while Chamoli district, in the northern part receive 74% of annual precipitation in SW monsoon season. The maximum average annual precipitation was received by Nainital while Uttarkashi received the lowest. Finally, the policymakers working in hydrology will be able to make sensible decisions from these types of studies, as it brings into light the regions requiring drought management, due to lack of precipitation and disaster management, for regions having an excess of it. Also, those working in the agriculture sector will be able to notify the types of crops to be sown to attain maximum benefit for the farmers.

Keywords: precipitation, homogeneity of data, CHIRPS, Google Earth Engine, Himalaya

Small Basin Management using Correlation Between Morphometric Parameters and SWAT Model Outputs

G.R. Kumawat[1*], Rohit Goyal[2] & Sumit Khandelwal[3]
[1,2,3]Malaviya National Institute of Technology, Jaipur, India
*2018rce9002@mnit.ac.in

Abstract

It has been observed that due to climate change and rapid expansion in infrastructure development, hydrology of the West Banas basin (India) has changed significantly, which leaded to high magnitude discharge during flash floods along with increased frequency of floods. This emphasize the need for quick estimation of discharge for un-gauged sub-basins. Hydrological analysis of West Banas basin is done by estimation of 18 morphometric parameters and their hydrological inferences discussed. A SWAT (Soil and Water Assessment Tool) model has been developed utilizing data of 32 years (1987-2018). It was observed that both the morpho parameters and response of catchment viz. sediment load and discharge, are functions of fundamental basin characteristics like slope, soil type, basin shape, catchment area, infiltration capacity, relief etc. Morphometrical parameters as well as hydrological variables were estimated at 6 different pour points in the basin. The 3 morphometric parameters namely Rho coefficient, Bifurcation ratio and Form factor were corelated with SWAT model output variable 'discharge per unit area' and represented in form of a numerical equation with r^2 values of 0.914. The correlation between 3 morphometric parameters namely Ruggedness number, Channel gradient and Relief ratio established with another SWAT output 'sediment concentration' and represented in the form of numerical equation with r^2 values of 0.843. The correlations were found satisfactory. The estimated values of sediment concentration and discharge per unit area obtained through empirical equations may be utilized for the sub-basins of similar characteristics, where the required observed data of continuous discharge is not readily available for calibration of the model.

Keywords: Correlation, Discharge, Sediment, Morphometry, SWAT.

Application of the Arc-SWAT model to assess climate change and land use/cover change impacts on water balance components of the Pawana River Basin, Maharashtra

Ranjeet Sabale[1*], Dr. H U Tiwari[2], Dr. Sudarshan Bobade[3], Dr. Arun Dhawale[4], Raju Narwade[5]
[1] Assistant Professor, Civil Engineering Department, Pimpri Chinchwad College of Engineering & Research, Ravet,Pune. ORCID- 0000-0003-4944-4625.
[2] Principal & Professor, Mechanical Engineering Department, Pimpri Chinchwad College of Engineering &Research, Ravet, Pune.
[3]Associate Professor & Head of the Civil Engineering Department, Pimpri Chinchwad College of Engineering &Research, Ravet, Pune.ORCID- 000-0001-7839-1855.
[4] Professor, Civil Engineering Department, Pimpri Chinchwad College of Engineering & Research, Ravet, Pune.ORCID- 0000-0001-7175-3809.
[5]Associate Professor, Civil Engineering Department, Pillai Hoc College of Engineering & Technology.
*ranjeetsabale7363@gmail.com,

Abstract

As a result of the burgeoning population, rapid urbanization, and climate change, water resources are under tremendous pressure. Water scarcity, secondary soil salination, waterlogging, and lowered groundwater levels are alarming situations that require immediate intervention to control their effects and plan sustainable water resources. Therefore, this study is planned to simulate and evaluate the effects of LULC and climate change on the Pawana basin of Maharashtra state. To fulfill the set objectives it is important to employ the efficient hydrological model therefore SWAT (Soil & Water Assessment Tool) was used in this work. The SWAT model was processed for metrological data from (2000-2020). The meteorological data was taken from IMD (India Meteorological Department, Pune) and Hydrological data was collected from HDUG group Nasik. The SWAT-CUP tool with the SUFI II algorithm was used to calibrate and validate the SWAT model. After processing, it was observed that the simulated and observed data have a good degree of fitness, indicating the acceptance of the SWAT model. Statistical parameters like NSE and R^2 were used to assess the sensitivity of the work. The R^2 value was observed at 0.80, and the NSE was 0.78. The water balance components for the Pawana basin were simulated with inputs taken from downscaled Global Climate Models (GCMs) data (for future scenarios (2030–2100) relative to a baseline period (1974–2004) under RCP-4.5 and RCP-8.5 and by creating hypothetical LULC change and management scenarios. Finally, it was observed that all GCMs show an increase in average temperature over the study basin, while precipitation over the basin shows high variance. These findings will help organizations and stakeholders workingin the water resources area to take action for mitigate the damaging effects of LULC and climate change on water supplies.

Keywords: ArcSWAT, Irrigation, GCM, Surface water, Simulation-Optimization.

Comparative Evaluation of Rain Garden Infiltration Rate using Conventional models and Soft Computing Techniques

Sandeep Kumar[1*], Dr. Krishna Kumar Singh[2]
[1, 2]Civil Engineering Department, National Institute of Technology Kurukshetra
*balwan.verma74@gmail.com

Abstract

Recent best management practices established for reducing urban flooding include rain gardens. However, there is no logical foundation for its design specifications. In order to forecast the infiltration features of the rain garden, the current work uses conventional and machine learning approaches. In order to conduct research on perennial flower species, a series of small rain gardens were constructed within the hydraulics laboratory at NIT Kurukshetra in Haryana, India. The study involved the utilization of three conventional models (the Philips model, Multi-linear Regression, and Kostiakov model) as well as two soft computing approaches to predict the rain gardens infiltration rate. The M5P tree model exhibited superior performance compared to other models in the study. The Correlation Coefficient (CC), root mean square error (RMSE), and Nash-Sutcliffe efficiency (NSE) values for the training data set are 0.960, 0.526 cm/hr, and 0.858, respectively, and for validation, data set values are obtained as (CC = 0.941, RMSE = 0.667 cm/hr, and NSE = 0.87). The results of this study will be helpful for accurately calculating the infiltration rate of the rain garden.

Keywords: Urbanization, Rain garden, conventional models, Infiltration rate, Urban flooding, and soft computing approaches.

Hydro Dynamic Flood Inundation Mapping of Urban Catchment

R. Venkata Ramana[1*], Y. R. Satyaji Rao[1]&V. S. Jeyakanthan[1]
[1]Scientist, National Institute of Hydrology, Kakinada. AP, India
*venkataramana_1973@yahoo.co.in

Abstract

Mitigation of urban floods and waterlogging, majorly in metropolitan cities, has drawn recent attention due to aggravated flooding in cities hindering socio-economic activities and ecology. The complexity of urban floods can be attributed due to rapid urbanization and extreme climatic events. The encroachment of water bodies and drains, unplanned construction, and destruction of natural storm conveyance need to be acknowledged to improve the drainage system to varying climatic conditions. Therefore, this study was carried out to address the inadequacy of the storm drainage network in Zone-IV GHMC (Greater Municipal Hyderabad Corporation), Hyderabad, Telangana. Environmental Protection Agency's (EPA) SWMM (Storm Water Management Model) software has been used to simulate the runoff in integration with the GIS application. Five tipping bucket rain gauges and three automatic water level recorders were installed in the pilot area for collecting the observed data. The model was simulated with different LULC periods from 1973, 1990, 2000, 2005, 2010, 2015, and 2020 and positive correlation between peak discharges, runoff coefficient, runoff depth, and percentage impervious area and find out the pilot area runoff coefficients (0.869, 0.851, 0.894, 0.903, 0.910, 0.925 and 0.956). The model simulated the runoff depth flood event for more than 100 years return period on 13 October 2020 and generated the flood inundation map using HEC RAS. Flood inundation depths are well compared with field observation marks. The dataset, the results obtained and the methodology followed in the current study can be used by urban planners to identify the potential flood risk zones and nodes and incorporate them to plan the mitigation and management strategies.

Keywords: Depth, Discharge, Flood, Network, Routing and Runoff.

Comparison of 1 D Hydrodynamic Flood Inundation Modeling Capabilities of MIKE Hydro and HEC-RAS

Komal Vashist[1*], K.K. Singh[1]
[1]National Institute of Technology Kurukshetra, Kurukshetra, India
*vashsitkomal94@gmail.com

Abstract

Floods are the most prevailing and catastrophic event that causes many causalities and a heavy toll on human lives and geological damage to the topology. Floods cannot be stopped completely, but their effect can be minimized by proper flood mitigation practices. Flood inundation modeling is one of the most exquisite non-structural measures for mitigating the effects of floods, although it is difficult in developing nations due to data scarcity. This study developed one-dimensional hydrodynamic models for the 178 km length of Krishna River and its tributary Bhima River, India, to perform the flood inundation simulation. MIKE Hydro River model and HEC-RAS model are employed in the study to compare the flood inundation modeling capabilities of the models. Freely available digital elevation models (DEM) of 30 m resolution are incorporated into the study to extract the geometry and cross-sections of the Krishna and Bhima rivers. The 1 D models are calibrated for the 2006 flood event and subsequently used for validation for the year 2009 flood. The performance of both models is assessed through statistical parameters like Correlation coefficient (CC), Root mean square error (RMSE), Index of agreement (d), and Percentage deviation in peak (%). The simulated water level obtained using the MIKE Hydro River model is in reasonable agreement with the observed values as indicated by the performance parameters.

Keywords: Flood, Inundation, Modeling, DEM, MIKE Hydro, HEC-RAS.

Effect of Spatial Discretization of Watershed on Runoff in Netravati Basin using SWAT Model

Agarwal Aashi[1], Vamsi Krishna Vema[1]
[1]Department of Civil Engineering, National Institute of Technology Warangal, Warangal, India
*aa22cer1r11@student.nitw.ac.in

Abstract

Hydrological modelling plays a pivotal role in water resource management in the face of climate and land cover changes. Selection of an appropriate model scale is crucial for hydrological modelling as the capability of hydrological models in reproducing observed frequency and spatial patterns can be influenced by the definition of sub-basins. The selection of threshold area defines the number of sub-basins, which may impact the sensitivity of model parameters. While the spatial scale and discretization level are the decisions of the modellers, a better understanding of their impact on the runoff simulations may result in informed decisions. This study aims to address the impact of spatial discretisation on streamflow in Netravati basin. SWAT model with three sub-basin configurations, namely (M1) with 5 sub-basins, (M2) with 9 sub-basins, and (M3) with 19 sub-basins was used to simulate the streamflow. The results revealed that differences in model structure resulting from variations in sub-basin spatial scale led to decline in NSE, KGE and R^2 values as observed from the high performing model M1 to less performing model M3. The analysis provides understanding to select an appropriate spatial resolution of the SWAT model and optimizing parameters in the selected study area.

Keywords: SWAT, Streamflow, sub-basin scale.

Flood Risk Mapping Using Analytic Hierarchy Process (AHP) - An Overview of Current Practices

Ankit Sharma[1] *, Komal Vashist[1], K.K Singh[1]
[1] Department of Civil Engineering, National Institute of Technology, Kurukshetra
*ankitsharma336@gmail.com

Abstract

Flood risk mapping (FRM) is an essential tool for determining the risk and susceptibility of flood-prone locations. FRM constitutes various criteria and factors that require a methodical and comprehensive decision-making framework. The Analytic Hierarchy Process (AHP) is a popular multi-criterion decision-making (MCDM) technique for dealing with complicated problems, including qualitative and quantitative factors. This study explores the applicability of AHP for developing flood risk maps and provides a thorough overview of various AHP-based methods applied in recent times for economical flood risk mapping. The study analyses 25 research articles to enumerate different hazard and vulnerability factors various researchers have used for flood risk mapping. The review concluded that distance from river channels, high rainfall data, land use land cover, elevation, rainfall deviation, low slope and dense network lay the foundation for a spatial multicriteria decision framework to assess the flood risk for vulnerable regions. AHP can provide a dependable and robust framework for mapping flood hazards in numerous scenarios and circumstances. It can be concluded that AHP should be employed for flood risk mapping because it can potentially help the precise identification of flood-prone areas and mitigation measures.

Keywords: Flood, Risk, Mapping, AHP, Hazard, Vulnerability

Performance Evaluation of Different Time of Ponding Models

*[1]Songa Uma Maheswara Rao, [1]Richa Ojha
[1]Indian Institute of Technology Kanpur
*songam20@iitk.ac.in

Abstract

The time of ponding in agricultural fields depends not just on the soil's hydraulic properties but the crop as well, under both steady and unsteady rainfall conditions. An accurate estimation of the ponding time is required, as it gives information about when the soil surface saturated for the first time. The existing studies provide relationships for estimating the ponding time for different Gardener soils mainly based on their soil hydraulic properties. In this study, we compare the time of ponding obtained using other existing relationships in literature with that obtained using numerical simulation of the Richards equation. The comparison is made for both with and without root water uptake and different soil types and boundary conditions. The results showed that ponding time obtained using the numerical solution of Richards equation and other existing relationships differs considerably for silty loam soil.

The Study of Effective Water Resource and Conservation Planning Using Various models: A Case Study

Sarvesh Kapoor[1*], Anuksha Gupta[1], Shailza Sharma[1] & Mahesh Patel[1]
[1]Department of Civil Engineering, Dr. B. R. Ambedkar National Institute of Technology Jalandhar, Jalandhar 144008, Punjab, India.
*sarveshk.ce.21@nitj.ac.in

Abstract

Conservation of water is very important to mitigate water scarcity challenges and to protect ecosystems. Accurate rainfall and groundwater level predictions are essential for effective water resource planning; mitigate the impacts of drought or excess water and consequently ensure sustainable water management. The present study emphasizes the importance of precise rainfall and groundwater level prediction at NIT Jalandhar campus for efficient water resource planning and long-term. Due to factors like urbanization and population increase, groundwater depletion is a major issue in the region. In order to prevent depletion and maintain sustainable water management, the study suggests employing the potential effects of measures like rain water harvesting (RWH) and artificial recharge to reduce the rate of depletion. This study concluded that groundwater was depleting rapidly in the NIT Jalandhar campus and installing the combination of sewage treatment plant, recharge pits and rooftop rainwater harvesting system can be a proficient solution for water conservation. This study also highlights the urgent need for action to protect and preserve the groundwater resources in the region, and emphasizes the importance of sustainable water management.

Keywords: Rainfall, Ground Water Level, Water Conservation, RWH

Trend Analysis of Panchganga Catchment Rainfall by Statistical Approach

C. Srishailam[1], N. Vivekanandan[2]*, R.G. Patil[3]
[1]Scientist-D, Central Water and Power Research Station, Pune, Maharashtra, India
[2]Scientist-C, Central Water and Power Research Station, Pune, Maharashtra, India
[3]Scientist-E, Central Water and Power Research Station, Pune, Maharashtra, India
*anandaan@rediffmail.com

Abstract

Rainfall is one of the most important climatic variables that determine the spatial and temporal patterns of climate variability of a region, which provides the useful information for planning of management of water resources, agricultural production, assessment of the impacts of climate variability, etc. The drastic changes in rainfall trend showed a significant impact on society and therefore its up-to-date information is needed to estimate the spatial distribution and variability at all points of the territory, which would lead to hazardous events like flood and drought. This paper presents the study on analysing the trend in annual 1-day maximum rainfall (AMR), annual total rainfall (ATR) and monsoon total rainfall (MTR) series that is derived from the daily rainfall data observed at Gaganbawada, Kolhapur, Lanja and Radhanagari rain-gauge stations, which are located within Panchganga catchment.The presence of significant trend in AMR, ATR and MTR series is evaluated through a non-parametric Mann-Kendall (MK) test.The results of the trend analysis of Lanja and Radhanagari indicated that there is a decreasing trend in AMR, ATR and MTR. For Gaganbawada, the results indicated that there is a significant increasing trend in AMR whereas decreasing trend in ATR and MTR. The results of trend analysis of rainfall of Kolhapur showed that there is a significant increasing trend in AMR and MTR whereas decreasing trend in ATR. The rate of increasing or decreasing trend in AMR, ATR and MTR series is determined from the slope of the fitted lines using linear regression and the results are presented in the paper.

Keywords: Climate change, Mann-Kendall, Rainfall, Regression, Trend analysis

Improving Urban Flood Resilience- An innovative approach based on Nature-Based Solutions

Saranya, Viswanath[1*] & Chithra,N.R[1]
[1]National Institute of Technology-Calicut, NIT Campus, Kozhikode, P.O 673 601, India
*saranya_m210174ce@nitc.ac.in

Abstract

Urban pluvial flooding is a major problem faced by cities around the world resulting from the inadequacy of existing stormwater infrastructure systems. The rising occurrence and severity of natural calamities amplify the risk of urban flooding. Innovative solutions to support existing stormwater infrastructure is needed to improve flood adaptation and resilience. In the present study, the authors analysed the flood characteristics of a selected city based on dynamic hydraulic flood modelling using PCSWMM Software. Kochi Municipal Corporation- the coastal commercial capital of Kerala state, which is suffering from frequent urban flooding is selected for the study. The detailed 1D and 2D flood model is further developed to test the efficacy of Low Impact Development (LID) based on Nature Based Solutions (NBS) to combat urban flooding. The study was able to find the urban flood hotspots and to further suggest the best possible LID options that can support existing physical infrastructure. The research concludes that Low Impact Development based on NBS is a very significant solution to urban flooding and its success depends on the selection of apt technologies based on ground conditions.

Keywords: Urban Flood Resilience, Urban Flood Modelling, PCSWMM, LID, NBS

Statistical Analysis of Flood-Drought Trend in Central India and the West-Coast

S.S. Lachure[1*], J.S. Lachure[2], A.D. Sawarkar1, K.R. Singh[3], S. Sahu[1], A. Lohidasan[1], N.D. Dhamele[4]
[1]VNIT, Nagpur, India (Research Scholar)
[2]NIT Raipur, Raipur, India
[3]YCCE, Nagpur, India
[4]PFT, Banglore, India
*sagarlachure@gmail.com

Abstract

The utilization of statistical analysis is crucial in acquiring the necessary data prior to formulating any hypotheses. It ensures that the results will be of superior quality. The utilization of the Precipitation Estimation from Remotely Sensed Information using Artificial Neural Networks and Climate Data Record (PERSIANN-CDR) dataset yields satisfactory outcomes in comparison to the conventional methods of human data collection or station-based measurements. This study seeks to assess the monthly, seasonal, and annual variations in the Central-India (CI) and West-Coast (WC) regions between the years 1983 and 2020, utilizing PERSIANN-CDR precipitation data. The utilization of the Mann-Kendall and Modified Mann-Kendall methodologies is subsequently employed to identify patterns in the data, while the Standardized Precipitation Index is computed for monthly, seasonal, and annual timeframes. The outcomes are subsequently examined and presented via Innovative Trend Analysis and the hydroTSM software. The present study examines data collected from a total of 1705 sites, employing both the Mann-Kendall and Modified Mann-Kendall statistical tests. The majority of them demonstrate a lack of alteration in the pattern. The annual precipitation in the region has experienced a 0.5 percent annual rise. The yearly precipitation in the CI-WC arena is recorded to be approximately 1303 mm, which accounts for a mere 0.038 percent of the overall annual rainfall. In contrast, the Standardized Precipitation Index, Innovative Trend Analysis (ITA), and hydroTSM indicate a little decrease in precipitation. In general, the results are commendable and provide evidence of the influence of global warming on the area. The maps illustrate a notable gap in average rainfall quantities between the lowest and highest values observed from 2012 to 2020, accompanied by an expanded area experiencing drought conditions.

Keywords: Mann Kendall, Innovative trend analysis, Standardized Precipitation Index, HydroTSM, Statistical analysis

Downscaling Satellite-Based Soil Moisture Products over the Cauvery River Basin

Fathima Jamsheena P[1*], Agilan V[2]
[1] Department of Civil Engineering, National Institute of Technology Calicut, Kerala, India,
[2] Department of Civil Engineering, National Institute of Technology Calicut, Kerala, India,
*fathimajamsheena2@gmail.com

Abstract

Soil moisture is a critical component of the water cycle, and its accurate estimation is essential for understanding hydrological processes and managing water resources. Due to the unavailability of in-situ soil moisture data, soil moisture data from satellites are used for various purposes. The availability of accurate and high-resolution soil moisture data can help to improve our understanding of hydrological processes in the region, which can inform better water management practices. However, satellite-based soil moisture products often have a coarse spatial resolution, which limits their usefulness in many applications. Therefore, downscaling techniques have been developed to enhance the spatial resolution of satellite-based data. This study aims to downscale satellite-based soil moisture products using a combination of Land Surface Temperature (LST) and Vegetation Index (VI) over the Cauvery River Basin. Optical data which include LST and VI with a spatial resolution of 1 km from the Moderate Resolution Imaging spectroradiometer (MODIS) are used to downscale the soil moisture data from the European Space Agency's Climate Change Initiative (ESA CCI) with a 25 km spatial resolution. In this study, two types of datasets were defined based on the vegetation index, namely ESA CCI-LST-EVI and ESA CCI-LST-NDVI. Regression coefficients were established for both datasets, which were then used to downscale the coarse-scale soil moisture estimates to generate two fine resolution soil moisture products. The results indicate that the ESA CCI-LST-EVI dataset has better RMSE values overall compared to the ESA CCI-LST-NDVI dataset. This suggests that the dataset which include EVI may be more accurate compared to the second dataset. However, further analysis and validation may be necessary to confirm these findings. The downscaling approach can also be applied to other regions where the availability of high-resolution soil moisture data is limited.

Keywords: Cauvery River Basin, Downscaling, Land Surface Temperature, Soil moisture, Vegetation Index

An Explicit River-Network Model for Large-Scale Flow Simulation

Chaitanya J C[1*] & S. N. Kuiry [2]
[1] PhD Research Scholar, Civil Engineering Department, Indian Institute of Technology Madras, India
[2] Associate Professor, Civil Engineering Department, Indian Institute of Technology Madras, India.
*chaitanyajc007@gmail.com

Abstract

A river-network model is developed for simulating flow dynamics in a large river system. The Saint-Venant equations are discretized using MacCormack finite-difference scheme. The junction nodes are treated as boundary nodes, and the method of Characteristics is used to solve the network system. The developed model is suitable for the river- network consisting of merging and diverging sub-reaches. The model is validated with the observed water surface profiles in a laboratory-scale river-network system. The validated model is then applied to simulate flow in the Adyar River flowing through Chennai city. The upstream discharge and downstream tidal variation are imposed as boundary conditions. The simulated results are compared with the 1D HEC-RAS model outputs. The model's accuracy confirms its applicability to simulate flow dynamics in a large river-network system.

Keywords: River-network, explicit model, MacCormack scheme, and Adyar River.

Identifying Potential Rainwater Harvesting Sites using a GIS Based Approach

Jaideep Kumar[1], Digambar S. Londhe[1*], Yashwant B. Katpatal[1]
[1]Department of Civil Engineering, Visvesvaraya National Institute of Technology, Nagpur, Maharashtra, India-440010
* digambarlondhe@students.vnit.ac.in

Abstract

Rainwater harvesting (RWH) is a sustainable practice that can help to mitigate water scarcity and enhance water resource management. The identification of suitable sites for rainwater harvesting systems is crucial for effective implementation and utilization. Geographic Information System (GIS) provide a powerful tool for identifying potential RWH sites by integrating various spatial datasets and analyzing key factors influencing the suitable locations. This study aims to develop a GIS-based methodology for identifying potential rainwater harvesting sites. The methodology involves the collection and integration of relevant spatial datasets, including rainfall patterns, land use/land cover, topography, soil characteristics, and hydrological features. The datasets are processed and analyzed using GIS techniques, such as overlay analysis, suitability modeling, and multi-criteria decision analysis. Weightage is assigned to each parameter based on its importance in determining the suitability of a site for rainwater harvesting. Study identified that 10.59% of the study area i.e. 255.36 sq.km. area is very high suitable areas. The methodology provides valuable information for decision-makers, urban planners, and water resource managers to prioritize suitable locations for implementing rainwater harvesting systems. By utilizing this approach, communities can optimize the utilization of rainwater resources, reduce dependence on external water sources, and contribute to sustainable water management practices.

Prioritization of Sub-Watersheds based on Soil Erosion in an Ungauged Basin using MOORA, COPRAS, MARCOS and MABAC

Vinoth Kumar Sampath[1,*] and Nisha Radhakrishnan[1]
[1]Department of Civil Engineering, National Institute of Technology Tiruchirappalli, Tamil Nadu, India
*vinothkumarin1995@gmail.com

Abstract

Soil erosion is a significant natural disaster that results in the removal of the top layer of soil, leading to reduced agricultural productivity and land degradation. Managing an entire basin can be challenging; therefore, it is divided into 13 sub-watersheds (SWs) using the Arc SWAT tool in a geographical information system (GIS). This division aims to facilitate proper mitigation and management of the basin. Identifying erosion-prone zones in an ungauged basin is crucial for implementing preventive measures, as soil erosion causes considerable annual damage to living beings in the basin by reducing food production and filling reservoirs with sedimentation. The primary objective of this study is to identify the high erosion sub-watersheds and determine a suitable Multi-Criteria Decision-Making (MCDM) approach to prioritize the SWs of the Ponnaniyar River basin in Tamil Nadu, India. In this study, Morphometric parameters under linear, areal, shape, relief and hypsometric aspects and various multicriteria decision making (MCDM) techniques such as Multi-Objective Optimization method on the basis of Ratio Analysis (MOORA), Complex Proportional Assessment (COPRAS), Measurement of Alternatives and Ranking according to Compromise Solution (MARCOS) and Multi-Attributive Border Approximation area Comparison (MABAC) has used for prioritizing the sub-watershed in the study area. For this application, CartoSat-1 with resolution of 30m x 30m used to obtain a digital elevation model (DEM) which used for extraction and analysis of 18 morphometric parameters causes soil erosion. Ranks of each sub-watershed from various MCDM techniques was integrated by grade average method to generate the final priority of SWs. Additionally, the closest method to final priority was found to be MABAC techniques which was identified by Root Sum of Squares (RSS) method with value of 43. These prioritization techniques are useful for proper planning for policy makers and construction of water harvesting structures to prevent higher possibility of soil erosion and sedimentation.

Keywords: Soil Erosion, Morphometry Parameters, MCDM, RSS, Integration of Ranks.

Assessment of Rainfall-Runoff Relation in Watershed Using SCS Curve Number Method

Kartikeya Mishra[1*], H.L. Tiwari[2] & M.S. Hora[3]
[1,2 & 3]MANIT, Bhopal, India
*mishra1999kartikeya@gmail.com

Abstract

Runoff plays a vital part in the hydrological cycle by returning excess rainfall to the lakes, rivers, and oceans. It regulates the flow of storm water into stream systems. Modeling of runoff can help to monitor, understand and manage both the quality & quantity of water resources. Generally, rainfall-runoff models are described by the model structure and spatial processes. The model structure is based on the governing equations. A model used to determine runoff can be categorized into empirical, conceptual, and physical structures. The estimation of rainfall and runoff in a catchment plays a major role in the design of various water management structures. In this study, an attempt has been made to develop a rainfall-runoff model for the watershed. The amount of runoff in terms of depth is estimated from the catchment by Soil Conservation Service Curve Number (SCS-CN) Method. The Curve Number (SCS-CN) method is integrated with remote sensing (RS) and geographic information system (GIS) technology to estimate the runoff efficiently. This study revealed that the watershed of the Upper Lake produces runoff as 6090.4 mm for rainfall of 7062.09 mm in the subjected period.

Keywords: Runoff, Hydrological cycle, modelling, SCS-CN, GIS.

Integration of HEC-RAS and Arc-GIS for Improved Flood Management in Lower Tapti Basin

Vishal Jain[1*], Ruchi Khare[2] & Vishnu Prasad[3]
[1,2,3]Maulana Azad National Institute of Technology, Bhopal, India
*jain.vishal612@gmail.com

Abstract

Floods stand out as a predominant and recurrent natural catastrophe, renowned for their devastatingimpact on a global scale. In India, around 12% of the total geographical area is prone to flooding. Therefore, it iscrucial to study floods and develop safety measures to mitigate their impact. Flood routing is essential for flood control measures. The movement of flood waves is a complex event of unsteady and non-uniform flow in a river channel. The integration of GIS technology with flood models can be beneficial for flood planning and mitigation in a watershed. The Lower Tapti Basin down stream of Ukai dam is a region that is prone to flooding. In this research paper, the integration of Arc-GIS and HEC-RAS is used to assess flood discharge in the Lower Tapti Basin. Various data sources such as DEM and hydrological data are used to create a detailed flood model (Flood year 2002 & 2006) of the basin. The outcomes of this investigation will furnish indispensable insights for flood management within the Lower Tapti Basin, thereby facilitating the formulation of effective strategies aimed at mitigating flood hazards within the region. In the present work, the simulated and observed stage hydrographs are compared for years and it is found that the simulated stage hydrograph closely matched the observed stage hydrograph up to certain extend. Collectively, this study underscores the universality of the flood analysis methodology employed in river systems, rendering it adaptable to analogous circumstances. Such versatility holds the potential to offer valuable insights for informed decision-making in forthcoming developmental endeavors.

Keywords: Flood management, Flood Routing, HEC-RAS, ArcGIS, Flood Model.

Neuro Genetic Programming approach for streamflow forecasting

P.S. Kulkarni[1]*, S. N. Londhe[2] & P. R. Dixit[1]
[1]Vishwakarma Institute of Information Technology, Pune, India
[2]Vishwakarma Institute of Information Technology, Pune, India
*Preeti.kulkarni@viit.ac.in

Abstract

Accurate forecasting of stream flow is of critical importance in effective water resource management and flood mitigation. Traditionally this is done by employing numerical schemes having exogenous data requirement. These physics-based models are physics based hard computing techniques. Despite using the physics and large amount of data the accuracy of these models still needs an improvement. In recent past standalone techniques like Genetic Programming (GP), Artificial Neural Network (ANN) have been used for estimating and forecasting discharge, but they often face challenges towards its performance. The present work proposes a novel approach, namely the Neuro Genetic Programming (NMGGP) which combines the capabilities of Multi Gene Genetic Programming (MGGP: variant of GP) and Artificial Neural Networks (ANN) to enhance the modelling capabilities and forecasting accuracy. The proposed model uses a multi-step evolutionary approach in which the influential genes from MGGP are recombined through ANN in that the inputs suggested by these genes are used as inputs to form an ANN model. This is done in order to have better input selection for ANN models along with using the capabilities of GP by virtue of its "survival of the fittest" principle. The exercise is carried out along the river Krishna, which is a major river in central and southern part of India. The streamflow (discharge) at the downstream station on river Krishna is predicted using the current and previous values of discharges at two upstream stations, one of which is on river Koyna, a tributary of the river Krishna. No other inputs than discharges at the upstream stations are used. The results of the models when compared with standalone MGGP and ANN models exhibit a better performance. Details about the model development and results will be presented in the full-length paper.

Keywords: Neuro Genetic Programming, Multi Gene Genetic Programming, Artificial Neural Network, streamflow forecast.

Application of XGBoost in Flood Modelling

Samyadeep Ghosh[1*], Dinesh Borse[1], Lakshmi Ram Kiran Padilam[1], Jose Dinu Maria1, Srinivas Kondapalli[1], Keith A. Sawicz[2], Kiran Chinnayakanahalli[2] and Hemant Chowdhary[2]
[1]Verisk Extreme Event Solutions, India
[2]Verisk Extreme Event Solutions, USA
*Samyadeep.Ghosh@verisk.com

Abstract

Estimating how frequently a river is expected to flood is essential for developing watershed management plans, designing flood control infrastructure, and determining the flood risk of a property next to a river. The conventional method of achieving this involves looking at annual peak flows recorded by river gauges and fitting a probability distribution to determine the exceedance probability of river flows. To transfer the information from gauged sites to ungauged catchments, a Regional Flood Frequency Analysis (RFFA) is carried out which regionalizes the information using data from hydro-morphologically similar gauged catchments and provides flow estimates for various return periods. However, the performance of these RFFA models is limited by the choice of similar gauged catchments and the adequacy and consistency of their observed flows. In our study, we propose the implementation of Extreme Gradient Boosting (XGBoost) machine learning approach to estimate different return period flows for the ungauged catchments. The XGBoost is a decision-tree based method and utilizes the same catchments attributes and observed flow quantiles as conventional method, but it has a better capability of learning the relationship between the attributes. Overall, the proposed methodology produces promising results both in terms of accuracy and consistency in the estimated return period flows and can pave the way for the adoption of XGBoost as a viable alternate approach for regional flood frequency analysis.

Keywords: XGBoost, Gradient Boosting, Machine Learning, Flood Frequency, Flood.

Hydrological Modeling of Sindphana River Basin Using Arc SWAT

Raju Narwade[1*], Dr. S. K. Ukarande[2]
[1]PhD Research Scholar, Department of Civil Engineering, Pillai HOC College of Engineering and Technology, Rasayani, Taluka: Khalapur, Dist. Raigad, affiliated to the University of Mumbai, Mumbai – 410207
[2]Principal, K. J. Somaiya Institute Engineering, and Information Technology, Mumbai –400 022.
*narwade.rajesh@gmail.com

Abstract

Hydrological processes and the ecosystems in watersheds are significantly impacted by climate change. Its effects are more influenced by temperature and precipitation, which mostly contribute to defining problems with global warming. The primary factors that balance the watershed ecosystems are temperature and precipitation. Even though these variables are unknown, they play a crucial part in the predictions of dimensional climate change studies. India's water management has significant challenges on both a qualitative and quantitative level. The hydrological cycle is crucial to address these problems therefore; hydrological models are crucial tools that have been employed in the management and planning of water resources. The present study is devoted to simulating and predicting the hydrological parameters of the Sindphana River Basin, which is a tributary of the Godavari River basin and covers nearly 80 per cent of the Beed District of the Marathwada region of Maharashtra state. The SWAT model was processed to simulate rainfall and runoff in the study basin using data like soil types, land use and land cover, the digital elevation model, flow, and meteorological data for the period 1995–2020. The output generated by the SWAT model was calibrated using SWAT-CUP with the help of observed streamflow values. To ascertain the sensitivity of hydrological parameters, the Sequential Uncertainty Fitting (SUFI-2) algorithm in SWAT-CUP was used. The result shows that R2 values in calibration and validation are 0.78 and 0.84, respectively, indicating acceptance of the model. The CN II and SOL__AWC are the most sensitive parameters; the model shows good agreement at curve number 76. The outcomes of the model are in terms of volume of surface runoff, sediment yield, potential areas for reservoir location, and vulnerable sub-basins for soil erosion, which can be useful to researchers, water managers, and policymakers to plan and manage water resources sustainably.

Keywords: Arc-SWAT, Hydrological Model, SWAT-CUP, Calibration, Validation.

Flood Inundation mapping using HECRAS in the Bamnidhi basin

Mamata Ekkaa, Pritam Kumar Bhuyan[a], Laxmipriya Mohanty[a*]
[a]Department of Civil Engg, VSSUT, Burla, Sambalpur, Odisha 768018, India
*lmohanty_ce@vssut.ac.in

Abstract

Hydrological extremes such as floods and drought are topics of concern for developing countries because of the damage associated with life and property. To minimize such risk, adequate knowledge about river basins is required, which includes flood inundation mapping. In the present research work, the flood inundation map of the Mahanadi River at the Bamnidhi sub-basin for nine different cross sections has been analyzed. Selection of the basin is based on two criteria least human intervention and travel time of surface runoff should be more than one day. The model is prepared by flow simulation using HECRAS. Digital Elevation Model (DEM) with 30m resolution was referred to prepare the terrain for the study area. Here HEC-GeoRAS extension was used to transfer the data from GIS to HECRAS. The results were compared with the NDWI method. It can be further helpful for hydraulic engineers and other agencies dealing with flood mitigation measures.

Keywords: HEC-RAS; flood inundation; hydraulic modeling; unsteady flow; NDWI; GIS.

Development of Rating Curve using ADCP for Mej River in the Semi-Arid Chambal Basin of Rajasthan, India

Sanjay Agarwal[1,3], Rakesh Choudhary[2], Priyamitra Munoth[3], Archana Sarkar[4] and Rohit Goyal[5]
[1,2,5] Malaviya National Institute of Technology, Jaipur, India
[3]Water Resources Department, Government of Rajasthan, Jaipur, India
[4]National Institute of Hydrology, Roorkee, India
*ska1971@gmail.com

Abstract

Precise measurement of river discharge is a challenging task and at the same time, it is necessary for planning and management of water resources. The stage-discharge curve is a traditional method that is used to identify the flow and requires river cross-section. Apart from this method, Acoustic Doppler Current Profiler (ADCP) is also in use by project authorities around the World. Generally, ADCP is used to calibrate the gauge discharge curve but there is less work available when no stage-discharge relationship is available for a section. Therefore, in the present study, a gauge site downstream of the over bridge located on state highway 37 across the river Mej which originates from Bhilwara district, of Rajasthan and joins the Chambal River at Kota district in Rajasthan, is taken where no stage-discharge curve is available. The state water resources department used ADCP to take multiple readings of a velocity profile for the period of 10th August 2021 to 31st October 2021. Thereafter, readings were extrapolated for the full depth of the river section by applying logarithmic plot method. The curve so derived was validated with the readings of the two automated rain gauge stations in the catchment. The values of the developed rating curve and observed data from the automated water level sensor & automated rain gauge show a good correlation value of 0.86. Therefore, with the use of ADCP readings, a rating curve can be established with the extrapolation equation for the ungauged rivers with fairly good results.

Keywords: ADCP; Chambal basin; Mej river; rating curve.

Climate Change Impact Assessment on the Hydrology of Shakkar River Watershed using Hydrologic Engineering Center-Hydrologic Modeling System (HEC-HMS)

S. Mandloi[1], T. Thomas[1], K.V. Jayakumar[2], A K Lohani[1], L. Patel[1] & R. Pathak[1]
[1]National Institute of Hydrology, Roorkee, India
[2]National Institute of Technology, Warangal, India
*suryansh.nihr@gov.in

Abstract

Climate change is complex and a burning global issue affecting various aspects of our planet including the hydrological cycle. Various tools are available for mimicking the hydrological cycle and hydrological modelling is one of them. Hydrological modelling is the most comprehensive and suitable approach for understanding the response of any watershed. HEC-HMS is one of the widely accepted and extensively used model builder in modern era. This paper aims to utilise the abilities of HEC-HMS model for evaluation of climate change scenarios for the Shakkar River Watershed (SRW), which is a part of Narmada Basin. The model has taken into account factors like temperature, precipitation, evaporation rates, soil characteristics and land use land cover. The HMS model setup is done using SRTM 30m DEM data. The watershed is divided into four sub watersheds. Soil Moisture Accounting method is used as loss model and Clark unit hydrograph method is selected for transform component. For routing the flow through reach time lag method is used. The model is simulated with IMD gridded precipitation dataset and has been calibrated for the period of 2008-2012. Model has been validated for the period of 2013-2015. The NSE of model is observed as 0.694 for calibration period and 0.674 for validation period. In order to assess the impacts of climate change, thirteen GCM models have been utilised for intercomparison and getting an ensembled mean of watershed response under two different scenarios SSP 2.4.5 & SSP 5.8.5 in each GCM. Model simulations have been run for historic/baseline period (1961-1990), present period (1991-2019), Near term (2020-2040), Mid-term (2041-2070) & End term period (2071-2100). Changes in average daily flows, maximum annual peak flows and average annual peak flows have also been considered for the SRW. The results from this study will be helpful for developing effective adaptation strategies to mitigate the adverse consequences of climate change on water resources management and planning at watershed scale.

Keywords: Climate Change Impact Assessment, GCM, HEC-HMS, Soil Moisture Accounting, SSP.

Application of Data Driven Technique for Prediction of Koyna Reservoir Outflow, India

Shelke, Mahesh.1, Dr.S.N. Londhe.2, Dr.P.R.Dixit3
1Research Scholar, Vishwakarma Institute of Information Technology, Pune - 411048, INDIA; Email: mahesh.shelke78@gmail.com
2Professor, Vishwakarma Institute of Information Technology, Pune - 411048, INDIA; Email: Shreenivas.londhe@viit.ac.in
3 Associate Professor, Vishwakarma Institute of Information Technology, Pune - 411048, INDIA
*Pradnya.dixit@viit.ac.in

Abstract

The regulations of reservoir outflow contribute huge socioeconomic benefits to the society. Consequentially knowledge of reservoir outflow and its pattern in space and time is essential for the effective reservoir operations. The poor management of the reservoir operations leads to the losses of resources. To address this issue, present study aims in predicting the Koyna reservoir outflow (Maharashtra, India) at different lead time intervals ranging from 1 day to 3 days ahead in time using a data driven techniques namely Artificial Neural Networks (ANNs). Twenty-seven years of previously measured rainfall records at nine rain gauge stations in the Koyna catchment, reservoir inflow, Storage and Evaporation data of Koyna reservoir were used for model development with different input-output combinations. Though from the last decade, the data driven techniques have proved their capabilities in various modelling exercises, their performance need to be assessed in every case specific study and hence in the present study. this technique is applied to forecast the Koyna reservoir outflow. Statistical error measures like Mean Absolute Error, Root Mean Squared Error are used to assess capability and efficiency of in predicting the reservoir outflow. all the developed models performed reasonably well with better correlation coefficient and low values of errors. With traditional errors measures of; r= 0.83, RMSE=302.78 m^3/s and MAE=28.93 m^3/s for 1 day ahead forecast; r= 0.73, RMSE=368.75 m^3/s and MAE=6.83 m^3/s; for two days ahead and r= 0.65, RMSE=302.78 m^3/s and MAE=24.88 m^3/s; for three days ahead lead time. It is clearly observed that as the lead time increases prediction accuracy decreases which is well proven tendency of data driven techniques. the details of which are presented in the of present paper.

Keywords: Reservoir Outflow, Rainfall, Artificial Neural Networks (ANNs).

Modelling of Rainfall Using Regression Analysis and Soft Computing Technique

Rahul, K[1], Jayasree, A[2], Sravan, M[3], Khuntia, J. R[4], Devi, K[5], Das, B. S[6]
[1,2,3]UG Student, Department of Civil Engineering, Vidya Jyothi Institute of Technology, Aziz Nagar Gate, C.B Post, Hyderabad, India – 500075.
[4,5]Assistant Professor, Dept. of Civil Engineering, Chaitanya Bharathi Institute of Technology, Hyderabad- 500075, INDIA
[6]Assistant Professor, Dept. of Civil Engineering, National Institute of Technology, Patna, 800005, INDIA
*kandakatlarahul18@gmail.com

Abstract

India is a country highly dependent on rainfall for its various activities which include agriculture, businesses and other direct metrics which directly affect the economy. The rainfall prediction does not only assist in analysing the changing patterns of rainfall, but it will also help in organizing the precautionary measures in case of disaster and its management. The changing patterns of rainfall are associated much with the global warming; that is increasing of the earth's temperature due to increase of Chlorofluorocarbons emitting from the refrigerators, air conditioners, deodorants, printers etc. causing melting of the snow caps, altered weather patterns have become significant part of everyone's life. The rainfall for a particular locati on is more dependent on the different factors like, relative humidity, specific humidity, temperature, wind speed, wind direction surface pressure, evaporation, transpiration, percolation, runoff, ocean currents, population, El Nino & La Nina etc. Rainfall forecasting or predicting is very important because heavy and irregular rainfall can have many impacts like destruction of crops and farms, damage of property, so a better forecasting or predicting model is essential for an early warning that can minimize risks to life and property and also managing the agricultural farms in better way. This project aims to create a distinctive and effective mathematical model and machine learning system for rainfall prediction. In this study, various rainfall metrics from Osman Sagar catchment of Gandipet mandal, Telangana are tested in order to measure the model's effectiveness and perseverance. This study focuses on development of mathematical model by using multi linear regression analysis (MLRA) and artificial neural network (ANN) models. The data learning is performed using a hybrid and back propagation network approach. The relationship between the dependent and independent parameters of rainfall have been demonstrated graphically. The MLRA and ANN models used in this study are trained and tested to achieve the sustainable results. The model's accuracy is checked by comparing the model's monthly rainfall forecasts with actual data after training and testing. The study's findings show that the model is effective in forecasting monthly rainfall data with the specific parameters and statistical error analysis has been performed to evaluate the strength of the models. Finally, the developed model has validated for the year 2022 and the future prediction has been done for the year 2025 and 2030.

Keywords: Rainfall prediction; Machine Learning; Artificial Neural networks; Multi Linear Regression; Error analysis.

Advances in Agricultural Hydrology: A Review

Meena A.[1], Prasad V.[2], Khare R.[3]
[1]PG Research Scholar, Centre of Excellence in Water Management, MANIT Bhopal-462003, INDIA
[2]Associate Professor, Centre of Excellence in Water Management, MANIT Bhopal-462003, INDIA
[3]Associatet Professor, Centre of Excellence in Water Management, MANIT Bhopal-462003, INDIA
*ashutoshmeena2904@gmail.com

Abstract

Agricultural hydrology plays a vital role in understanding and managing water resources for sustainable agricultural practices. This review paper presents an overview of recent advancements in agricultural hydrology, focusing on key research areas, methodologies, and their implications for improving water management in agricultural systems. The paper begins by discussing the fundamental concepts of agricultural hydrology, highlighting the intricate relationships between precipitation, soil moisture, evapotranspiration, runoff, and groundwater recharge. It explores the impacts of climate change on the hydrological cycle and its consequences for agricultural water availability and productivity. The review then delves into various innovative approaches and techniques that have emerged in agricultural hydrology research. These include remote sensing and GIS technologies for assessing spatiotemporal variability in soil moisture and vegetation dynamics. It also discusses the integration of precision agriculture techniques, such as sensor-based irrigation and variable rate applications, to enhance water use efficiency and crop yield. The review concludes by addressing the challenges and future directions in agricultural hydrology research. It emphasizes the need for interdisciplinary collaborations among hydrologists, agronomists, climatologists, and policymakers to develop holistic and integrated approaches for managing water resources in agriculture. The potential benefits of adopting sustainable practices and technologies, such as agroforestry, water harvesting, and smart irrigation systems, are also highlighted. Overall, this review paper provides a comprehensive synthesis of recent advances in agricultural hydrology and offers valuable insights for researchers, practitioners, and policymakers seeking to enhance water management strategies in agricultural systems.

Keywords: Agricultural hydrology, Hydrological cycle, Remote sensing, Precision agriculture

Study of Soil Erosion in Watershed

[1]N. Arya, [2]K. Mishra & [3]H.L. Tiwari
[1,2,3]MANIT, Bhopal, India
*222129106@stu.manit.ac.in

Abstract

Soil erosion is a serious problem. Erosion is degrading the quality and standard of soil across the globe continuously. It emerges as significant socio economic and environmental threat throughout the world. This paper describes comprehensive summary on estimation of soil erosion carried by past researchers using different models. This study found that soil loss prediction by using different models gives different accuracy of it. The area with higher slope range seems to be more prone to erosion compare to lower slope range. The utilization of different technique to estimate the mean annual soil loss is an effective tool in mapping the spatial distribution of entire watershed.

Keywords: Erosion, Model, soil loss, watershed

Development of Vertical Soil Moisture Profile for the Godavari basin using SMAP data

Sudardeva[1], Manali Pal[1]
[1]National Institute of Technology, Warangal, TS, INDIA
*manalipal000@gmail.com

Abstract

Vertical Soil Moisture Profile (VSMP), a key hydrological variable along with its dynamics, needs to be defined in order to understand, model and analyze the hydrological process. The estimation of VSMP plays an important role in improving the efficiency of crop yield and management along with understanding different hydro-climatological processes. Though the data acquired from the field observations are mostly accurate, however, attaining longtime and widespread data is nearly impossible. Recently, the satellite retrieved surface soil moisture data along with Hydrological Soil Groups (HSG) information () have been utilized to develop a statistical model namely Statistical Soil Moisture Profile (SSMP) Model (Pal et al., 2020). The same has been used to develop a vertical soil moisture profile for entire Indian mainland (Pal et al., 2021). The developed dataset consists of numbers of missing values derived from the input surface soil moisture information. Recently, NASA has launched -Soil Moisture Active Passive (SMAP) mission to provide daily global soil moisture information at 9km× 9km spatial resolution. It is a fine resolution SM data with mere missing values. Hence, the current study aims to utilize this SMAP data to develop a Vertical Soil Moisture Profile (VSMP) database (at 10, 20, 51 and 102 cm depths) for the Godavari river basin in India. The study also applies the SSMP model which is based on the coupling and memory approach on the SMAP data to generate VSMP. The spatially varying nature of soil moisture is incorporated in the study by overlaying the HSG information (developed to define the runoff potential of soil) obtained from Natural Resources Conservation Services (NRCS) database at 250m×250m spatial resolution. Although, the developed dataset is devoid of missing values due to continuous availability of SMAP data, however, the study is limited by unavailability observed data leading to no or inaccurate validation. Thus, the study generates VMSP database by utilizing spatially varying SSMP model which has immense potential in the field of hydrological modelling and agricultural practices.

Keywords: Soil Moisture Profile, SMAP, Statistical Soil Moisture Profile Model, Hydrological Soil Groups.

Comparison of several predictor selection techniques for station-wise regression-based statistical downscaling of precipitation for the Lower Krishna River Basin

Sruthi Thangallapalli[1] & Dillip Kumar Barik[2*]
[1]Research Scholar, School of Civil Engineering, Vellore Institute of Technology, Vellore, Tamil Nadu-632014, India
[2] Professor, School of Civil Engineering, Vellore Institute of technology, Vellore, Tamil Nadu-632014, India
[*]dkbarik@vit.ac.in

Abstract

Climate change impact studies have been significantly applied in the past few decades, where understanding and implementing available global datasets at regional and even station levels is inevitable. In the highly complex hydrological phenomena happening globally, the various predictors and their complex relationships with local predictand (precipitation) play a crucial role. Towards this step, numerous predictor selection techniques such as maximum relevance minimum redundancy (MRMR), least absolute shrinkage and selection operator (LASSO), step-wise regression (SWR), and whale optimization technique (WOA) are adapted. Twenty-two predictors measured during a period of 30 years (from 1985 to 2014) from 14 stations distributed throughout the lower Krishna River basin are used as the data set. The selected predictors from each method are tested on simulated historical data from 1985-2014 by CMIP6 MPI-ESM1-2-HR global climate model at every station using artificial neural networks (ANN). Applying the best set of predictors and choosing them according to the site, can boost downscaling of precipitation by the ANN model, based on the evaluation results of screening methods. WOA outperformed in finding the optimal predictors over other methods, SWR, MRMR, and LASSO. The most effective predictors from WOA for all sites are relative humidity at 850 and 1000hPa, geo-potential height at 500hPa, u-wind at 850hPa, v-wind at 10m and 500hPa, minimum temperature, mean sea level pressure and mean zonal gravity wave stress.

Keywords: Climate change, downscaling, MRMR, LASSO, SWR, WOA, CMIP6, ANN.

High and Dry: Elevation-Dependent Changes in Precipitation over Indian Extent of Indus River Basin

A. Dubey[1], D. Swami[1], V. Gupta[1] & N. Joshi[2]
[1]School of Civil and Environmental Engineering, Indian Institute of Technology Mandi, Mandi, India
[2]Department of Civil Engineering, Indian Institute of Technology Jammu, Jammu, India
*amitd818@gmail.com

Abstract

Precipitation is of great significance as far as global water cycle is concerned. Occurrence of hydrological extremes such as floods and droughts depend on the amount of precipitation. This when coupled with changing climate and topographic variability, makes management of water resources challenging especially in the high-lands. Vulnerability to the climate change, shown by the higher altitutde regions are more when compared to the lower elevations. Thus, for the efficient management of the available water and modelling of hydrological extremes, comprehension of variability of precipitation is of much importance. Therefore, the present study aims to appraise the spatio-temporal variability of the drought characteristics in conjunction with the assessment of elevation-dependent changes in drought over the Indian drainage cover of Indus River basin. The said basin is found out suitable for exploring the relationship between drought and elevation because of the spatial elevation extent of the basin varying between 93 m – 8489 m. Hence, for this purpose gridded monthly precipitation data of 0.12º × 0.12º spatial resolution (1956 grids) for a time period of 42 years (1979-2020) is utilized to study the annual and seasonal (pre-monsoon, monsoon, post-monsoon and winter) variations in precipitation. Significant precipitation trends in the region are identified by employing Sen's slope method and Modified Mann- Kendall test. Results revealed that across different seasons, the precipitation trends in basin area have very high heterogeneity. Overall, 14% of the grids shows increasing trends whereas, 9% of the grids exhibits decreasing trends with a mean rate of 4.826 mm/year for annual time series analysis. However, seasonally, pre-monsoon season shows that drying (decreasing) trends prevails in larger parts of the region (26%), while post-monsoon (12%) and monsoon (23%) seasons have larger area in the basin with wetting (increasing) trends. No particular precipitation pattern neither decreasing nor increasing is observed during winter season across almost all the grids. It is found that an elevation-dependent relation of precipitation exists. The altitude up-to around 2000 m elevation shows increasing (wetting) trends, however the rate of wetting decreases along the altitudinal gradient. Furthermore, decreasing (drying) trends are experienced between the altitudes around 2000-6000 m. Elevations beyond 4000 m experiences lesser rate of decrease in precipitation when compared with the elevations between 2000-4000 m. Therefore, the findings of the study points towards the dryness (wetness) of the region at higher (lower) altitudes.

Keywords: Precipitation, Elevation dependency, Seasonal variability, Modified Mann-Kendall test, Sen's slope estimator.

Hydrodynamic Modelling of 2018 Kerala Floods in Nilambur Municipality

Jishnu M[1], Dr. Santosh G Thampi[2] & Dr. Manoj Kumar[1]
[1]Central University of Haryana, India
[2]Department of Civil Engineering, National Institute of Technology Calicut, India
*jishnumohanatholi@gmail.com

Abstract

Among various natural disasters, floods affect the largest number of people globally and have significant socio-economic and environmental impacts. Fluvial or river floods are largely caused by very high precipitation, resulting in rivers overflowing its banks. Dam break can also cause fluvial floods. The floods of 2018 in Kerala were a tragic natural disaster and caused extensive inundation, loss of life, and widespread damage to property and infrastructure; the problem was compounded by landslides at few locations in the affected areas. Hydrodynamic modelling of flood events helps to understand the causative factors, generate flood inundation maps, assess flood risks, identify flood prone/ affected zones and propose appropriate and effective measures and strategies for flood management in order to minimize damages during flood events. This work is mainly performed to assess the flood extent and impact of the 2018 floods in the geographical area of the Nilambur Municipality in Malappuram District, Kerala. In this study, hydrological modelling of the catchment area of the Chaliyar River upstream of the geographical extent of the Nilambur Municipality was performed using the Hydrologic Modelling System (HEC-HMS) software. Thereafter, two-dimensional hydrodynamic modelling of the river reach was done in the River Analysis System (HEC-RAS) software. SRTM DEM data were used to prepare the flood inundation map of the area under the Nilambur Municipality. Flood depth and flow velocity values obtained from the HEC-RAS model were used to generate the flood hazard map of the Nilambur Municipality. The flood inundation extent was observed to cover an area of 9.5 sq.km. It is observed that about 15 % of the area under the Nilambur Municipality falls in the H6 category, i.e., unsafe for both people and automobiles, and buildings in this zone are vulnerable to failure whereas about 46 % of the area is considered to be safe.

Keywords: Chaliyar River, Flood inundation, HEC-HMS, HEC-RAS, Nilambur Municipality, SRTM DEM

Modified Soil Water Retention Curve (SWRC) for Unsaturated Soils

Bhupeshwar Prasad[1] & Umesh Kumar Maheshwari[2]
P.G. Scholar[1] & Professor[2], Civil Engineering Department, K.N.I.T., Sultanpur, U.P. 228118, India
*bhupeshwar.2010102@knit.ac.in

Abstract

It is essential to evaluate first the soil properties to understand the behaviour of soils under different loading conditions, for different types of construction activities. Generally, for such purpose, soil is taken as saturated soil but most of the constructions are on unsaturated soils. However, it has been found that testing data and analysis for unsaturated soil is scantly available. The soil water retention behaviour is important for such soils. The soil water retention behaviour is represented by Soil Water Retention Curve (SWRC). The soil water retention curve (SWRC) is a basic hydro-physical characteristic of geological porous media, usually described as the dependence between soil moisture (water content or degree of saturation) and suction (capillary pressure).

Based on the literatures available, the present paper is devoted to establish a modified theoretical soil water retention curve (SWRC) based on the model already developed.

In the present work, an attempt has been made to modify this model in the following condition:

Perimeter of the air-water interface is taken as through mathematical approximation formula

$L \quad = 2\pi[(a^{2} + b^{2})/2]^{0.5}$ $\quad a\_w \quad g \quad \varepsilon$

Aspect ratio, assumed to be based on the ratio of minor to major axis of elliptical shape of the air/gas bubble on 2D cross-section is express as function of suction. Further it is approximately express by a simple power law function through a good curve fitting method.

The surface tension is defined as function of temperature.

The main conclusions that may be drawn are:

Aspect ratio function simplified as $f2(\delta_g) = 2.0842\delta_g{}^{-341}$ with $R^2 = 0.96$

Surface tension with respect to temperature is obtained as $T_S = -0.1675T + 76.077$ with $R^2 = 0.9982$

By using these two functions, suction is defined as $s = \varepsilon\ \phi^{\varepsilon}2(02.0842\delta^{-0.341})^{0.5}\frac{(1-S_e)}{} \quad T$

$1 \quad 1 \quad S_e \quad s$

Keywords: Soil Water Retention Curve (SWRC), Aspect Ratio, Unsaturated, Saturation, Fluid-Solid Interaction.

Estimation of Soil Hydraulic Properties from Tension Infiltrometer Experiments

RR Panda[1], SN Sahoo[2]
[1] National Institute of Technology, Rourkela, India
*rohanrajpanda12@gmail.com

Abstract

This study uses tension infiltrometer tests to assess the soil hydraulic characteristics at different sites in National Institute of Technology Rourkela campus. The main characteristics being examined are unsaturated hydraulic conductivity, saturated hydraulic conductivity, sorptivity, weighted pore size diameter. An important factor that describes the soil's capacity to convey water under partial saturation is its unsaturated hydraulic conductivity. It is calculated by doing tension infiltrometer studies at various soil water potentials. On the other hand, saturated hydraulic conductivity indicates the soil's capability to convey water while it is saturated and offers essential information about the soil's ability to drain. Another crucial characteristic, sorptivity, measures how quickly water is absorbed into the soil from the surface. It aids in understanding the early phases of infiltration and is impacted by many elements, including the structure and texture of the soil. The current study attempts to measure these hydraulic parameters by stress infiltrometer studies at different sites within NIT Rourkela. The data acquired was analysed using proper statistical procedures to ascertain the average values and variances across the sites. By helping to understand better and simulate water movement in the vadose zone, this knowledge helps enhance agricultural practices and water management plans. This study offers a new understanding of unsaturated and saturated soils' hydraulic conductivity, sorptivity, Van Genuchten Parameter, and weighted pore size diameter. The research adds to the body of knowledge and has a variety of uses, including hydrological modelling, groundwater management, and soil conservation techniques.

Keywords: Unsaturated hydraulic conductivity, Saturated hydraulic conductivity, sorptivity, Van Genuchten Parameter, weighted pore size diameter, Tension Infiltrometer.

Zone Budgeting of Chakdah Block of Nadia District, West Bengal, using MODFLOW-6

Sayan Haldar[1], Suresh A Kartha[1] & Kalyan Kumar Bhar[2]
[1]Indian Institute of Technology, Guwahati, India
[2]Indian Institute of Engineering Science and Technology, Shibpur, Howrah, India
*shaldar@iitg.ac.in

Abstract

Globally, groundwater is a significant natural source of freshwater. Groundwater recharge is an essential component of the natural water cycle. Estimates of recharge are vital for water balance studies, water supply engineering, and applications involving water resources. MODFLOW has been used to visualize groundwater flow and estimate recharge in the Chakdah Block of the Nadia District in West Bengal. The primary purpose of this research is to examine the Annual volumetric water budget of the study area and the groundwater and surface water interactions. The total area under study is approximately 350 km^2. The study area is surrounded by the Hooghly River in the west. The estimated average precipitation in the area of study is 1450 mm. The slope of the ground in the study area is less than 10 meters per km. A conceptual model was developed with various boundary conditions, including rivers, wells, precipitation, and evapotranspiration. Hydraulic conductivity, specific yield, and specific storage estimates were assigned to each layer of the model based on the hydrological formation and pumping tests. A transient state model was developed from 2016 to 2019. Using Volumetric Budget, the overall discrepancy of the Groundwater flow model was evaluated.

Keywords: Groundwater Modelling; Volumetric Budget; MODFLOW; QGIS; Finite-difference.

Prediction of Streamflow in the Brahmani River using GEP and MLR Models

P. Behera[1], A. Priyadarshini[2] & K.K. Khatua[3,]
[1,2,3]National institute of technology, Rourkela, India
*pb800189@gmail.com

Abstract

This study focuses on streamflow estimation in the Brahmani River, India, utilizing two modelling techniques: Gene Expression Programming (GEP) and Multiple Linear Regression (MLR). The objective is to develop accurate models that can predict streamflow based on different hydroclimatic parameters. The study utilizes historical data of streamflow and corresponding hydroclimatic variables, including rainfall, temperature, and river stage. The dataset is divided into training and testing sets for model development and validation.Both the GEP and MLR models are applied to estimate streamflow, and their performances are evaluated using statistical metrics such as Root Mean Square Error (RMSE), Mean Absolute Error (MAE), and coefficient of determination (R^2). The results indicate that both models can effectively estimate streamflow in the Brahmani River. However, the GEP model demonstrates superior performance compared to the MLR model. It exhibits lower error values and higher R^2 values, indicating its ability to capture the complex relationships between hydroclimatic parameters and streamflow.The analysis of the models reveals that rainfall and river stage are significant predictors for streamflow estimation in the Brahmani River. These findings emphasize the importance of incorporating multiple hydroclimatic parameters to enhance the accuracy of streamflow predictions. The study also highlights the advantages of using GEP as a modelling technique due to its ability to handle non-linear relationships and capture complex patterns.Overall, this research provides valuable insights into streamflow estimation in the Brahmani River using GEP and MLR models with different hydroclimatic parameters. The findings contribute to the development of reliable tools for water resource management and hydrological forecasting in the region, facilitating informed decision-making based on accurate streamflow predictions.

Keywords: GEP, MLR, Brahmani River Basin, Stream flow.

Soil Moisture Analysis of Agricultural Watershed in India Using Google Earth Engine and SMAP

Mahendra Patel[1], Jami Tarun Kumar[1], Reshma Talari[1], Chirasmayee Savitha[1]
[1]NIT Andhra Pradesh, Tadepalligudem, India
*pj032101@student.nitandhra.ac.in

Abstract

In India, where agriculture is a vital source of livelihood for two-thirds of the population, accurate estimation and analysis of soil moisture are essential for effective hydrological modeling, weather forecasting, and irrigation management. Soil moisture is a critical parameter for assessing crop stress, potential yield losses, and scheduling irrigation water applications. The Google Earth Engine (GEE) provides a powerful platform for analyzing satellite data to determine soil moisture levels in a cloud environment. The present study utilizes GEE to determine soil moisture levels in the agricultural watershed, Tadepalligudem India, covering an area of 5375 hectares, dominated by agriculture. The analysis utilizes NASA USDA SMAP satellite data and applies an algorithm to measure the microwave emissions from the earth's surface via passive microwave radiometry and active wave sensing. The SMAP satellite measures the amount of water in the top 5 cm of the soil layer with a temporal resolution of 3 days. The results of the soil moisture analysis using GEE and SMAP data provide valuable insights into the levels of soil moisture in the agricultural watershed, facilitating better irrigation management without incurring any crop yield losses. This study demonstrates the effective potential of GEE for soil moisture analysis, contributing to better agricultural practices and sustainable water resource management.

Keywords: Active wave sensing, Agricultural Watershed, Google Earth Engine, Irrigation Management, SMAP, Soil Moisture.

Analysing a Hydrological Model Based on Single-Site and Multi-Site Calibration in Sub-Catchments of Tapi Basin, India

Ankur Sharma[1], Suniti Kumari[2], Ruchi Khare[3] and M.K. Choudhary[4]
[1,2,3,4]Department of Civil Engineering, Maulana Azad National Institute of Technology, Bhopal, India
*ankursharma1912@gmail.com

Abstract

Planning and managing water resources effectively requires accurate streamflow models. In the Middle Tapi Basin of India, this work focuses on evaluating the efficacy of streamflow modelling using single-site as well as multi-site methodologies of calibration. The SWAT model is employed for the simulation of flow in the study region. Calibration at the basin outlet and single-site have been used earlier. However, in order to consider geographic variability in watershed features, this work presents a unique multi-site calibration technique. There are several different hydrological conditions in the Middle Tapi Basin. Three streamflow measuring stations, Sarangkheda, Ukai, and Gidhade, are incorporated to calibrate the model. Statistical metrics like R2, NSE and PBIAS assess the model performance during the calibration phase. The outcomes show how effective the multi-site calibrating strategy is. The performance of the Ukai model has slightly improved. Gidhade and Sarangkheda both perform better than before. This work highlights how calibrating hydrological models for large-scale basins requires considering regional differences in watershed features. The multi-site calibration method improves streamflow models' accuracy and lowers the uncertainty level in hydrologic forecasts. The results offer helpful guidance for water resource managers and hydrological modellers in choosing the best calibration approach. More accurate hydrological projections may be made in the Middle Tapi Basin by considering regional heterogeneity and utilising multi-site calibration approaches, allowing for improved water resource planning and management.

Keywords: Hydrological modelling, Calibration, MSC, SSC, Middle Tapi Basin, SWAT

Effect of Temporal Resolution and Model Complexity on Performance of a Lumped Hydrological Model for Mountainous Catchments

R. Buragohain[1], H. Medhi[1] & K.U. Ahamad[1]
[1]Tezpur University, Tezpur, India
*rbgn@tezu.ernet.in

Abstract

The choice of data resolution in rainfall-runoff modelling primarily depends on its availability. However, if high-resolution data is available, it is important to choose a model with appropriate complexity since a simpler model may be insufficient to extract additional information available in high-resolution data. On the other hand, when applying a complex model to low-resolution data, some of the model components may become redundant, and computational effort and time may not be judiciously utilized. To assess the impact of temporal resolution and model complexity on model performance, a lumped model structure with variable complexity was developed and tested on two mountainous catchments using rainfall and streamflow data available at a 15-minute resolution. Downscaled resolutions of hourly, daily, and weekly time steps and altered model structures were tested to observe the impact of reduced resolution and reduced complexity on model performance. The general observation is that if high resolution data is available, modelling at that resolution and downscaling the output to a desired lower resolution preserves the accuracy better than running the model at the lower resolution. Comparison of results from the two test catchments showed that a slow responding catchment can be modelled at a lower resolution and by a simpler model. However, for the catchment that produces rapidly rising and receding hydrographs with sharper peaks, a complex model may be warranted, and the data should also be of finer resolution containing sufficient information to support such a model.

Keywords: Lumped Hydrological model, Model Complexity, Temporal Resolution.

Streamflow Estimation for Harangi River Basin, Karnataka, India

Mukul Kumar Sahu[1*], Shwetha H.R.[1] G.S. Dwarakish[1]
[1]National Institute of Technology Karnataka, Surathkal, India
*mukulkumarsahu.207wo010@nitk.edu.in

Abstract

Water is scarce, and there are millions of people across this globe who spend their entire day searching for it. Therefore, conserving water is crucial, and it is believed that accurate estimation collection of runoff is the first step to provide solutions to save water. In this paper Hydrologic Engineering Center – Hydrologic Modelling System (HEC-HMS) model was used to simulate the rainfall-runoff process for the Harangi river basin (Area =1703.0421 Km^2) located in Kodagu District, Karnataka, India. The rainfall-runoff data were collected from 1995-2020 out of which five rainfall-runoff events were selected randomly for the study, three of these were selected for calibration, and the other two were selected for validation. The Soil Conservation Service – Curve Number (SCS CN), Soil Conservation Service Unit Hydrograph (SCS UH), and Muskingum routing methods were selected to calculate runoff volume, peak runoff rate, and flow routing. The model performance was assessed using the following criteria: Nash Sutcliff Efficiency (NSE), coefficient of determination (R^2), and root mean square error (RMSE). The results showed that the model works well during both the calibration and validation periods (NSE = 0.895, R^2 = 0.948, RMSE=346.435 m^3/s; NSE = 0.887, R^2 = 0.917, RMSE = 131.476 m^3/s). Thus, the model can be used to manage different flood events and adopt effective decision and warning systems. Furthermore, other catchments with similar hydrological characteristics can use the created models

Keywords: Hydrologic Modelling, rainfall-runoff simulation, Harangi watershed, Cauvery, HEC-HMS.

Assessment of Water Footprint of Maize in Urban Districts of Jharkhand in India

AindrilaGhosh[1*], PratibhaWarwade[1] and Ajai Singh[1]
[1]Central University of Jharkhand, Ranchi, Jharkhand 835205, India
*ghoshaindrila1203@gmail.com

Abstract

In present days depletion rate of freshwater availability is alarmingly high globally. The condition is much worse in urban areas than the rural areas. The main drawback for water scarcity in urban areas is over population and rapid urbanization. Water is majorly consumed to produce agricultural products and it increases along with food demand which has direct relationship with population. To manage water efficiently, proper understanding of water consumption is much needed and water footprint (WF) will be a helpful indicator for this. This study was conducted by assessing WF of maize using Cropwat 8.0 model in four urban districts- Bokaro, Dhanbad, East Singhbhum and Ranchi of Jharkhand over the period of 2016 to 2021. The sharing of total WF of maize (kharif) in three districts Dhanbad, Bokaro and Ranchi under Central and Northeastern plateau zone are 22%, 24% and 20% whereas the East Singhbhum under Southeastern plateau zone shares 33% of total water footprint despite of having highest forest cover with highest urbanization. These results suggest regional level study. This study recommends not to cultivate crops having high blue WF in any region considering seasons like kharif and rabi to manage water sources, making water policy by suggesting and sometimes mandating the people especially in water-scarce regions and over-populated areas to consume more food from water-saving crops and less from water-consuming crops according to health condition and invent high-yielded variety of water retentive crops to reduce water footprint in a region and to achieve sustainable food security.

Keywords: Water Footprint, Cropwat 8.0 model, Green Water Footprint, Blue Water Footprint, Total Water Footprint.

Role of Canopy Position in Characterizing and Up-Scaling Leaf Water Use Efficiency (WUE_L) in Rain-fed Cotton

Syam Chintala[1], Arun Rao Karimindla[1] & KBVN Phanindra[1]
[1]Indian Institute of Technology Hyderabad, Sangareddy, India
*ce22resch11012@iith.ac.in

Abstract

Water use efficiency (WUE) relates two important processes of the plant atmosphere continuum, namely carbon assimilation (through photosynthesis) and water utilization (through evapotranspiration). The need to trade off WUE between accurate quantification at the leaf level (WUE_L) and effective implementation at the plant level (WUE_P) demands accurate scaling relations. Conventional mid-day, fully expanded, sun-lit measurements of WUE_L are found to be poorly correlated with WUE_P, thus questioning the applicability of scaling relations. This research is aimed at obtaining optimal canopy position to characterize and upscale WUE_L for effective implementation of management strategies. Leaf gas exchange parameters were monitored in a rain-fed cotton field at five canopy positions for one crop season and further correlated with WUE_P considering individual as well as spatial averages of WUE_L. Diurnal variations in WUEL conclude that the maximum WUE occurs during 15:00 to 16:00 hours irrespective of leaf position and growth stage. WUE_L was continuously increased from flowering stage (49.13 ± 6.48 µmol CO_2 mol-1 H2O) to boll bursting stage (100.46 ± 17.37 µmol CO_2 mol-1 H_2O), WUE_P showed an increasing trend up to boll bursting stage (2 ± 0.28 g/L to 6.67 ± 0.32 g/L), followed by a rapid fall (1.4 ± 0.2 g/L). Scaling relations between WUE_L and WUE_P are linear with correlation strengths ranging from 0.28 (west bottom) to 0.65 (plant top). Our results conclude that scaling relations between WUE_L and WUE_P need to be established cautiously considering the canopy position.

Keywords: Water Use Efficiency, Leaf Scale, Plant Scale, Canopy Position, Scaling relations.

Spatial-Temporal Analysis of CHIRPS satellite precipitation estimates over a Small Agricultural Watershed in India

Chudalmanikanta Bolisetty[1], Chirasmayee Savitha[1]*, Reshma Talari[1]
[1] NIT Andhra Pradesh, Tadepalligudem, India
*pj032101@student.nitandhra.ac.in

Abstract

Precipitation is one of the most crucial components of the hydrological cycle. Precise and accurate spatial and temporal assessment of precipitation is needed for various fields such as water resources systems, agricultural practices, climatology, hydro-energy, etc. Daily rainfall data serves as a pivotal and highly sought-after input in water resources studies. Yet, it faces significant challenges due to the often-low density and subpar quality of in-situ observations. Traditionally, the precipitation over the region is estimated from point-based rain gauge measurements, which are interpolated to display the areal precipitation. However, information from the rain gauge networks usually underestimates precipitation and has poor spatial coverage. To overcome this challenge, satellite-based precipitation is used to provide rainfall estimates with high spatio-temporal resolution over large regions. However, this data is often marred by substantial errors, particularly when considered at a daily temporal resolution. Consequently, there is a pressing need for effective methods and protocols for downscaling, validating, and bias-correcting rainfall data. The primary objective of this study is to validate the downscaled satellite-derived daily rainfall dataset by comparing it with in-situ observations. This validation process is instrumental in further merging the downscaled datasets with the in-situ observations, ultimately enhancing their accuracy. Subsequently, an evaluation is carried out to identify the superior-performing dataset. In the present study, the Climate Hazards Group InfraRed Precipitation with Stations (CHIRPS) precipitation estimations were analyzed and compared with station-based precipitation measurements at daily, monthly, and yearly time scales. To compare the performance of the satellite with the rain gauge observations for a small agricultural watershed in Tadepalligudem, India, a contingency matrix and statistical and categorical validation measures are used. The agricultural watershed has an area of 5375 ha and receives most of its rainfall from July to October from the southwest monsoons. The watershed receives annual rainfall of 850–950 mm. The statistical and categorical evaluations help to avoid uncertainties that would arise from either underestimation of rainfall estimates or overestimation of satellite data. The results of this study help in analyzing the role of satellite precipitation datasets, their use, and their reliability for various hydro-climatological and hydrological models in small agricultural watersheds.

Keywords: CHIRPS, Precipitation, Rain-gauge, Satellite Estimates, Spatial-temporal analysis.

Effect of Non-Stationarity of Rainfall on the Landslides in Wayanad District of Kerala, India

D.S. Shamla [1]*, S. Ardra [2], Tsewang Stanzin[3], Deekshitha Dev[4], S. Adarsh [5], A. Muhammed Siddik [6]
[1-6]Department of Civil Engineering, TKM college of Engineering, APJ Abdul Kalam Technological University, Kerala, India.
*dsshamla@gmail.com

Abstract

Rainfall ranging from persistent rain lasting days to weeks to heavy downpour has been considered as the main trigger of shallow landslides. Changes in rainfall patterns can have a considerable impact on the frequency and amplitude of landslides, resulting in numerous fatalities and enormous economic damage. As a result, the landslide hazards are assessed by accounting for the temporal probability of a landslide by incorporating rainfall exceedance probability and landslide susceptibility into consideration. Research investigations have shown that hydrological records in some cases show non-stationarity in the form of increasing or decreasing trends and abrupt changes. As a result, it is no longer appropriate to estimate the temporal probability of landslides adopting the stationary assumption. In this study, the rainfall non-stationarity for the multiple sites of the Wayanad District of Kerala is taken into account for developing the landslide hazard map (LHM). The landslide susceptibility map (LSM) of Wayanad district is created in the first stage of landslide hazard mapping using the Random Forest (RF) model. Then the exceedance probability of a rainfall threshold is evaluated accounting for antecedent rainfall upto 3 days using the non-stationary extreme value analysis based on a novel multi-site rainfall information approach. This temporal probability of rainfall is then integrated with landslide susceptibility map to develop the LH maps of Wayanad district for the return period up to 50 years. The preparation of LHM is found to be more resilient when the non-stationarity of the rainfall is taken into account.

Keywords: Landslide, Rainfall, Temporal Probability, Non-stationary.

Assessing Changes in Downstream Flow Characteristics in Sinuous Channels Due to Sand Mining Pit Positioning on Flood Plains

Om Prakash Maurya[1*], Suresh Modalavalasa[2], Prof. Subashisa Dutta[1]
[1]Department of Civil Engineering, Indian Institute of Technology, Guwahati, India (781039)
[2]Department of Civil Engineering, Aditya Institute of Technology and Management, Tekkali, Andhra Pradesh, India (532201)
*om1996@iitg.ac.in

Abstract

This study investigates the downstream impact of sand mining in a riverine system, focusing on how different positions of floodplain rectangular sand mining pits affect the flow characteristics of a low sinuous channel. Three scenarios are considered: a sinuous channel without mining pits, a sinuous channel with two mining pits, and a sinuous channel with three mining pits. The research employs both experimental and numerical approaches, both methods are employed only for the first scenario for the validated purposes, and the other two scenarios were simulated numerically only. The results show that the streamwise velocity is concentrated with a higher magnitude at the inner bank, while secondary currents are more pronounced at the outer bank. The presence of an extra mining pit in the third scenario narrows down the highest zone of streamwise velocity and reduces the concentration of secondary currents at the outer bank. Vorticity exhibits clockwise circulation at the inner bank and anti-clockwise rotation at the outer bank. Turbulence intensity is found to be highest at the inner bank and lowest at the outer bank, with an approximately 8% increase in intensity when an extra mining pit is present in the third scenario. These findings provide valuable insights into the flow characteristics under different positions of sand mining pits, aiding river management practices and potentially extending to the study of sediment transport phenomena. The experimental and numerical approaches complement each other, enhancing the understanding of the riverine system's behavior. However, there is a discrepancy in the quantitative results, with errors ranging from 18% to 34% between the experimental and numerical simulations. Despite this, the qualitative agreement between the two approaches is promising.

Keywords: Sinuous channel, Sand mining pits, Flow characteristics, Numerical modeling, Flow3D Hydro.

Rainfall-Runoff Modelling of PUNPUN River, India Using HEC-HMS

Prince Kumar[1], Praveer Kumar Parhi[1], Rajiv Kumar Ranjan[2], Vinod Kumar[3]
[1]Department of Civil Engineering, Central University of Jharkhand, Ranchi, India
[2]Department of Civil Engineering, National Institute of Technology Warangal, Warangal, India
[3] Science, Technology and Technical Education Department Govt. of Bihar, Patna, India
*princekumar8523@gmail.com

Abstract

Various hydrological models were used in different river basins to simulate the runoff on available rainfall, land use and soil property data. The HEC-HMS model is used by several researchers to estimate the water potential of the basin through rainfall-runoff modelling. In this study, a rainfall-runoff model for the Punpun river basin has been developed using HEC-HMS. Daily rainfall and runoff data from the years 2005to 2017 were used for the development of model. ArcGIS has been used to analyze the hydrological parameters, preparation of LULC, soil and slope maps for the computation of curve number as input into the HEC-HMS model. Daily, monthly and monsoonal rainfall-runoff models have been developed. The performance of all the models has been evaluated using statistical indices–coefficient of determination (R2), Nash-Sutcliffe efficiency (NSE), percent bias (PBIAS) and RMSE- observations standard deviation ratio (RSR). R2 and NSE values for all the models are greater than 0.75 and PBIAS is less than 10, which shows very good results from all the models except the daily model, in which NSE values are less than 0.75. Based on statistical indices, the monthly model performs better than the daily and monsoonal models.

Keywords: ArcGIS, HEC-HMS model, Punpun river basin, rainfall-runoff model.

Use of LBP and GIS in Planning and Scheduling of Irrigation Projects

Aman Chauhan[1*], & V. K. Bansal[1]
[1] NIT Hamirpur, Hamirpur, India
*ac891506@gmail.com

Abstract

The construction of an irrigation structure mainly includes the construction of intake structures, water storage tanks, and laying pipelines at different locations. In hill areas, the construction of irrigation structures at different locations is highly complex and individualistic in nature. Effective planning is essential to develop an executable construction plan for an irrigation structure. The construction of almost similar irrigation structures at different locations is a repetitive type of construction. This study explores the use of the repetitive planning and scheduling technique called Location-based Planning (LBP) for planning and scheduling the construction of irrigation structures located at different geographical locations.

Keywords: Planning, Scheduling, LBP, GIS, Irrigation projects

Surface Water Dynamics Study using Google Earth Engine: A Review

Manjunath D R[1] & Jagadeesh P[1*]
[1]Vellore Institute of Technology
*p.jagadeesh@vit.ac.in

Abstract

It's a fact that, a significant amount of the water we consume is sourced from impoundments primarily feed the primacy of water quality is alert in urbanites. Digitized plethora of future water access processes exist. The digitization work in accordance to a time-saving, cost, storage idea ans earth remote sensing holds up in all criteria. With the broad deployment of Google earth engine, image-based extraction widely adopted due to high-tech data availability. Millions of images with billions of pixels access indicates platform band classifier. Google cloud Engine uses much computing power in all Envi-events. Through this study discusses various classifiers available in cloud engine to check out the urban reservoirs' long-term research by considering various facets of water. Large scalable & super cloud computing in pure water affect nearby cities. hence, urban water dynamics need water-efficient management. Aforesaid study, will help urban water alert researchers study WQI.

Keywords: Google Earth Engine, Image based extraction, Indian Water resources, Pure Water, Urbanite reservoirs.

Multi Criteria Decision Making for Selection of Best Fertilizer: An AHP Approach

Chetan S. Kadlag[1*] & Jyotiba B. Gurav[2]
1 Research Scholar, Department of Civil Engineering, Amrutvahini College of Engineering Sangamner, Dist: Ahmednagar-422 608, SPPU Pune, Maharashtra State, INDIA
2 Professor, Department of Civil Engineering, Amrutvahini College of Engineering Sangamner, Dist: Ahmednagar-422 608, SPPU Pune, Maharashtra State, INDIA
*chetankadlag@gmail.com

Abstract

The main objective of the present study is to propose the methodology for selecting the best fertilizer amongst the organic and inorganic fertilizers. In the present study, two alternatives and six criteria have been considered for the analysis. The alternatives are organic fertilizer and inorganic fertilizer. The criteria include the availability of fertilizer, cost of fertilizer, crop yield, effect of fertilizer on the soil, environment and human health. The methodology for Multi Criteria Decision Making (MCDM) using Analytical Hierarchy Process (AHP) has been proposed and applied it successfully for the case study of a group of farmers of village Nimgaon Bhojapur, Tal. Sangamner, Dist. Ahmednagar, State Maharashtra, India. Formulating the pairwise matrix of criteria and alternatives calculates normalized weights, lambda, Consistency Index (CI), and Consistency Ration (CR). Based on the result, it is found that organic fertilizer is most suitable for crops based on criteria considered for evaluation purposes. This study will help farmers/decision-makers to make judicious decisions regarding fertilizer selection.

Key Words: Multi Criteria Decision Making (MCDM), Analytical Hierarchy Process (AHP), Organic Fertilizer and Inorganic Fertilizer

Crop Area Estimation Using Sentinel-2 and GEE

Sri Lakshmi Sesha Vani J[1], Shivarathri Akhil[2], Pathlavath Pavan[2] & Seenu P Z[2*]
[1]NIT Warangal, Warangal, India
[2]VNR VJIET, Hyderabad, India
*seenu_pz@vnrvjiet.in

Abstract

This paper proposes an approach for detecting changes in cropping patterns using Sentinel-2 data and Google Earth Engine (GEE) in the Ramappa command area, an important agricultural region in India. Cropping pattern changes can indicate various factors such as changes in land use, climate, and management practices, and timely detection of these changes is essential for effective agricultural monitoring and management. The proposed approach involves pre-processing of Sentinel-2 data in GEE, cloud masking, and image compositing. Then, temporal analysis is performed by comparing the NDVI classified images acquired in different time periods (2019 - 2022) to detect changes in cropping patterns. A combination of spectral indices matching and machine learning algorithms is used to enhance the accuracy of the analysis. The proposed approach is tested in the Ramappa command area, and the results show that it can effectively detect changes in cropping patterns. The results obtained are compared with the open source crop area statistics available from Water Resources Information System (WRIS), by NRSC Bhuvan. The proposed methodology has the potential to be applied in other agricultural regions for change detection and monitoring. The use of Sentinel-2 data and GEE makes the approach scalable and cost-effective. The results can be used for timely decision-making, resource management, and land use planning in the Ramappa command area. The paper provides a valuable contribution to the field of remote sensing and agricultural monitoring, especially in the context of detecting changes in cropping patterns in the Ramappa command area.

Keywords: Cropping Pattern change detection, Sentinel-2, GEE, Ramappa Command Area.

Geospatial Techniques for Soil Erosion-Based Watershed Prioritisation: A Review

W. Makhdumi[1], R. Suragamallika[1], H. R. Shwetha[1] & G. S. Dwarakish[1]
[1]National Institute of Technology Karnataka, Surathkal Mangalore, India
*waleed.korn@yahoo.com

Abstract

The degradation of the environment caused by anthropogenic has raised significant concerns about the sustainability of land, water, and energy resources. It is crucial to acknowledge the unique characteristics of each watershed and the variability in the impact of human and natural activities across regions. Soil erosion emerges as a major threat, which leads to degraded soil, reduced agricultural productivity, and water pollution. Effective watershed management is essential for preventing soil erosion and ensuring the sustainability of resources. A fundamental step in effective watershed management involves evaluating and identifying the most severely impacted sub-watersheds. This study focuses on soil erosion-based prioritisation studies in India, examining their main findings, models, and methodologies. Geospatial techniques, which include Remote Sensing (RS) and Geographic Information System (GIS), have proven effective for mapping and assessing soil erosion at different scales. These methods identify erosion-causing factors, including land use, slope, rainfall intensity, and soil characteristics. By integrating geospatial data, accurate assessments of soil erosion vulnerability can be made, supporting informed decision-making. Multi Criteria Decision Analysis (MCDA) helps in prioritisation by evaluating multiple soil erosion criteria, and assigning weights based on their relative importance. Geospatial tools facilitate comprehensive assessments of soil erosion vulnerability, aiding decision making processes. The review offers insights for researchers to conduct reliable assessments and generate data on soil erosion. Integrating Land Use Land Cover Changes (LULCC) and socio-economic conditions in prioritisation studies is recommended. This paper can assist researchers generate reliable data on soil erosion, enabling policymakers to make informed decisions regarding adaptation and mitigation strategies.

Keywords: Watershed management, Prioritisation, Soil erosion, Geospatial techniques, Decision-making.

The Effect of Spatial-Temporal Scales of Analysis on Regionalization of Extreme Rainfall in India

Agami Pramanik & V. V. Srinivas*
Indian Institute of Science, Bengaluru, India
*vvs@iisc.ac.in

Abstract

Regionalization of extreme rainfall refers to the delineation of an area into several regions homogeneous in extreme rainfall characteristics. The delineated regions facilitate the pooling of extreme rainfall-related information from various gauged locations to obtain effective quantiles and design hyetographs corresponding to different exceedance probabilities for sparsely gauged and ungauged locations. The design hyetographs find use in studies related to landslides in hilly regions. Furthermore, design floods derived corresponding to those hyetographs are necessary for flood risk analysis at various hot spots in river basins, including large-scale flood control and conveyance infrastructure (e.g., dams, barrages/bridges, levees, culverts, weirs), and in land use planning and management. In recent years, India has witnessed an increase in the frequency and intensity of extreme rainfall and flooding events, and there are concerns about the safety of several (~20% of 5300) dams in the country as they would be over 50 years old by 2025. Against this backdrop, investigations are necessary to derive effective homogeneous extreme rainfall regions in the country to facilitate effective risk analysis. From this perspective, investigations are undertaken over India to form the desired regions by accounting for uncertainty in their number (count) and spatial extent with changes in both spatial and temporal resolutions of the rainfall data. Towards this, regionalization analysis was repeated considering four different spatial resolutions (0.12º, 0.25º, 0.50º, and 1.00º) and seven temporal resolutions (1, 2, 3, 4, 5, 6 hours, and 1-day). Among the datasets, 0.25º resolution gridded daily rainfall data were collected from the India Meteorological Department. The data were regridded to 0.50º and 1.00º resolutions using the biharmonic spline interpolation technique to extract annual maximum rainfall values corresponding to those resolutions in addition to the original 0.25º resolution. The hourly data corresponding to the finer (0.12º) spatial resolution were collated from the database of the Indian Monsoon Data Assimilation and Analysis project. The data, which are based on regional reanalysis over India (from 1979 to 2018), were subsequently aggregated to different coarser (2-, 3-, 4-, 5- and 6-hour) resolutions. The regionalization of extreme rainfall was performed using Competitive Agglomeration fuzzy clustering algorithm. Covariates/attributes considered for regionalization included location indicators (latitude, longitude, altitude/Elevation, and distance from sea) and L-statistics of the annual maximum rainfall. The regions discerned corresponding to different spatial-temporal resolutions are compared both qualitatively and quantitively. The regions formed are not found to be contiguous in the geographical space. As the spatial resolution becomes coarser, grids represent larger geographic areas. Investigations indicated that the statistical heterogeneity of regions (examined in the L-moment framework) increases with an increase in spatial resolution (or as grids become finer).

Keywords: extreme rainfall, regionalization, L-moments, cluster analysis, India

Assessment of Land Surface Temperature and Land Use Land Cover changes in and around Mangalore, Karnataka – A Study based on Geoinformatics Approach

Abhishek R*[1], H Gangadhara Bhat[2]
[1]Research Scholar, Department of Marine Geology, Mangalore University, Mangalagangothri – 574 199, India
[2]Professor, Department of Marine Geology, Mangalore University, Mangalagangothri – 574 199, India
*abhishekraj29410@gmail.com

Abstract

In the present research, an effort has been made to comprehend the effects of urban land coverage on the land surface temperature (LST) and whether there is any influence of this increased temperature on Mangalore city of Karnataka, India has been attempted. Metropolitan regions have greater temperatures compared their surroundings to rural areas. This urban phenomenon is known as Urban Heat Island (UHI). The main objective of the current study is to understand Land Use/Land Cover (LULC) changes and their impact on LST of the urban environment of Mangalore City. The city has expanded significantly over the years, and today there are a number of concrete buildings, asphalt/concrete roads, and developed areas in once vegetation-covered areas. Maximum likelihood algorithm and Anderson classification have been applied to generate LU/LC maps up to level III classes. The results show that the LST has increased from 17°C to 36°C in the year 2022. The LULC result shows that area covering the quarters of 47.16 km2 similarly the area covers the hotel of 28.41 km2. The apartments and residential area is 9.61 km,2, Railways highways and airport covers almost 7.51 km2 .The industries and companies covers the 6.21km2 and other built up 7.72 km2. The LULC result shows that mixed agriculture covers 177.54 km2.The coconut and crop plantation covers the area of 17.52 km2.The study area covering the evergreen forest of 123.48 km2. The area covering the mixed forest of 62.55 km2. The area covers the river of 20.60 km2.The area covering the estuaries and lakes 4.29 km2 and 4.14 kms2, and the reservoir covers 0.87 km2 including other water bodies 1.09km2. The forest wetlands having area of 2.78 km2 .The area covers the barren lands of 27.70 km2. The area covers the rock exposure 12.02 km2. As a result, the LST of the city has increased and the central part of the city shows higher temperature due to the presence of impervious layers. Vegetated lands are often transformed into built-up areas. The detailed study based on the Geoinformatics approach has helped to understand the impact of land surface temperature on Mangalore's urban environs and it has also helped to propose mitigating measures to lessen UHI.

Keywords: UHI, LST, LULC, Remote Sensing, GIS (Geographic Information System), Single Window Algorithm.

Estimation of Crop Evapotranspiration under Lower Manair Command Area Using Remote Sensing

Sudhakar Modugu[1], Ayyappa Reddy Allu[2*] & Shashi Mesapam[3]
[1]Assistant Engineer, Nippon Koei India Private Limited, Vijayawada, India
[2]Research Scholar, Department of Civil Engineering, NIT Warangal, India
[3]Associate Professor, Department of Civil Engineering, NIT Warangal, India E-mail: *aa721015@student.nitw.ac.in

Abstract

Conventional methods for estimating evapotranspiration (ET) through experiments are accurate but limited to specific point locations, restricting their applicability for regional-scale estimations. However, the utilization of remote sensing (RS) data from satellites enables the assessment of ET over large areas. An important advantage of RS is the ability to compute ET without the need to quantify additional complex hydrological processes. The objective of this study is to estimate ETcrop (crop evapotranspiration) and Kc (crop coefficient) by utilizing RS and Geographic Information System (GIS) techniques in the LMD (Lower Manair Dam) command area, encompassing the Karimnagar, Warangal, and Khammam districts in India. The estimation of ETcrop is performed using the SEBAL (Surface Energy Balance Algorithm for Land) model, with Landsat 8 imagery selected for processing due to its high spatial resolution, ensuring enhanced accuracy. SEBAL is preferred over other methods due to its ability to minimize reliance on ground-based measurements and its automatic internal calibration capabilities. To calculate ET, SEBAL employs a series of computations, including the determination of net surface radiation (Rn), soil heat flux (G), and sensible heat flux (H) to the air. A residual energy flux is derived by subtracting the soil heat flux and sensible heat flux from the net radiation at the surface, which is then utilized for estimating ET. The crop coefficient (Kc) is obtained by relating ETcrop to the FAO-56 Penman's equation. In summary, this study demonstrates the integration of RS, GIS, and the SEBAL model to estimate ETcrop and Kc within the LMD command area. Landsat 8 imagery with high spatial resolution is utilized for reliable analysis, and SEBAL is recommended due to its ability to minimize the need for ground-based measurements and its automatic internal calibration capabilities.

Keywords: SEBAL, Landsat-8, Evapotranspiration, Remote Sensing

Coefficient of Consolidation on Saturated Soil at Various Points in Aurangabad Region

Prof S.V Ighare*, V S Pradhan
Assistant professor Civil Engineering Department, MGM University Aurangabad
Maharashtra 431003
*sunilighare@gmail.com

Abstract

Knowledge of coefficient of consolidation of soil layer is essential in designing of structure on it. This can be achieved by different method. As square root of time fitting and logarithmic of time method has been carried out by experimentation. Also, correlation of Coefficient of consolidation (cv) and index properties of soil as liquid limit and plastic limit shows the different property's.

Keywords: coefficient of consolidation, index properties.

Groundwater vulnerability assessment using GIS based DRASTIC-LUH model and Electrical Resistivity Tomography method in and around Rupnagar Block, Punjab, India

Thallam Prashanth[1*], Sayantan Ganguly[2], Dolon Benerjee[3], Shreya Ganguly[4]
[1,3,4]Research Scholar, Department of Civil engineering, Indian Institute of Technology Ropar, Nangal Road, Rupnagar, Punjab 140001.
[2]Assistant Professor, Department of Civil engineering, Indian Institute of Technology Ropar, Nangal Road, Rupnagar, Punjab 140001.
[*]thallam.21cez0007@iitrpr.ac.in

Abstract

The groundwater at many places in our country is polluted due to the extensive utilization of fertilizers and pesticides used in agriculture. These pollutants often infiltrate the ground surface and join the groundwater table, posing a great risk to human health. This study categorizes different areas of the Rupnagar district, Punjab, as per their vulnerability to groundwater contamination from agricultural sources. Various thematic maps have been considered here to determine the areas prone to groundwater contamination, such as groundwater table depth, recharge rate, aquifer and soil characteristics, topography, vadose zone impact, and hydraulic conductivity. The groundwater vulnerability map is prepared by determining the weightage and ranking for each thematic layer and alternatives by using the “Entropy technique” and “Technique for Order of Preference by Similarity to Ideal Solution” (TOPSIS) method. These vulnerable zones are validated using the longitudinal conductance determined by the Electrical Resistivity Tomography (ERT) method.

Keywords: Groundwater vulnerability, Entropy technique, TOPSIS, longitudinal conductance, ERT.

Application of Frequency Ratio model for the mapping of groundwater potential zone

Souvick Kumar Shaw[1], Nowdu Sravani[1] & Anurag Sharma[1*]
[1] National Institute of Technology, Rourkela, India
*sharmaan@nitrkl.ac.in

Abstract

Now a days, due to rapid growth of population and industries; some economic developments and urbanization, surface water cannot meet the entire agricultural demand mainly in some arid and semi-arid regions in India. Due to the presence of large area occupied by cropland, pediment pediplain complex, there may be high possibility of good to excellent groundwater potential zone in Sundargarh district, Orissa (study area). It may highly satisfy the existing and future water demand for the crops due to the limitation of surface water. The aim of this present study was lying in finding the possible zones of groundwater by Frequency Ratio (FR) method which is an important statistical bivariate approach. Eight thematic layers viz. geomorphology, rainfall, slope, drainage density, lineament density, soil, land use/ land cover (LULC) and normalized difference vegetation index (NDVI) were used to delineate probable zones of groundwater. Final groundwater potential zone (GWPZ) map was categorized into four classes viz. poor (16.5%), fair (23.2%), good (34.6%) and excellent (25.7%). Validation was done by taking 70% training dataset (66 dug wells) and 30% testing dataset (28 dug wells) during pre-monsoon season of 2021 by Receiver Operating Characteristics (ROC) method. AUC value for success and prediction rate curve for FR model were measured as 0.719 and 0.747 respectively. Performance of the FR model was checked by using Radial Bias Function (RBF) tool in SPSS 23 and Map removal sensitivity analysis (MRSA) was also studied to show the percentage contribution of each factor.

Keywords: Frequency Ratio, Bivariate approach, Thematic layers, ROC, Success and Prediction rate curve, Percentage contribution

Geospatial Assessment of Groundwater Quality Using Water Quality Index

Hemant Raheja[1*], Arun Goel[1] & Mahesh Pal[1]
[1]National Institute of Technology Kurukshetra, Haryana, India
*raheja.hemant788@gmail.com

Abstract

The water quality index (WQI) is the principal technique applied to characterize water quality in the world. The current study investigates groundwater quality for drinking use in the Rohtak district, a central part of the Haryana state. One hundred ten groundwater samples were identified and examined for major anions and cations from 2008 to 2018. Several water quality parameters of all groundwater samples were identified for this study, such as pH, EC, TH, Ca2+ , Mg2+ , Na+ , K + , HCO3 - , NO3 - , Cl- , SO4 2- , and F - . The results were compared with water quality standards prescribed by the Bureau of Indian Standards and World Health Organization. The abundance of cations was observed as Na+ > Mg2+ > Ca2+ > K+ , and anions in decreasing order (HCO3 − > Cl− > SO4 2− > NO3 - > F -) during all period. The study found that the total hardness of water varied from the hard to very hard categories and that groundwater has an alkaline nature. The WQI results ranged from 27.43 to 1248.01 with a mean of 251.52, where 26.36 % of groundwater samples are unfit for drinking uses. The inverse distance weighting (IDW) technique was used to construct a spatial distribution map, revealing that the unsuitable groundwater is located in the western part of the study area. Therefore, the combination of WQI and GIS approaches is efficient in giving clear information for evaluating the appropriateness of groundwater for drinking and its regulating elements. It can also assist in decision making in vulnerable areas like Haryana.

Keywords: Groundwater; Drinking; Water quality index; Inverse distance weighting; ArcGIS

Demarcation of Groundwater Potential Zones in a tropical river basin using Geospatial Techniques

Remya V R*[1], Sathyanathan R[2]
[1, 2] Civil Engineering Department, SRM Institute of Science and Technology, Kattankulathur, Tamil Nadu.
*rv2355@srmist.edu.in

Abstract

Water resource assessment research makes extensive use of geospatial and remote sensing tools. Because of their usefulness in identifying various geomorphic features, satellite images are increasingly being utilized in groundwater exploration. The Vamanapuram river basin in Kerala, India's Southern Western Ghats, were the focus of the current investigation. The groundwater potential zones are delineated from ten thematic layers such drainage density, elevation, slope, land use/land cover, lineament density, topographic wetness index, rainfall distribution, curvature, dissection index, and topographic position index. Weighted overlay analysis was used to integrate the factors in the GIS platform. Through discussions with experts in the field, weights have been given to various classes of thematic maps based on their impact on groundwater hydrology, and factor ranks have been assigned. The final map depicts the potentiality values of the occurrence of groundwater in the study area, which were categorized into 5 classes such as very low, low, moderate, high and very high zones. The very low and low groundwater potential zone covers 27.49 % of the study area, the moderate potential zone covers 27.93%, and the high and very high potential zone covers 44.58 %. Due to the growing demand for freshwater for a variety of purposes, groundwater resource mapping has gained prominence in recent years. The current study demonstrates that groundwater resource assessments rely heavily on GIS and remote sensing.

Keywords: GIS, Thematic layers, Vamanapuram basin, weighted overlay, potential zones

Remote sensing and GIS-based groundwater level fluctuation (GWLF) and associated impacts on groundwater in Nagpur district of Maharashtra, India

R. K. Verma[1*] and A. B. Mirajkar[2]
[1]PhD Research Scholar, Department of Civil Engineering, VNIT Nagpur, India – 440012
[2]Associate professor, Department of Civil Engineering, VNIT Nagpur, India – 440012
*rashvrma@gmail.com

Abstract

Nagpur City of Maharashtra, India has been experiencing groundwater level fluctuations (GWLF) in many parts during the past several decades. Hence, this study aims to describe spatial variation in annual GWLF during pre- and post-monsoon season in the study area for the period of 1989 to 2021. As groundwater level and ground recharge are closely related, precipitation-induced groundwater fluctuation is critically analyzed and related spatially using ArcGIS tool. Groundwater recharge is estimated using the SCS curve number method, hydrological soil groups, and land use/cover type. For this purpose, groundwater level data was acquired from CGWB regional office of Nagpur. Geospatial analysis of groundwater also includes the influence of geology and topography representing elevation data using the Weighted overlay method, and seasonal groundwater recharge maps are generated. Analysis of data showed that till 2012 there was a continuous rise in the water table after post-monsoon season compared to pre-monsoon. However, the year 2013 was recognized as a water level falling year in which GWLF was observed to be 0.85m which continued till the year 2017. Water level fall after the post-monsoon season was observed to be ranging between 0.43 to 1.57m with a maximum fall in the year 2021. Decadal moving average analysis of GWLF showed that the year 2002 was a change point which showed 97cm decrease w.r.t. decadal mean. Similarly, 2013 was again found to have another change year with a 2.975m decrease w.r.t. decadal mean which continued till 2021. Decadal analysis 33year's fluctuation data showed that the study area has been experiencing decreasing groundwater levels which is alarming. This study will help in understanding and visualizing seasonal fluctuations in groundwater levels to establish efficient planning and monitoring of irrigation practices.

Keywords: Groundwater-Level-Fluctuation, RS-GIS, SCS Curve Number, Thornthwaite Method.

Simulation and Forecasting of Groundwater Levels of Gadilam River Basin of India using Artificial Intelligence techniques

Ch. Venkateswarlu*[1] and R. Manjula[2]
[1]Ph.D. Scholar, [2]Associate Professor, Department of Civil Engineering, National Institute of Technology Tiruchirappalli, Tamil Nadu, India
*venkateswarluchalla100@gmail.com

Abstract

Most of the world's liquid freshwater supply is kept in groundwater, which is increasingly strained due to overdraft. Groundwater Resource (GWR) is one of major sources for agricultural crop production, water supply, land development, and economic progress. Accurate simulation and forecasting of Groundwater Levels (GWLs) will aid in the sustainable management of GWR. The main objective of present study is to simulate and forecast monthly GWLs using univariate Artificial Intelligence techniques such as M5 Model Tree (M5-MT), Naive Bayes Tree (NBT), and Radial Basis Function Support Vector Machine (RBF SVM) at three observation well locations in Gadilam River Basin of India, that are Kullanchavadi, Porto Novo, and Cuddalore. Based on observed data for each model, this study suggests a methodology for simulating the time series of GWLs. Time series analysis was used in this framework to extract time-dependent characteristics of basin from groundwater data. Next, simulation models to simulate monthly GWLs have been developed for training period (Jan 1998 - Jun 2008) and testing period (Jul 2008 - Dec 2012), respectively, using time-domain characteristics extracted using M5-MT, NBT, and RBF SVM, respectively. The developed models were utilized to forecast monthly groundwater levels from January 2013 to December 2017. The outputs from these three models were evaluated using statistical Performance indices such as Mean Absolute Error (MAE), Root Mean Squared Error (RMSE), and R^2. M5-MT model outperformed all other models considered that are NBT and RBF SVM models, with R^2 values in testing period of 0.86, 0.84, and 0.81 for Cuddalore, Kullanchavadi, and Porto Novo, respectively. The study's data-driven modelling approach will aid in making sustainable policy decisions by estimating groundwater levels at larger scales in areas with scant data.

Keywords: Groundwater, Sustainable Management, M5-MT, NBT, RBF SVM, Data-driven Modelling.

Identification of the best yield point for Groundwater using the ERT method

Seenu P Z*, Tokachichu Preethi & K Srinivas
VNR VJIET, Hyderabad, India
*seenu_pz@vnrvjiet.in

Abstract

The identification of the potential fracture zone is a crucial step in determining the best location for the best yield point of groundwater location. Subsurface profile refers to the various layers of soil that exist in a particular location. The profile can provide information about the geological formation of the area, the depth and thickness of the soil layers, the thickness of the rock layer and its physical and chemical properties. This information is essential in determining the best location for a fracture zone, which is an area where the rock has been broken or fractured, and there is potential for water to flow through the fractures. Various techniques can be used to identify the soil profile, such as soil sampling, geophysical surveys, and remote sensing. In this study, we used the Electrical Resistivity Tomography (ERT) method to know the subsurface profile to identify the fracture zone. Seven locations in Hyderabad are selected for this study. Resistivity varies from 30 ohms to more than 5000 ohms. Based on the resistance value, we have identified the thickness of the subsurface layers. The subsurface lithologies are identified as sandy soil, weathered granite, Hard granite with minor fracture, weathered granite, fracture granite, hard granite with fracture, and fracture granite with boulders according to the resistivity values.

Keywords: Electrical Resistivity Tomography (ERT), Groundwater yield point, fracture zone

Impact Assessment on Water Quality under Surface-Groundwater Interaction in Kali River Basin

Prabhat Dwivedi[1*], Brijesh Kumar Yadav[2]
[1]Research Scholar, Department of Hydrology, IIT Roorkee, Roorkee-247667
[2]Professor, Department of Hydrology, IIT Roorkee, Roorkee-247667
* p_dwivedi@hy.iitr.ac.in

Abstract

The suitability of surface and groundwater for drinking and irrigation can be negatively impacted by growing populations and improper discharge of solid and liquid wastes. Depending on the water levels, surface and groundwater bodies are interconnected via losing or gaining streams. This interaction process affects the water quality when contaminants from one system can potentially affect the other by influencing the composition of ions in the mixing water. To develop management strategies, such as land use planning and water treatment measures, it is essential to conduct hydrogeological studies and water quality monitoring to assess the impact on water quality in identified regions of surface-groundwater interaction. This study has reviewed the changing behaviour of hydrogeochemical parameters in the highly polluted stretch of the Kali River basin in the Muzaffarnagar district. The in-situ and laboratory-based observation revealed that Surface and groundwater samples show a similar trend in the ionic composition. Excessive ionic concentration in surface water can penetrate through the soil through seepage and contaminate the groundwater of this region with possible clogging of surface water boundaries. In addition, excessive groundwater extraction can reduce the amount of water flowing into surface water bodies, potentially leading to lower water levels and altered flow patterns. Therefore, it is important to understand how contaminants are transported within the watershed. This involves assessing factors such as flow rates, sediment transport, groundwater movement, and chemical reactions. The current study is very effective in building effective field scale management strategies and reforming government policies to solve contaminated groundwater shallow aquifer zones.

Keywords: Hydrogeochemical Parameters, Surface water Quality, Groundwater Quality

Estimation of Surface and Groundwater Interaction by Stable Isotopic Techniques – A Case Study on Chengalpattu District- OMR Region

Surendar_Natarajan*
[1]Sri Siva Subramaniya Nadar (SSN)College of Engineering, India
*surendarnatarajan86@gmail.com

Abstract

Isotopes are atoms of element have same atomic number but different mass number. Isotopes in hydrology and water resources are used for identifying its occurrence, movement, residence times, recharge, and discharge process. Stable isotopes of hydrogen(δ^2H) and oxygen(δ^2O) are used for identifying the surface and groundwater interactions as it constitutes hydrogen and oxygen. In this study stable isotopes of oxygen and hydrogen are used to identify surface and groundwater interaction in OMR regions of Chengalpattu district. The precipitation, lake, surface, and groundwater are collected for pre-monsoon, monsoon, and post-monsoon seasons. The collected sample is analysed for stable isotopic compositions of oxygen and hydrogen in seasonal wise. The measured stable isotopic compositions during pre-monsoon season for stable oxygen are -4.29 to -2.00 and stable hydrogen are -29.39 to -24.67. The isotopic compositions during monsoon season ranges from -4.72 to -4.00 and for hydrogen ranges from -29.39 to -23.50. During monsoon season the depletion of isotopic composition is seen and the enrichment of isotopic composition is observed during pre-monsoon season. The variation in stable isotopic composition of oxygen and hydrogen are observed. A Groundwater Water Meteoric Water Line (GMWL) is developed for the study area, and it is compared with Local Meteoric Water Line (LMWL) for better interpretation of the results. A slight deviation is observed to that of GMWL to LMWL is mostly due isotopic depletion and evaporation effects. From the analysis a good corelation exists between precipitation and surface water in the study area indicates about recharge mechanism existing in the study area. The groundwater recharge is observed during monsoon seasons and discharge is more towards the pre-monsoon seasons.

Keywords: Stable isotopes, OMR region, GMWL, LMWL, oxygen and hydrogen

Subsurface investigation for groundwater resource assessment: A case study of Dehola/ Dauhla village, Haryana, India.

Neha Rani[1*], T. Vijaya Kumar[1]
[1]Delhi Technological University, New Delhi, India
*neha.mor5@gmail.com

Abstract

Water exists on the surface as well as the subsurface area of the earth. The water beneath the land and between hard rock aquifers is groundwater. Thirty percent of total freshwater is groundwater, but all of the groundwater cannot be used directly for various purposes such as irrigation, domestic and industrial usage, etc. Groundwater occurrence depends upon the formation of the geological structure, climate, and surface water conditions. As geology and geomorphology are different w.r.t. locations, the presence of groundwater is also non-uniform. Due to the scanty rainfall and limitation of surface water resources, we need to withdraw the groundwater. To exploit the groundwater, the study of aquifers and the water potential of that area is required. Nowadays, various surface and subsurface scientific techniques are used to explore and exploit groundwater, such as Esoteric methods, Geomorphologic methods, Geological & structural methods, Soil and Micro-Biological methods, Surface Geophysical methods, and Remote Sensing Techniques. In this case study, electrical well logging was done to analyze the lithology and the groundwater condition of village Dehola. Thirty-four soil samples were collected at 2m depth intervals. The process was carried out to a depth of 68m. Analysis and interpretation of logging data were conducted to check the groundwater conditions. Water was found to be not fit for irrigation as well as domestic usage.

Keywords: subsurface investigation, groundwater, electrical well logging, resistivity logs, Self-potential logs

Groundwater Flow Modelling using Model Muse: A case Study of Patna district of Bihar, India

Prem Chand[1*], Shikha Chourasiya[1] & Nitesh Patidar[2]
[1]Central University of Jharkhand, Ranchi, Jharkhand, India
[2]National Institute of Hydrology, Roorkee, Uttarakhand, India
*premcuj2014@gmail.com

Abstract

Groundwater is primary source of drinking water for approximately 2.58 million residents of Patna district of Bihar in India. Due to over exploitation of groundwater from the aquifer, rapid depletion of groundwater level is occurred in this district. Therefore, a quick assessment is needed to analyse distribution of groundwater level in order to manage this limited resources sustainably. In this study, groundwater levels of Patna district were observed in monsoon session over 1998 to 2021 with the help of MODFLOW model. The data are collected from WRIS INDIA and NAQUIM Aquifer reports. Total seven bore wells were selected for analysing the groundwater level fluctuations of two aquifers. With the help of MODFLOW model, the simulation of groundwater flow in the aquifer systems of whole district were done with the prediction of groundwater level ranges between 0 to -14 mbgl of the first aquifer and 0 to -29 mbgl for the second aquifer. In Phulwari Sharif region, levels of groundwater were about to -17 mbgl which is very critical situation for this region, but in Bakhtiyarpur, there was a relatively better situation among all places with groundwater level of 4 mbgl. Increasing rate of pumping of groundwater from aquifer systems in Bakhtiyarpur in recent years, change in monsoon due to climate change, have great impact in declining rate of groundwater recharging to the aquifer system. Therefore, to do more research on this topic at regional level is very necessary to control the over-exploitation of groundwater.

Keywords: Groundwater levels fluctuations, MODFLOW

Development of Water Resources Sustainability through Strategic Identification of Suitable Sites and Artificial Groundwater Recharge Structures in the Kadalundi River Basin, South India

C.D. Aju[1*], A.L. Achu[1], A. Ashwin[2], M.C. Raicy[3] & Girish Gopinath[1]
[1]Department of Climate Variability and Aquatic Ecosystems, Kerala University of Fisheries and Ocean Studies, Kochi, Kerala, India
[2]PG Department of Applied Geology, GEMS Arts and Science College, Kadungapuram P.O, Ramapuram, Malappuram (Dist), Kerala – 679321, India
[3]Centre for Water Resources Development and Management (CWRDM), Calicut, Kerala, India
*ajucd2012@gmail.com

Abstract

Artificial recharge of aquifers has emerged as a viable solution to counter the increasing depletion and degradation of groundwater in various river basins worldwide. In this context, the present study focuses on identifying suitable sites for potential recharge structures in the Kadalundi River Basin (KRB), located in South India, which experiences water scarcity in many parts during the summer. The study investigates the basin's potential for artificial recharge by analyzing various geo-environmental variables using remote sensing, geographical information system (GIS), and the analytic hierarchy process (AHP) technique. The considered geo-environmental variables include drainage density, rainfall, soil characteristics, lineament density, land use/land cover, available space for recharge, slope, geomorphology, and geology. Furthermore, the study identifies suitable locations for four site-specific groundwater recharge mechanisms: rainwater infiltration pits, percolation ponds, injection wells, and pond-cum-injection wells, utilizing a rule-based approach. The groundwater recharge potential map reveals that 10% of the area falls under a very low recharge potential class, while 28% falls under a low recharge potential class. Moderately suitable recharge potential covers 36% of the area and 20% and 6% of the area are classified as having high and very high recharge potential, respectively. The western and central-eastern parts of the study area mainly consist of high and very high recharge potential areas. Rainwater pits are suitable in most areas except the east and some random locations. Percolation ponds are suitable in the central-eastern and central-western regions. The locations for injection wells and pond-cum-injection wells are distributed randomly across the study area.

Keywords: Kadalundi River basin, Groundwater recharge zonation, GIS and AHP, Percolation ponds, Injection wells, infiltration pits

An Overview of Groundwater Scenario from the Apex of a Propagating Delta Front - A Post Monsoonal Survey at Namkhana Block, Sundarban Biosphere Reserve, India

Uddipan Das[1*], Susanta Chaudhuri[1], Bijay Halder[3], Poulomi Dutta[1]
[1]Department of Geological Sciences, Jadavpur University, Kolkata 700032.
[3]Department of Remote Sensing & GIS, Vidyasagar University, Midnapore 721102.
*dips.geo@gmail.com

Abstract

Real-time hydrogeological investigation was conducted to delineate the overall groundwater scenario and spatial variations of its major physicochemical parameters at southern most apical fringe of Indian Sundarban Biosphere Reserve area in meso-scale during recent post-monsoon season. The study was based on acquisition and analysis of primary field data collected from southern most apex of the river GangaBrahmaputra- Meghna delta and mostly restricted to Namkhana development Block, of South 24 Parganas district, West Bengal, India. Twenty-two groundwater samples were collected from bore wells during postmonsoon season (October 2022). Measurements of major affecting parameters, i.e., water table head, pH, TDS and EC, were done in-situ. Geospatial contour maps representing variations of influencing parameters were prepared. Drinking and irrigation suitability of the water was validated by existing standard equations and relevant plots. Chemical analyses were done to evaluate hydrochemistry and its suitability for drinking and agricultural purposes. Obtained results primarily revealed that TDS and pH are at marginal ranges with significant alarming concentration for some major contributing ions, chiefly bicarbonates & sodium, in most of the studied locations. Overall suitability of groundwater towards agriculture, drinking & domestic purposes is also adversely differing from normal acceptable limits, despite the temporal period of the study was being within the hydrogeologically favourable seasonal span of 'Post-monsoon'. Excessive and unplanned water exploration from deeper aquifer for agriculture seemed to be the prime factor responsible for this situation.

Keywords: Groundwater scenario, Indian Sundarban, physicochemical parameters, deeper aquifer, post monsoon, unplanned exploration

Hydrogeological Investigation of Chromium Contamination in Groundwater nearby COPR Disposal Sites in Rania-Khan Chandpur Villages, Uttar Pradesh, India

Vaibhav Deoli[1*], Pankaj Kumar Gupta[1]
[1]Centre for Rural Development and Technology, Indian Institute of Technology, Delhi-110016
*rdz228545@iitd.ac.in

Abstract

In India, Rania-Khan Chandpur is one of the highly contaminated sites due to the leakage of Chromium from the multiple Chromite ore processing residue (COPR) dump hotspots left in the open since the 1970s. This study presents a hydrogeological assessment of groundwater impacted by chromium (Cr) at Rania-Khan Chandpur. The extent of Cr contamination in the groundwater within the proximity of COPR sites during the monsoon season has been analysed. The study revealed site-specific variations in Cr concentrations within groundwater, spanning a range from 0 to 252.97 mg/L with most of the samples having Cr concentrations more than the permissible limits. The highest Cr concentration was observed in Khan Chandpur village, located in downstream of the COPR dump site, exceeding safe drinking water standards (0.05 mg/L) to a significant extent. We found that the chromate leachate is leaching towards the Khan Chandpur village from the dumped location by advection and hence more than 95% of wells were affected by Cr in that area consistent with site hydrology. Alternatively, Rania village exhibits distinct hydrogeological characteristics with multiple active chromate plumes driven by diffusive fluxes, and comparably lower (one-third) monitored wells were affected by the Cr concentration. These findings underscore the essential need for remediation measures and heightened monitoring efforts in areas with elevated Cr contamination, especially near COPR sites, to mitigate the potential health risks associated with drinking water consumption.

Keywords: Chromium, COPR, Groundwater, Hydrogeology, Rania-Khan Chandpur

Groundwater Resource Evaluation of Regions in Kurukshetra District, Haryana, India

S. Kumar[1*] & N.K. Tiwari[2]
[1]National Institute of Technology Kurukshetra, Kurukshetra, India
*sunilkumar820017@gmail.com

Abstract

To fulfill its fundamental needs, humanity depends on surface water and groundwater resources. A limited source that can be replenished is groundwater. To assess the importance of factors affecting groundwater, a widespread method of weighing multiple factors when making decisions using the Analytical Hierarchical Process (AHP) model. Spatial data sets affecting groundwater were also integrated using a GIS (Geographic Information System), a type of spatial data technology. Rainfall, slope, land use and land cover (LULC), geology, geomorphology, drainage density, lineament density, and soil, which are the factors affecting the subject layer, were studied. The study's main aim is to identify potential zones of groundwater using remote sensing and Arc-GIS. A weighted sum overlay was used in this study to identify potential zones. Kurukshetra district of Haryana (India), was selected as a case study area in this proposed study. This study can aid organizations in taking decisions to avert drought-like conditions. It can help them to decide the placement of discharge and recharge wells, ensuring efficient use of water resources. Five groundwater potential zones (GWPZ) were extracted in the research area using the AHP model and GIS technologies. The area is estimated at 1530 km^2. It has a very high potential, accounting for only 12.95% of the total study area. As per the data from 2013-2022, the Babain, Ladwa, Pehowa and Shahbad regions have seen a 29.32%, 32.42%, 36.08% and 19.47% decrease in the net groundwater availability, respectively.

Keywords: Analytical hierarchical process (AHP), geographic information system (GIS), groundwater potential zones (GWPZ), land use and land cover (LULC), Kurukshetra district.

Mapping Groundwater Recharge Potential Zones in Kandivalasa River Sub-Basin, Andhra Pradesh, Using Multi-Criteria Decision-Making Techniques

Gaurav Verma[1], Pramod Kumar Sharma[2*]
[1]Postgraduate, [2]Associate Professor
Department of Civil Engineering, Indian Institute of Technology Roorkee
*pramod.sharma@ce.iitr.ac.in

Abstract

Groundwater is an important natural resource that provides a significant portion of the world's drinking water supply. Overuse and mismanagement of groundwater resources have led to depletion and contamination, threatening the sustainability of water supply systems. Estimation and mapping of groundwater recharge potential is one way to address this issue, guiding sustainable management and conservation of groundwater resources. This study aims to estimate the groundwater recharge in the Khandivalasa River subbasin using two methods: water table fluctuation and rainfall infiltration. Additionally, the study involves mapping the groundwater recharge potential zones in the subbasin using the Analytical Hierarchy Process (AHP) method and the Multi-Influencing Factor (MIF) method. The study focuses on the years 2016-2019, with recharge estimated using pre-monsoon and post-monsoon groundwater levels and rainfall data. The percentage of rainfall converted to groundwater recharge is 8.95%, 12.5%, 8.8%, and 8.66% for the years 2016-2019, respectively. The AHP and MIF methods are used to integrate various spatial data layers to map the groundwater recharge potential zones in the subbasin. Both methods provide valuable tools for mapping groundwater recharge potential zones, which can guide sustainable management and conservation of groundwater resources in the Khandivalasa River subbasin. These findings have important implications for the sustainable management of groundwater resources in the region and contribute to the broader goal of ensuring the long-term sustainability of water supply systems.

Keywords: Groundwater recharge potential zone, sustainability, Analytical Hierarchy Process (AHP), Multi-influencing factor (MIF), spatial data layers.

An appraisal of Groundwater vulnerability in a Semi-arid Coastal - inland aquifer of South East India

Achu A L[1*], Girish Gopinath[1], Sabitha A R[1] Pragath Mullankandy[2]
[1]Department of Climate Variability and Aquatic Ecosystems, Kerala University of Fisheries and Ocean Studies (KUFOS), Kochi-682 508, Kerala, India.
[2]NeST Digital Private Limited, Kochi-682033 Kerala India.
*achu.geomatics@gmail.com

Abstract

The freshwater aquifers play a crucial role as a primary groundwater source in coastal regions. The utilization of the DRASTIC model enables the anticipation of aquifer vulnerability by assessing areas most susceptible to changes in intrinsic and specific factors. The DRASTIC model incorporates seven hydrogeological data layers, integrating them to gauge aquifer vulnerability based on the relative importance of these layers. The combined approach of Synchronized Multi-Criteria Decision Making (MCDM) and the DRASTIC model plays a pivotal role in evaluating and categorizing vulnerable aquifers within a given area. This study focuses on modelling the coastal-inland alluvium and crystalline aquifers in a semi-arid coastal stretch of the Tuticorin coast using the DRASTIC model in conjunction with the GIS-MCDM technique. Seven thematic layers were established, drawing on both field and secondary data. The DRASTIC model was subsequently applied, incorporating normalized weights determined through the Analytical Hierarchy Process (AHP) technique. The findings reveal that approximately 29.52% of the study area falls within the very high vulnerability zone, with an additional 33.25% falling under the high vulnerability index. The porous and permeable vadose aquifer media, coupled with shallow groundwater levels, predominantly contribute to the very high to high vulnerability class. Notably, the high vulnerability index values are concentrated in the coastal area, while lower values are observed in inland regions, reflecting the inherent hydrogeological differences.

Keywords: Groundwater vulnerability, GIS, DRASTIC, Tamil Nadu,

Assessment of groundwater vulnerability in an urban river basin of north Kerala using Fuzzy AHP-GIS based DRASTIC-L method

Jesiya N P[1*], Santosh G Thampi[2] and Girish Gopinath[3]
[1]Postdoctoral fellow, Department of Civil Engineering, National Institute of Technology Calicut, Kerala, India673601
[2]Professor, Department of Civil Engineering, National Institute of Technology Calicut, Kerala, India- 673601
[3]Associate Professor, Department of Climate Variability & Aquatic Ecosystems, Kerala University of Fisheries and Ocean Studies, Kochi, India-682508
*jesynp@gmail.com

Abstract

Evaluation of the vulnerability of an aquifer to groundwater pollution involves integrating a wide range of variables pertaining to soil characteristics, hydrologic conditions, aquifer characteristics, and topographic factors. In this study, an intrinsic groundwater vulnerability assessment of the Kallai river basin in Northern Kerala, India, is performed using a GIS-based modified DRASTIC-L technique and Fuzzy Analytical Hierarchical Process. The quantity and quality of both ground and surface waters have been impacted by uncontrolled urbanization, discharge of untreated wastewater and solid waste from numerous large and medium-sized industries and establishments located along the river bank, accumulation of filth in the river, and dumping of household garbage into the river. In this study, for the purpose of assessing vulnerability to groundwater pollution, eight hydrogeological characteristics are taken into account, namely, Depth to watertable (D), Net recharge (R), Aquifer media (A), Soil media (S), Topography (T), Impact of Vadose Zone (I) and Hydraulic Conductivity (C) and Landuse/ Landcover (L). Weights and rating of these eight influencing criteria and its sub-criteria are calculated using a Fuzzy-AHP comparison matrix. Based on the values of the groundwater vulnerability index obtained from the analysis using DRASTIC-L and AHP, the river basin is divided into four zones. 39% of the total area of the river basin falls in the “very high” vulnerability category. The aquifers in this zone are composed of coastal sand and alluvial sandy formations that are highly susceptible to pollution by infiltration. About 21% of the area falls in the “high” vulnerability category. This zone is characterised by gentle slopes, shallow aquifers underlying lateritic and sandy alluvial deposits, high recharge, and coarse sand aquifer media. Groundwater quality in these two zones is adversely affected by sewage discharge and seawater intrusion. The movement of pollutants from surface water to groundwater is facilitated by the highly permissible sandy alluvium and weathered laterite strata in the “high” vulnerability zone. 23% of the area of the river basin is classified as “moderate” vulnerability zone, comprised of lateritic unconfined formations, weathered charnockite rocks etc. The “low” vulnerability zone covers 17% of the river basin and is characterised by low permeable vadose zone and steeply sloping terrain.

Keywords: Groundwater vulnerability, GIS, Fuzzy-AHP, DRASTIC-L, Urban river basin

Efficiency of Sheet Piles for Controlling the Seepage of Earth Dams having Permeable Foundations

T. Satheesh kumar[1*], A. Kothari[1], C. Manga[1], Md M. Zahir[1], and S. Biswas[1]
[1]National Institute of Technology, Warangal, India
*ts21cerer07@student.nitw.ac.in

Abstract

This study aims to evaluate the efficiency of sheet piles to reduce the exit gradient and flux of earth dams with permeable foundation soil with the variation of sheet pile length, position, and number. Finite element models are created using GeoStudio 2021 in the SEEP/W module to carry out the steady-state seepage analysis of the earthen dam with the inclusion sheet piles. Both homogenous and core earth dam of 45 m base length and 10 m height is considered for the study having a 10 m depth of foundation soil as sand. The model is validated using existing literature. A parametric study has been performed by changing the pile length (2 m, 4 m, 6 m, 8 m, 10 m), position (upstream/downstream/mid-stream), and number (one, two, three) of the sheet piles. The permeability of the foundation soil is also varied in the analysis. It is found from the analysis that the flux and exit gradient decreases as pile number and length increases. This study indicates that the use of sheet piles at the downstream side is more efficient for the earthen dam as compare to other positions. It is also observed that the increment in permeability of the foundation soil increases the flux and decreases the exit gradient. The difference in the observed values of flux and exit gradient between the core and non-core dam is found insignificant.

Keywords: Earth dam, Finite Element Analysis, Sheet Pile, Seepage, Flux.

Water Level Monitoring and Mapping Seasonal Changes in the Reservoir Body using Altimetry Data: A Case Study of Shivsagar/Koyna Reservoir

Ahalya Nalluri[1*] & Ramesh H[1]
[1]National Institute of Technology, Karnataka, Mangalore, India
*nalluriahalya@gmail.com

Abstract

Water is essential to human existence, and current research emphasizes the need to monitor freshwater bodies. A considerable segment of India is presently struggling with a condition of water stress. Monitoring of rivers, reservoirs and lakes is always a booming question in a field of research where it comes to a question of minimal cost and time. Gauging stations are disappearing because of the high maintenance cost of Indian Reservoirs. The use of satellite data can help to aid in minimizing all these parameters with effective results. Monitoring of smaller reservoirs is highly unlikely to occur. Satellite altimetry has been successful in monitoring inland water bodies for the past three decades. The current study emphasizes using SARAL/Altika, one of India's high-frequency satellites in the field of altimetry, to monitor water levels (WL) of Koyna Reservoir, which is located over the Koyna River in the state of Maharashtra, India. The seasonal water spread of the reservoir is mapped with the use of Landsat-8 imaging satellite, 30m resolution, which has a particular band to monitor water. BRAT (Broad view radar altimetry toolbox) is used for processing SARAL. Bias correction is observed while calculating water level from altimetry which is mainly caused due to geography of the reservoir. The normalized differential water index (NDWI) is employed to derive the water spread area of the reservoir. A capacity survey of the reservoir is quantified, and a loss of reservoir storage over the years is calculated using a mathematical approach. SARAL/ Altika and Landsat -8 data's which are freely available and downloaded and processed from April 2013 to May 2016. SARAL/Altika derived WL has validated against the field WL. The coefficient of determination, R^2 is 0.9 for all the years, and the root-mean-square error (RMSE) is found to be less than 0.3. Additionally, altimetry studies can be employed for deriving bathymetry information, monitoring river systems, reservoir operations and various other applications.

Keywords: Altimetry, SARAL/Altika, NDWI, Water level, Reservoir, Reservoir Capacity.

A Machine Learning-Based Approach for Leakage analysis in Water Distribution Systems

Gaurav[1]&Shweta Rathi[1*]
[1] NIT Kurukshetra, Kurukshetra, India
*shwetarathi@nitkkr.ac.in

Abstract

Access to clean and reliable water is a fundamental human right, yet ensuring a steady supply of safe and potable water can be a daunting task, particularly in urban areas where water distribution systems (WDS) are often complex and aging. However, despite efforts to maintain and upgrade these systems, problems such as leaks, bursts, and contamination still persist, leading to significant economic, environmental, and health consequences. Conventional leak detection methods in WDS include acoustic, visual, and statistical approaches. However, these methods are often time-consuming and expensive and may not detect small leaks or those located in hard-to-reach areas. These limitations emphasize the need for more advanced and reliable leak detection techniques, such as those based on machine learning (ML). The objective of this study is to compare the performance of different ML models such as KNN Classifier, Random Forest Classifier, Support Vector Machine for leakage analysis considering no leak and leak scenarios. EPANET Example 3 is considered for hydraulic modeling using EPANET. Extended period simulation is performed and pressure and discharge relationship is considered. Accuracy score using the three techniques, The KNN Classifier, Random Forest Classifier, and Support Vector Machine are employed to evaluate the ML model's performance which provided the accuracy score of 87.93 %, 88.81 % and 88.19%. It is observed that the use of Machine Learning based approaches supersedes the conventional methods in terms of efficient handling of large dataset in less time.

Keywords: Classification, Hydraulic Modeling, Leak Detection, Machine Learning, Water Distribution Systems.

Clustering for water distribution systems

Shreya Dixit[1] & Shweta Rathi[1]
[1]M. Tech Environmental Engineering, National Institute of Technology, Kurukshetra, India.
[1]Assistant Professor, National Institute of Technology, Kurukshetra, India.
*shwetarathi@nitkkr.ac.in

Abstract

The water Distribution System (WDS) is one of the critical components of the water supply system. Due to its huge sprawl and the large number of components are involved in the systems and thus it is difficult for operation and maintenance when considering it as a whole for providing good quality and quantity of water to the consumers. Due to uncertainty and complex nature and interrelationships of the parameters, makes the system difficult to divide the system into subsystems for the design, control and maintenance of the systems at different stages. It helps to divide the WDS into subsystems to reduce its complexity and improving management, minimizing water losses, reducing infrastructure cost, locate crucial locations for pressure and water quality sensor and improving the overall efficiency of WDS. The main objective of the study is to focus on the different methodologies available for the clustering techniques, such as spatial, topological and statistical clustering etc. In this study, K-means and fuzzy clustering are used to divide the hypothetical WDS and its application is shown on one of the example network. K-means is used for subdividing the areas where consumers having similar water consumption patterns like residential or commercial areas and low or high-water demand consumer pattern localities. Fuzzy clustering is used for uncertain and time-varying water demand patterns. Advantages and disadvantages of both methodologies are discussed.

Keywords: Clustering, Water Distribution System, Water Demand.

Water Wheel Based Run-of-River Pumping System for Irrigation

Sanjeev kumar[1], Sandeep Gupta[2], Anand K. Plappally[3], P.M.V Subbarao[4]
[1,2,3]Indian Institute of Technology Jodhpur, Rajasthan, India
[4]Indian Institute of Technology Delhi
*kumar.277@iitj.ac.in

Abstract

Farmers at Semera Bujurg village in the district of Lalitpur, Uttar Pradesh used to irrigate their fields using an engine pump that runs on diesel. Setup resulted in a higher expenditure of more than INR 500 Rs./day for irrigation per farmer. Sajnam River with a width of around 200 feet flows through the Semera Bujurg village. The usage of the power available with flowing water through the river showed the potential solution to the woes of the farmers at that location. A water wheel is designed to extract the energy from flowing water through the river and is used to run a pump for irrigation. A region near the river was chosen due to its previous earthen constructions which provided resistance to flowing water. These earthen constructions were to be propped up in order to create a weir through which water can diverted for a water wheel to be installed. The calculation of the construction of the earthen–stone dam, as well as the weir, are enumerated. The design of the width of the dam and the forces on it are enumerated. Further, the flow rate through a weir of 1.5 m and opening of 2ft of the sluice gate on the weir is also calculated. The sluice gate can be opened and closed as per requirements. Depending upon the flow rate and head available, the water wheel design is initiated. The power produced by the water wheel is calculated. Vanes are designed using the velocity triangle method. The shaft of the turbine is designed by assuming an allowable maximum shear stress of 3500N/m2. The gearbox design for the system with a 1:40 ratio was initially developed for input and output of around 40 KW. Here negligible losses are assumed in the transmission capacity of a gearbox. A commercially available self-priming centrifugal pump of 11.29kW or 15hp was attached to the gearbox to enable water pumping requirements requested by the farmers of Semera Bujurg Village. At present the whole run-of-river water wheel setup is working continuously for the last several months on the Sajnam River, in Lalitpur, UP, and irrigating the more than 100 acres of land in Semera Bujurg Village.

Keywords: Run-of-River, Water wheel, Irrigation, Renewable energy, Gearbox, Check dam.

Estimation of Crop Water Requirement using Field Water Balance and Soil Moisture Data

Ghanshyam Giri[1], Manoj Yadav[1], Hitesh Upreti [1], & Gopal Das Singhal[1]
[1] Water Management Field Laboratory, Shiv Nadar Institution of Eminence, Delhi-NCR, Greater Noida India - 201314
*gg303@snu.edu.in

Abstract

The knowledge of crop water requirements (CWR) is very crucial in the area of irrigated agriculture. This knowledge is also helpful in increasing water use efficiency, which is extremely low in India at present. The reason behind extremely low water use efficiency is the excess amount of water applied to the fields by farmers. A field experiment was conducted during the 2021-22 wheat crop season at the Water Management Field Laboratory of Shiv Nadar Institution of Eminence, Greater Noida, India. The experiment consisted of a plot with four replications. The irrigation applied to the plot was based on the irrigation thumb rules used by the local farmers. The irrigation was applied using the flood irrigation method with similar arrangements as the local farmers in the region. The soil moisture was measured with the help of a profile probe at regular intervals. The aim of the study was to estimate deep percolation (DP) and CWR. The DP in the study was estimated based on the soil moisture deficit and the irrigation and rainfall received by the plots. The total DP for all four replications was 124.4 mm, 119.1 mm, 115.4 mm, and 82.9 mm, respectively, and 38%, 41%, 28%, and 27% of the applied irrigation and rainfall. The CWR was estimated using the field water balance and soil moisture depletion methods. The CWR estimated from these two methods was compared with the crop evapotranspiration estimated through the FAO-56 method (crop ET). The values of CWR using field water balance and soil moisture depletion were well correlated with crop ET. The values of R^2 between CWR using field water balance and crop ET for all four replications were 0.93, 0.96, 0.98, and 0.98, respectively. The values of R^2 between CWR using soil moisture depletion and crop ET for all four replications were 0.96, 0.86, 0.85, and 0.95, respectively.

Keywords: Crop water requirement, Deep percolation, Soil moisture depletion, crop evapotranspiration, water use efficiency.

Reliability-Based Optimization of Water Distribution Networks: A Review

Tiwari, A.[1*], Khare R[2].
[1]PG Research Scholar, Centre of Excellence in Water Management, MANIT Bhopal-462003, INDIA
[2]Assisstant Professor, Centre of Excellence in Water Management, MANIT Bhopal-462003, INDIA
*ayutiwari786@gmail.com

Abstract

Water distribution networks are essential infrastructures for supplying reliable and safe water to urban areas. As urbanization expands and existing systems age, ensuring the reliability and performance of these networks has become increasingly challenging. In response, researchers have focused on reliability-based optimization techniques to improve network design and operation. This paper presents a comprehensive review of state-of-the-art reliability-based optimization methods employed in water distribution network analysis. It discusses the importance of reliability in meeting user demand, minimizing system failures, and maximizing network performance. The review covers various reliability assessment approaches, including analytical, simulation-based, and hybrid methods. Optimization algorithms such as genetic algorithms, particle swarm optimization, and ant colony optimization are explored, highlighting their role in finding cost-effective designs that meet reliability constraints. Additionally, the review examines different objectives considered in reliability-based optimization, such as minimizing failure risks, enhancing resilience, reducing vulnerability, and improving water quality. It discusses the trade-offs involved and provides insights for decision-making processes. The paper identifies current research trends, challenges, and future directions, including the integration of real-time data, dynamic demand patterns, renewable energy sources, and the impact of climate change. This review consolidates and analyzes existing literature, offering valuable guidance to researchers, engineers, and decision-makers in the water industry for developing robust, efficient, and sustainable water distribution systems to meet the evolving demands of urban areas.

Keywords: Reliability, Water distribution network, Optimization.

Hydraulic Analysis and Simulation of Dumas Village Water Distribution Network Using EPANET

A. Patel [1], G.D. Kale [1] & J. Venkatesh [1]
[1]Sardar Vallabhbhai National Institute of Technology, Surat-395007, Gujarat, India
*gdk@ced.svnit.ac.in

Abstract

Effectual water supply (WS) is of utmost importance in designing a new water distribution network (WDN) or in enlarging the prevailing one. To ensure adequate WS with required pressure, analysis of existing WDN is crucial. None of the reviewed studies have examined the WDN of the Dumas village in Surat City, Surat District, Gujarat, India. Thus, in the present study, EPANET software is used for analysing the WDN of the Dumas village. From the analysis of aforesaid WDN, it was found that, demand values are varying between 1.12 litres per second (LPS) to 42.58 LPS while pressure values are ranging from 53.41 metre to 57.02 metre. Flow values are varying from 2.24 LPS to 505.55 LPS, velocity values are ranging from 0.12 metre/second (m/s) to 1.79 m/s and unit head loss values are varying from 0.09 metre/kilometre (m/km) to 4.37 m/km. From the analysis, it is found that, the existing WDN can fulfill the water demand at all nodes for the year 2044.

Keywords: Water Distribution Network, Dumas village, EPANET.

Monthly Reservoir Inflow Prediction using Deep Learning Techniques

Deepjyoti Deb[1*], Anupam Mitra[1], S. Sai Vignan Reddy[1], Yashraj Jha[1], A. Vasan[1], K. Srinivasa Raju[1]
Department of Civil Engineering, BITS Pilani Hyderabad Campus, Hyderabad, IndiaEmail: *
*p20210410@hyderabad.bits-pilani.ac.in

Abstract

Reliable inflow prediction is essential for determining efficient water allocation and release policies. In this regard, the capability of Long-Short Term Memory (LSTM) and Gated Recurrent Unit (GRU) in predicting monthly inflows of the Sri Ram Sagar Project in Telangana, India, are studied. HyperOPT was used to fine-tune the architecture of the techniques and improve their efficacy. One time series (S1) and two cause-effect (S2, S3) scenarios are developed based on the historic monthly rainfall, evaporation, and inflow. Forty years of monthly reservoir data were considered, out of which 28 years were used for training. Theperformance of the techniques is assessed using Nash Sutcliffe Efficiency (NSE). LSTM optimized using the HyperOPT framework(LSTM-HOPT), and GRU-HOPT performs better than LSTM and GRU without hyperparameter tuning. Among GRU-HOPT and LSTM-HOPT, the former performed better than the latter in all three scenarios. GRU-HOPT and LSTM-HOPT performed best inthe S3 scenario, with highest NSE values of 0.80 and 0.77 during training and 0.72 and 0.69 during testing, respectively. Additionally, in S1 scenario, the algorithms have shown decent performances by attaining KGE value of 0.74 and 0.73 in trainingand 0.65 and 0.63 in testing. HyperOPT framework have improved the efficacy of LSTM and GRU in S3 with an increase in NSE value of 2.67 % and 2.5% during training and 9.52 % and 12.50 % during testing, respectively. The present work demonstrates that LSTM-HOPT and GRU-HOPT can be efficiently deployed for simulating reservoir inflow.

Keywords: Reservoir inflow, Gated Recurrent Unit, Long Short-Term Memory, Sri Ram Sagar Project, HyperOPT

Multi-Attribute Decision-Making for Rehabilitation of Water Distribution Network

Nikita Palod[1], Rajesh Gupta[2]
[1]Assistant Prof. (Adhoc), Civil Engineering Department, VNIT Nagpur
[2]Professor, Civil Engineering Department, VNIT Nagpur
*npalod@gmail.com

Abstract

Multi-attribute decision-making (MADM) can be used for determining the priorities among various available choices. In the present work, the priorities in the case of the rehabilitation material of the water distribution network (WDN) is identified using different MADM techniques. The ranking of technical solutions is performed using three different methods of MADM techniques which include the Analytical Hierarchy Process (AHP), Preference Ranking Organization Method for Enrichment Evaluation (PROMETHEE), and Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS) methodology. The ranking of the alternatives so obtained is compared with other studies performed using different MADM methods. It is observed that the best solution i.e., the alternative with rank one always remains the same in all the techniques, clearly highlighting the alternative which in the present case study is fiber cement pipe is the supreme choice for the rehabilitation of pipes in WDN of Cluj-Napoca, Romania. In the present study ductile cast iron, gray cast iron, polyethylene, prestressed concrete, fiber cement, and steel materials are compared for the rehabilitation of WDN. A similar study can be performed on a real-life network involving a larger number of choices. The MADM techniques can also be applied to identify the best solution from the various feasible solutions that are generated by the multi-objective optimization technique in the form of a Pareto front. This can ease the decision-making process for a design engineer.

Keywords: Water distribution Network, Rehabilitation, MADM, Sustainable options, Materials

Analysis of Optimal Solutions of a Benchmark Water Distribution Network

Laxmi Gangwani[1*], Shilpa Dongre[2], Rajesh Gupta[3]
[1]Department of Civil Engineering, Shri Ramdeobaba College of Engineering and Management, Nagpur – 440013, India.
[2]Department of Civil Engineering, Visvesvaraya National Institute of Technology (VNIT), Nagpur – 440010, India.
[3]Department of Civil Engineering, Visvesvaraya National Institute of Technology (VNIT), Nagpur – 440010, India.
*gangwanilr@rknec.edu

Abstract

Optimal design of water distribution networks (WDNs) has always attracted the attention of researchers due to various complexities involved in it. The general cost optimization problem is categorized as NLP-Hard problem. Several evolutionary techniques have been developed in the last three decades that have the capability of search from multiple starting points and have more chances of reaching to the global optimal solution. Almost all these techniques have been applied to design WDNs. The efficiency and effectiveness of the proposed methodology by any researcher is checked through its application on different benchmark problems of various complexities. A two-source network problem is one of the benchmark problems which is used by many researchers. The network was first introduced in 2008 and GA with full as well as reduced search space was applied. The network was used later by many researchers to test their algorithms by either providing a better solution/similar solution or reducing the execution time. In few occasions better than the previously available best solution is obtained. Still the global optimality of the best solution available in the literature is not guaranteed. This paper aims at the analysis of the available solutions for this two-source network based on certain parameters to explore the possibility of achieving better than current best solution.

Keywords: Analysis, Design solution, Critical nodes, Flow pattern, WDN’s.

Green water and Blue water assessment for crop stress monitoring in a water-scarce Riverbasin

Alka Sharma [1], P. L. Patel[2*], Priyank J. Sharma [3]
[1]Ph.D. Research Scholar, Sardar Vallabhbhai National Institute of Technology Surat, Surat-395007, Gujarat, India.
[2]Professor, Sardar Vallabhbhai National Institute of Technology Surat, Surat-395007, Gujarat, India.
[3]Assistant Professor, Department of Civil Engineering, Indian Institute of Technology Indore, 453552, India.
*plpatel@ced.svnit.ac.in

Abstract

Estimating the changes in the hydroclimatic variables under future climate scenarios is vital to devise suitable climate action. This study employs the Soil and Water Assessment Tool (SWAT) model to examine the fluctuations in blue water (BW), green water flow (GWF), and green water storage (GWS) at sub-watershed level in a semi-arid Dharoi catchment of the Sabarmati River basin, India. The projected changes in the hydroclimatic variables (rainfall, temperature, BW, and GW) are evaluated with respect to the baseline period (1995-2019) using a multi-model ensemble of five GCMs over three future periods i.e., near-future (2020-2040), mid-future (2041-2070), and far-future (2071-2100) under RCP4.5 and RCP8.5 scenarios. The Anthesis heat stress (AHS) for wheat at the district level is also evaluated. Modified Mann Kendall (MMK) and Sen's slope method are applied to determine statistically significant alterations in the water balance components in the future and baseline periods to investigate the variability and trend at sub-watershed level using. High variability of rainfall and BW, specifically, in sub-watersheds 5, 7 and 8 are observed in baseline period. On the other hand, green water (GWF and GWS) shows less (up to 24%) variability in the said period across the basin. Nominal variability of projected rainfall is noticed for all the periods under RCP4.5 and RCP8.5 is observed (up to 15%). On the contrary, the magnitude of uncertainty for BW is high, nearly 15.3 - 40% (23.6 - 41%) in all the periods of RCP4.5 (RCP8.5). Rainfall and BW has similar decreasing trend in both the scenarios of RCP4.5 and RCP8.5 in almost all sub-watersheds of the catchment. Thus, baseline (future) climate shows a wetter (drier) tendency across all sub-watersheds which may impact the water availability of the catchment. The result also suggests that heat stress due to rising temperature imposes an increasing risk to agricultural production in all districts of the catchment for wheat crop in baseline as well as future period under RCP4.5 and RCP8.5. The study outcomes could help us develop suitable adaptation plans to mitigate the adverse effects of climate change in the Dharoi catchment in future period.

Keywords: Anthesis heat stress, Aridity Index, Climate change, CMIP5, Multi-model ensemble approach, Semi-arid basin.

Impact of environmental conditions on the Crop Water Stress Index

Aditi Yadav[1], Hitesh Upreti[2], Gopal Das Singhal[3]
[1]PhD Research Scholar, Department of Civil Engineering, Shiv Nadar Institution of Eminence, Greater Noida, U.P
[2]Assistant Professor, Department of Civil Engineering, Shiv Nadar Institution of Eminence, Greater Noida, U. P
[3]Associate Professor, Department of Civil Engineering, Shiv Nadar Institution of Eminence, Greater Noida, U.P
*ay453@snu.edu.in

Abstract

The impacts of climate change on agriculture are governed by erratic precipitation and water demand that contribute to a decline in crop yield. Designing irrigation schedules that increase crop yield while conserving water is an urgent need of the hour. For this, controlled crop experiments were conducted during the 2021-2022 season on wheat crops in the semi-arid region of western Uttar Pradesh to understand the dynamic interaction between environment, soil, and plant parameters. Using these parameters, a plant-based index known as the crop water stress index (CWSI) is studied under two different environmental conditions. CWSI is empirically derived using three parameters: air temperature (T_a), canopy temperature (T_c), and vapor pressure deficit (VPD). The two different environmental conditions were created for plots 1 and 2, subjected to a similar type of drip irrigation treatment with a 50% maximum allowable depletion (MAD). Plot 1 was roof covered by polyethylene sheet that blocked around 50% of incoming solar radiation and Plot 2 was open to the sky. The weather variables of T_a, VPD, and wind speed decreased by 5%, 21%, and 44%, respectively, owing to the presence of the partial shade condition of the polyethylene sheet. The non-stressed condition of the lower baseline was designed for open sky conditions with the help of an additional drip irrigated plot 3, subjected to a 25% MAD. The lower baselines for the pre-heading and post-heading stages of wheat growth were $(T_c\text{-}T_a)_{LL}$= -1.39 (VPD) - 0.66 and $(T_c\text{-}T_a)_{LL}$ =-1.29 (VPD) -2.19, respectively. Using the lower baseline devised from plot 3 as a reference scenario for non-water stressed conditions, empirical CWSI values for both open-to-sky and partially shaded conditions were calculated. It was seen that the mean CWSI values of plot 1 and plot 2 were 0.25 and 0.1, respectively, which implies a 60% decrease in water stress in plot 2. The crop yields of plot 1 and plot 2 were 3684 kg/ha and 5011 kg/ha, respectively. The lesser crop water demand within the polyethylene sheet leads to a 107% water savings than the open sky conditions. This study quantifies the significance of well-lit, sunny conditions for the development of CWSI and also signifies the cumulative effect of weather variables on water management and crop yield.

Keywords: Drip irrigation, lower baselines, crop yield, water use efficiency, Uttar Pradesh, sun-lit conditions

Human health risk assessment of nitrate in groundwater of Faridabad and Gurgaon districts of National Capital Region, India.

S. Rabi Kumar Rao[1*], Shashi Shankar Ojha[2], Mani Bhushan[3], Bibhuti Bhusan Sahoo[4]
[1,4]Department of Agricultural Engineering, Centurion University of Technology and Management, 761211, Odisha, India
[2]Department of Civil Engineering, National Institute of Technology, Patna,800005, Bihar, India.
[3]Department of Civil Engineering, GEC Khagaria,848203, Bihar, India.
*203001170009@cutm.ac.in

Abstract

This study utilized geospatial and statistical methods to assess the degree of nitrate contamination in groundwater quality in the National Capital Region (NCR) of India's Faridabad and Gurgaon districts, which have undergone significant urbanization and development in recent years. The study examined the levels of nitrates in the groundwater of these two districts and evaluated the potential health risks to individuals of different ages through the chronic daily intake, dermal absorbed dose, and hazard index (HI). Infants in the study area were found to be at a higher risk than adults and children due to escalating nitrate concentrations in groundwater, which can have a direct impact on human health. The study determined the compatibility of the groundwater quality for human drinking purposes by comparing the concentration of parameters at each site with respect to the allowed limits recommended by the Bureau of Indian Standards (IS 10500: 2012). Nitrate concentration in groundwater was found to range from 0 to 96mg/L across the sites, with over 35 percent of the total sites considered hazardous for drinking purposes based on the WQI research. The first principal component (PC1) explained more than 95% of the total variance, significantly reducing the dimensionality according to the PCA results. The findings of this study suggest that the increased levels of nitrate in groundwater may be due to anthropogenic activity, as evidenced by the relationship between nitrate loading and water quality parameters. The results emphasize the importance of routine water quality monitoring and provide valuable information for water resource planning and management, particularly in NCR's industrial zones. The outcomes of this research may be used to create effective environmental management policies to enhance groundwater quality and ensure safe drinking water. Furthermore, the study highlights the significance of incorporating geospatial and statistical techniques in groundwater quality assessment, which can provide more accurate and precise information for decision-making. The use of these techniques enables researchers to identify

and locate the sources of nitrate contamination, which is crucial in developing effective strategies to mitigate the risks associated with contaminated groundwater. The findings of this study also raise concerns about the potential impact of nitrate contamination on agricultural productivity in the region. High levels of nitrates in groundwater can affect crop yields and quality, as well as soil health, thereby impacting the overall agricultural productivity of the area. Therefore, the study's outcomes may also be valuable for policymakers and stakeholders in the agricultural sector. This study demonstrates the importance of regular groundwater quality monitoring and the need for efficient management strategies to address nitrate contamination in the groundwater of rapidly developing regions such as NCR. The study's outcomes provide valuable insights into the risks associated with nitrate contamination and highlight the significance of incorporating geospatial and statistical techniques in groundwater quality assessment. Policymakers and stakeholders in the region may use these findings to develop effective policies and programs to improve groundwater quality, ensure safe drinking water, and promote sustainable agricultural practices.

Keywords: WQI, NCR, Hazard index, nitrate

Understanding the role of land-atmosphere interaction on soil moisture persistence

Mir Farhan Ul Haq[1], Tushar Apurv[2]
[1] Indian Institute of Technology Kanpur, India
[2] Indian Institute of Technology Kanpur, India
*farhan20@iitk.ac.in

Abstract

Droughts are one of the extremes that pose severe threats to biodiversity and future food security as they occur over large areas and long periods. Due to land-atmospheric feedback, drought evolves with space and time, and soil moisture plays a pivotal role in governing the feedback. As soil desiccates during droughts, it reduces latent heat flux and increases sensible heat flux, warming the atmospheric boundary layer. The persistence in soil moisture plays a critical role in the extent of propagation of droughts and can, therefore, help improve seasonal climate predictions. We use a simple water balance model to analyze the effect of land-atmospheric interactions on soil moisture persistence. The model is run in two scenarios, first by ignoring the land atmospheric interaction and assuming atmospheric water demand to be solely a function of net radiation, and then we introduce the interaction by using a simplified relationship.

Keywords: Droughts, Land-atmospheric feedback, Soil-moisture persistence

Cost Effective Technique for Domestic Wastewater Treatment

Devakolati Shivasai Kumar[1], Haravath Ravi[1],
Manoj Langhi[2] & Jaidevi Jeyaraman[2]
[1] B.Tech. Students, Department of Civil Engineering, Institute of Infrastructure Technology Research and Management, Ahmedabad, India
[2]Asst. Prof., Department of Civil Engineering, Institute of Infrastructure Technology Research and Management, Ahmedabad, India
*manojlanghi@iitram.ac.in

Abstract

Water scarcity is one of the major emerging problems due to urbanization, climate change and industrialization. To combat this crisis, there is a need for an adaptive approach at a regional scale for water conservation, wastewater treatment and ultimate reuse of wastewater. Primarily, efforts are made on water conservation, but it is not enough to solve the problem of water scarcity. Therefore, there is a need for efficient technology for wastewater treatment for its reuse. Domestic Multi Recycler is a new emerging technology for an efficient wastewater treatment which uses anaerobic process and does not require electricity. The treated water can be used for irrigation, the anaerobic treatment sludge is composted and can be further utilized as an organic fertilizer. The Zero Liquid Discharge (ZLD), an engineering technique is followed in case of DMR where the water is treated to comply with the discharge standards, and the sludge is recovered. DMR consists of filter bed tanks, divided into three anaerobic sections, combined in series. Initial two compartments of DRM are filled with polypropylene filter material to provide medium for bacterial growth with a third compartment as a sedimentation tank. Samples are collected at different sections of DMR once a week for the period of 10 months (July 2022-May 2023) and are analyzed to determine the various water quality parameters. The average reduction of BOD is 75% and COD is 82%. The TDS and pH concentrations in effluent of DMR are 826 mg/L and 7.26 mg/L met the conventional STP values. Results showed that DMR is economical for domestic wastewater treatment.

Keywords: Domestic Multi Recycler, BOD, COD, Zero Liquid Discharge

Identification of Foam Forming Locations and its Management in the Delhi Yamuna Reach

Neenu, Mitthan Lal Kansal
Water Resources Development and Management Department, Indian Institute of Technology Roorkee, India
*neenu@wr.iitr.ac.in

Abstract

Foam accumulation in the river poses environmental concerns and requires effective management to mitigate its effects. This study aims to evaluate the causes, impacts, and potential management strategies related to the foam formation in the Yamuna River stretch in Delhi. To address this issue, the Data Envelopment Analysis (DEA) model is utilised for benchmarking, identification, and prioritisation of specific locations that need attention for intervention. Wazirabad (u/s) exhibited an efficiency score of one compared to the other locations and emerged as a benchmark. In contrast, the downstream locations of ITO Bridge, Nizamuddin Bridge, and Okhla Barrage (d/s) had lower efficiency scores of 0.512, 0.327, and 0.445, respectively. Therefore, pollution highly affects the Nizamuddin to Okhla (d/s) stretch, primarily due to the influx of wastewater from polluted drains and industrial areas. The presence of foam, likely originating from the discharge of surfactants and phosphates, exacerbates the pollution levels in this region. The DEA model was also used to determine slack values for each inefficient location to account for the required hydrochemical parameter improvements relative to the benchmark. The findings of this study underscore the potential to improve the efficiency of these locations by implementing an effective treatment sequence. Finally, the study recommended managing foam formation through monitoring, preventive measures, and treatment. Managing river foam requires regular data collection and monitoring of water quality indicators related to foam formation, rigorous industrial and domestic wastewater treatment laws, and cutting-edge technologies like TERI Advanced Oxidation Technology (TADOX).

Keywords: Foam, Yamuna River, DEA, Benchmarking, Slack values, TADOX

A Study on Water Quality Evaluation and Apportionment of Pollution Sources in Mahanadi River Basin, Odisha

Abhijeet Das[1, a], C.V. Raman[2]
[1]Department of Civil Engineering
[2]Global University (C.G.U), Bhubaneswar, Odisha, India
[*]das.abhijeetlaltu1999@gmail.com

Abstract

Surface water quality due to geogenic factors, aggravated by anthropogenic activities is a significant threat to human well-being and agricultural practices. An attempt has been made in this work to understand the suitability of surface water in Mahanadi Basin, Odisha for human consumption. Nineteen samples consisting of 20 physicochemical parameters for 2019-2022 period, were evaluated and were compared with the standard guidelines recommended by WHO techniques to assess water quality using two indexing methods: Weighted Arithmetic Water Quality Index (WA WQI) and Stepwise Weight Assessment Ratio Analysis Water Quality Index (SWARA-WQI). Despite being an essential factor for rating of under exploitation survey sites, WQI entails conflicting issues. As a result, Multiple-criteria decision making (MCDM) models, such as Compromise Programming (CP), Ordered Weighted Averaging (OWA) and Combined Compromise Solution (CoCoSo) were adopted to alleviate contradictions involving WQI index and has been employed for identifying ideal locations along the river stretch with the water quality pertaining to drinking standards. The spatial variation map was prepared using Inverted Distance Weighting (IDW) technique in ArcGIS environment to visualize the spatial spread of water quality over each location. The patterns for the average anion and cation concentrations were Cl->SO4 2->NO3 ->Fand Fe2+>B+ respectively. However, TC and TKN concentrations increased gradually from upstream to downstream and were very high compared to WHO standards, which means the river waters were heavily polluted. Further, the WQI results shows in the study area, which ranged from 23.78-96.09 (WA WQI) and 14.6-1065.2 (SWARA-WQI). The results of the WQI indicates that 15.79% (WA WQI & SWARA-WQI) of surface water samples had poor to very poor drinking water quality. The overall WQI in the study area indicates that the water is safe and potable (around 84.21% good water) except few localized pockets in location SP-8, 9 and 19. Each of the modelled geospatial maps was validated using a set of 20 in-situ observations. Four semi variogram models such as circular, exponential, spherical and Gaussian were used and found to be the best fit for analysing the spatial variability in terms of WA WQI and SWARA-

WQI. The interpretation of semivariogram modelling also shows that Gaussian model obtains the best fit for both WA WQI and SWARA-WQI dataset. Putting the above MCDM models into practice, it was clarified that SP9 was most polluted in comparison with other locations. This was evident from the highest WA WQI and SWARA-WQI values at these locations. Finally, this work provides insights for the protection of water resource and the treatment of surface water pollution in the future.

Keywords: Mahanadi Basin, WA WQI, SWARA-WQI, CP, OWA, CoCoSo, ArcGIS, semi variogram.

Importance of hydraulic model studies for development of the existing fair-weather fishing harbour into all-weather harbour

R. K . Chaudhari[1], S.K. Kori[2] and Dr.Prabhat Chandra[3]
[1]Scientist 'C', CWPRS, Khadakwasla, Pune, India -411024
[2]ARO, CWPRS, Khadakwasla, Pune, India -411024
[3]Additional Director CWPRS, Khadakwasla, Pune, India -411024
*rajeev_cwprs@yahoo.co.in

Abstract

The all weather fishing harbour should essentially provide enough tranquil space for landing as well as for parking of the fishing vessels during entire year with maximum significant wave heights less than the 0.30m at berths. The requirements of harbour layout, length and alignment of protective breakwaters are decided through hydraulic model studies. In the present paper, an existing fair weather fishing harbour at Belekeri situated in west coast of India in the Ankola taluka of Uttar Kannada District of Karnataka, has been proposed to be developed as an all weather fishing harbour. Presently, almost 150 fishing boats are being operated during non monsoon season. It is experienced by the local fishermen that due to the presence of high waves in the harbour during monsoon season, the berthing operations are not possible and parking of the vessels as well. To overcome this problem, an all weather harbour layout has been suggested with the help the mathematical model studies. In order to provide the necessary wave protection against the waves during the monsoon season at the harbour, an additional breakwater of 200m length upto -2.5m contour has been evolved.

Keywords: Breakwater, Fishing harbour, Tranquillity, Hydraulic model studies, significant wave height.

Production of Hydrogen from Waste Water Treatment: A Critical Review

Arun Kumar Sharma[1], Prashant Sharma[2], Niranjan Damle[1], Bhupendra Gupta[3] & Bhagavanulu DVS[4]
[1]Gyan Ganga College of technology, Jabalpur, India
[2]Shri Ram Institute of Science and Technology, Jabalpur, India
[3]Jabalpur Engineering College, Jabalpur, India
[4]Gyan Ganga Institute of Technology& Sciences, Jabalpur, India
*arunksharma232@gmail.com

Abstract

Wastewater encompasses all water channels that have been contaminated by lives activity; hence, its molecular structure changes widely based on where it comes from. Wastewater from homes, towns and cities is typically high in bacteria, organic debris, metals, and minerals such as phosphorus or nitrogen. Municipal wastewater treatment systems frequently process these wastewaters. On the other hand, industrial waste streams are varied, emerging from several activities. Certain wastewaters from industries are comparable in chemical structure to residential wastewater and are processed in urban wastewater treatment facilities, whilst others comprise compounds that require a particular and sophisticated treatment method, such as persistent organics, antibiotics, or metals.

These wastewaters, which are the result of human activities, must be cleaned in order to minimize contamination and safeguard ecological systems, which demands a significant amount of energy. Combining the generation of hydrogen with the elimination of contaminants provides a viable approach for recovering energy from wastewater also while addressing the problem of water contamination. Researchers and technologists have invested substantial time and money in the past few decades working for improved waste water treatment systems combined with hydrogen generation. In fact, hydrogen energy generation by waste water treatment has an opportunity to significantly reduce water pollution and contributing to clean energy, but large-scale hydrogen production via waste water treatment have yet to be accomplished. As a result, the present research offers a bibliometric analysis and comprehensive literature assessment of papers relating to hydrogen synthesis from waste water published in between 2001 and 2020. The findings also emphasize existing conditions and potential developments in the subject, which will continue to be a key area to be investigated by scientists and an effective gauge for sustainable development in the following period.

Keywords: Waste Water Treatment, Hydrogen Production, Effluent, Bibliometric Analysis, Research Hotspot.

Radon concentration (^{222}Rn) in the groundwater of Tropical River Basin, Southern Kerala,India

Anjali N[a]*, Achu A L[a], Resmi T R[b], Girish Gopinath[a]
[a]Department of Climate Variability and Aquatic Ecosystems, Kerala University of Fisheries and Ocean Studies, Kochi 682506, India
[b]Ecology and Environment Research Group, Centre for Water Resources Development and Management(CWRDM), Kozhikode, Kerala, 673 571, India
*681anjulakshmi@gmail.com

Abstract

Radon is a naturally occurring radioactive inert gas found in the earth's crust and is transported to groundwater through soil. However increased amount of radon (^{222}Rn) on groundwater has serious environmental andhealth concerns. In this present investigation, the groundwater in a tropical river basin (Achankovil River Basin (ARB), southern Kerala), flowing through Achankovil shear zone, is analysed to determine radon gas concentration and its relationship with geological structures. A total of 36 groundwater samples are collected considering lithologicaland geomorphological heterogeneity of the ARB, during pre-monsoon season and measured radon concentrations using the RAD7 radon detector. ~25% of the total samples have radon concentration above 11BqL^{-1}. In fact, the measured radon values in the ARB ranges from 0.2 BqL^{-1} to 68.7 BqL^{-1} during pre-monsoon. Moreover, the results show a significant relationship between the radon gas concentrations in the groundwater with the distance of wells from the lineaments. Findings of the present study suggest that the lithological and structural variability of the basin influences the radon concentration in groundwater.

Keywords: Groundwater, Radon, Achankovil river basin, Kerala

Assessment of Water Quality Index for Panchavati Region of Nashik City, Maharashtra

Umare, Shubhangi Niranjan[1], Ajay K. Thawait[2], Sumit H. Dhawane [2]
[1]PhD Scholar, Civil Engineering Department, MANIT Bhopal-462003, INDIA
[2]Assisstant Professor, Department of Civil Engineering, MANIT Bhopal-462003, INDIA
[2]Assisstant Professor, Department of Chemical Engineering, MANIT Bhopal-462003, INDIA
*ershubhangiumare@gmail.com

Abstract

Groundwater quality is essential for ensuring the future, reliable utility of sources for many actions, particularly for domestic, agriculture, industries and many more. Conversely, the increase in intensive agriculture practices, industrialization and urbanization have often caused groundwater contamination due to untreated industrial and municipal wastewater disposal into the adjacent area of the river. Nashik is an important city in northern Maharashtra, known for its Grape Wine industries and the origin of the Godavari River. The study aims to determine the physio-chemical parameters and groundwater quality using the water quality index (WQI) method. The groundwater samples were collected from 30 bore wells from different adjoining areas of the Panchavati region. Numerous Physio-chemical parameters were considered for experimental analysis, such as pH, Electrical Conductivity, Temperature, Alkalinity, Total hardness, Chlorides, Sodium, Potassium, Calcium, Magnesium, Turbidity, and Dissolved Oxygen. The groundwater quality index (WQI) has also been calculated based on the test outcomes. The results reveal that most of the detected chemical parameters of all bore wells significantly exceed the WHO water quality standards due to sewage interference and garbage dumping in the adjoining study area.

Keywords: Groundwater quality, Water Quality Index, Bore well, Godavari River, Panchavati Region

Assessment of Water Quality Index (WQI) and Pollution Mapping of Pashmalyam Lake of Patancheru Industrial Belt Hyderabad

B. Jayadeep[1], Angshuman Das[1], Dudam Bharath Kumar[1]*
[1] Chaitanya Bharathi Institute of Technology (Autonomous), Hyderabad
*dbharath.iitkgp@gmail.com

Abstract

Water is an elixir of life. Extinction of safe water resources poses a pressure on social communities across the world. Availability of drinking water has been observed to be scarce in India like developing country. On this context, water quality assessment is an essential part of urban surface water resources, particularly, lakes situated in urban regions. In this study we analyse the water quality index (WQI) and pollution mapping of the Pashamalyam Lake of Patancheru of mega city Hyderabad, Telangana, India. Observationally analysed parameters encompass pH, Electrical conductivity (EC), Total dissolved solids (TDS), Alkalinity, Hardness, Dissolved oxygen, Chemical oxygen demand (COD) and Biochemical oxygen demand (BOD), which were implemented in calculations of the WQI. Water quality parameters over five sites were studied to diagnose the health of the lake water. Results from WQI analysis show that Site-2 and Site-5 have been found to be relatively highly polluted ($0<WQI<50$) locations compared to Site-1, Site-3 and Site-4 with $WQI>50$. In particular, pH variability exhibits no prominent change across the sites. For instance, TDS, EC and Hardness have high importance while Alkalinity has less importance towards influencing the WQI at Site-2 and Site-5, as these parameters exhibited 3 times higher than those of the other three Sites (1, 3 & 5). However, our findings highlight the predominance of dissolved solids and the negligible levels of dissolved oxygen in the surface water of the Lake. Further complete cleaning is required to perform and stringent policy guidelines to be framed and implemented to combat the eutrophication of this lake. The surface water quality information maps of the entire lake area have been prepared using GIS spatial interpolation technique for the studied parameters. The results obtained in this study and the spatial database established in GIS will be helpful for monitoring and managing groundwater pollution in the study area. Mapping was coded for potable zones, in the absence of better alternative sources and non-potable zones in the study area, in terms of water quality.

Keywords: Lake, WQI.

Evaluation of potentially toxic heavy metal contamination of ground water and associated health risk assessment of inhabitants in the industrial corridors of integrated Vellore district, Tamil Nadu, India

Loganathan K[1]*, Vignesh Rajkumar L[1]
[1]Vellore Institute of Technology
*loganathan.k2020@vitstudent.ac.in

Abstract

Groundwater quality in the integrated Vellore district of Tamil Nadu is being impacted by population growth and industrial pollution. This study evaluates the groundwater quality of the industrial corridors of Ambur, Ranipet, and Vaniyambadi. The degree of heavy metal contamination, human health and environmental impacts in these corridors are analysed using multivariate statistical analysis, contamination factor (CF), and geographic information systems. 42 groundwater samples were collected from open and bore wells and five heavy metals (Cr, Cd, Fe, Pb, and Co) were considered in all three industrial corridors. The t-test results show Cd and Cr concentrations are significantly higher exceeding the WHO limits. CF examines Cd and Cr pollution and the findings reveal highest CF value at Ranipet with 78% and 22%, respectively. The PCA results at Ambur show that EC, TDS, pH, TH, and F have a total variance of 29.33% and a strong positive correlation with Cd and Cr. The PCA at Ranipet shows that Cd and Cr positively correlate with Mg^{2+}, Cl^{-}, TH, and SO_4^{2-}, which comprise 36.64% of the total variance. In Vaniyambadi, EC, K^{+}, TH, and SO_4^{2-} positively correlate with Cd and Cr with a total variance of 27.76%. In Ambur EC, TDS, pH, TH, and F positively correlate with 29.33% cumulative variance. The PCA results at all three industrial corridors manifest that hydrogeochemistry is impacted by anthropogenic and geogenic forces. Health risk assessment shows Cr and Cd significantly impact infants and children for carcinogenic risk (>75%), while adults and children have non-carcinogenic impacts (>65%).

Construction and demolition waste: a review on its role in ground water contamination

Neha S N[1] & M H Prashanth[2]
[1] Research Scholar, Department of Civil Engineering, National Institute of Technology Karnataka,
Surathkal, Mangalore – 575025 (D.K), India
[2] Assistant Professor, Department of Civil Engineering, National Institute of Technology Karnataka,
Surathkal, Mangalore – 575025 (D.K), India
*nehashridhar.227cv009@nitk.edu.in

Abstract

It is widely observed that construction industries around the world not only consume more natural resources and energy, but also generate huge construction and demolition waste. There are some issues associated with the disposal of Construction and demolition waste in landfills. Pre-evaluating wastes to environmental damage at the design stage of building projects could provide an opportunity to understand and minimize potential environmental impacts. Management of C&D waste is still a challenge for urban local bodies. Most cities do not have formal demolition permits and developers hire local contractors for demolition. Even government agencies like PWD invite bids for demolition based on what contractors would pay for recoverable. Although the Construction and demolition waste contains inert materials but some harmful materials such as cement, plaster, metal, wood, plastics etc. could also be present which are detrimental to its immediate surroundings. The disposal of C&D waste in landfills could also contaminate groundwater and surface water. Contaminated surface water may get into to water bodies like ponds and rivers affecting aquatic life as well as animals consuming water directly from the ponds and rivers. These are in turn supplied to households and affect people's health. The excess sediment itself in water can be a problem, but also contaminated discharge from construction activities mixes with soil. A variety of sources can cause soil or sub-surface contamination. Deconstruction activities normally leave behind large debris of materials that may lead to soil contamination. These debris particles can be swept off from site harming the surrounding ecosystem. Further discharge also can directly enter the groundwater. Construction and demolition waste that is dumped in water bodies leads to various detrimental impacts on the environment. Proper management of demolition waste is a complex process and requires systematic thinking and analysis. Many methods have been proposed to study the environmental impact assessment of demolition waste management.

Assessment of Environmental Flow Requirements of the Meenachil River, Kerala

Ansa Thasneem S[1] & Drissia T K[2]
[1,2]Hydrology and Climatology Research Group, Centre for Water Resources Development and Management
Kunnamangalam, Kozhikode-673 571, Kerala, India
*ansathsnm@gmail.com

Abstract

Assessment of environmental flow is important for maintaining the ecological balance, health, and functionality of rivers and their related ecosystems. This study focuses on evaluating the environmental flow requirements of the Meenachil River in Kerala, India. The Meenachil River is a vital water resource supporting various ecological processes and human activities within the basin. Anthropogenic interventions such as sand mining and reduction in tree covers are increasing in the river and its basin in the recent years. In addition, many hydraulic structures are proposed to be built in the river in the coming years. In this context, it is imperative to establish effective regulations for maintaining the environmental flow for ensuring the long-term sustainability of the river and the ecosystem linked with it. In this study, the environmental flow requirements of Meenachil River are estimated using Tennant method, Tessman method and Variable monthly flow method. These three methods calculate environmental flows based on mean annual flow and mean monthly flows, for different seasons of the year. Daily discharge data from the Kidangoor gauging station of Central Water Commission for a period of 33 years spanning from 1986 to 2017 was used for this purpose. The results show that the Tennant, Tessman, and Variable monthly flow methods estimate the average environmental flow requirements of the Meenachil River to be 30%, 43.3%, and 31.5% of the mean annual flow, respectively. The average environmental flow requirements during low flow season are obtained as 10.5 m^3/s, 4.13 m^3/s and 2.48 m^3/s whereas those for the high flow season are obtained as 21.1 m^3/s, 38.67 m^3/s and 29 m^3/s respectively for the Tennant, Tessman, and Variable monthly flow methods.

Keywords: Environmental flow requirements, Tennant method, Tessman method, Variable monthly flow method

Identification of Spectral Band of Phosphorous in Water by Spectroradiometer

Pranav P Bansode[1] & Dr. D. G. Regulwar[2]
[1]Research Scholar at Government College of Engineering Aurangabad, Aurangabad, India)
[2]Professor and Head in Civil Engineering Department at Government College of Engineering Aurangabad, Aurangabad, India
*pranavbansode.9@gmail.com

Abstract

: Phosphorous contamination in water bodies poses a significant environmental concern due to its potential to trigger eutrophication and impair water quality. Efficient and accurate monitoring of phosphorous levels in water is essential for effective water resource management and environmental protection. Spectroradiometry, a non-invasive remote sensing technique, offers a promising approach to identifying spectral bands associated with phosphorous in water, thereby enabling remote monitoring and assessment. This research paper presents a comprehensive study on the identification of spectral bands of phosphorous in water using a spectroradiometer. The study was conducted under open-sky conditions during a sunny day, specifically between 12 pm and 2 pm., employing water samples with varying phosphorous concentrations. An SVC XHR-1024 spectroradiometer was employed to acquire spectral reflectance data over the wavelength range of 350 to 2500 nanometres. The acquired data were analysed to determine the specific spectral bands associated with the presence of phosphorous in water. Our findings reveal distinct absorption features in the spectral domain, indicative of phosphorous presence. Notably, as the phosphorous concentration increases, there is a discernible variation in reflectance values, emphasizing the potential of spectroradiometry for accurate phosphorous quantification. This research contributes to the ongoing efforts in environmental monitoring and opens avenues for the development of robust remote sensing techniques applicable to real-world scenarios. This discovery provides a critical insight into the spectral characteristics of phosphorous, which can be harnessed for remote sensing and monitoring applications. Moreover, this research opens avenues for the development of remote sensing techniques that can contribute to more effective and timely mitigation measures for phosphorous contamination in aquatic ecosystems.

Keywords: Phosphorus identification, Water quality assessment, Spectroradiometer, Spectral band, Remote sensing, Water resource management.

Electrocoagulation Treatment of Landfill Leachate: Influence of Electrodes and Characteristics

V. Ektha [1], A B Biji[2], M Devika[2], R Shalini[2], B Rhul Krishna[2], S Bhuvaneshwari[2], S K Pramada[1]
[1] Department of Civil Engineering [2] Department of Chemical Engineering, National Institute of Technology, Calicut, India
*ekthap_220193ce@nitc.ac.in

Abstract

The electro-coagulation procedure was investigated as a viable treatment approach for electrolytic degradation and decolorization of landfill leachate. Landfill leachate (LL), produced by the percolation of rainwater through landfill leads to severe environmental issues aided by high concentrations of organic and inorganic compounds. The untreated landfill leachate discharged into the surrounding environment needs an effective treatment process. Electrocoagulation is a promising approach for the treatment of untreated leachate, which employs electrical current to coagulate and destabilize, suspended particles and dissolved substances. The present study involves the comparison of the efficiency of two sets of electrodes (aluminium and mild steel), in the treatment of leachate collected from Kozhikode Municipal Corporation, Kerala, India. The increase in dilution enhances the removal efficiency of contaminants through electro-coagulation. The mild steel electrode with 1:20 sample dilution has 34.7 % of turbidity removal and 94.71% of TDS removal. Due to the high toxicity and dissolved contaminants, the landfill leachate is very turbid and it's very difficult to treat using the raw sample. The applied electricity cannot pass through the sample properly. That affects the efficiency and performance of the electro-coagulation treatment.

Keywords: Landfill leachate, Electro-coagulation, aluminium, mild steel, Turbidity, TDS.

Soil Pollution and Ecological Risk Assessment in the Thai Binh Mangrove System of Vietnam

Nguyen, Bich Thi Ngoc; Kansal, Mitthan Lal*
1Water resource Development and Management
2Indian Institute of Technology, Roorkee
*mlk@wr.iitr.ac.in

Abstract

Mangroves act as a sink for both organic and inorganic contaminants/pollutants. The soil of the mangrove systems plays a vital role in maintaining coastal ecosystem health and nutrient cycling. Contaminants that are released by commercial, aquaculture, and agricultural operations find their way to the soils of the mangrove system. Like any other system, the soil of the mangrove system also has a specific carrying capacity beyond which the functions of the soil get affected. This study focuses on assessing soil pollution and its potentially harmful effects on the ecosystem in Vietnam's Thai Binh Mangrove systems. It is on the west coast of the Gulf of Tonkin and has geographical coordinates from 20013'27" to 200 38'59" North latitude and 106035'00" to 106040'10" East longitude with a coastline of 54 km. In 2022, mangrove soil samples were collected at 20-30 cm depths and analyzed for various parameters such as heavy metals, pH, and nutrients. Cluster analysis was carried out to divide the whole study area into various clusters based on the properties of the tested parameters. In addition, the Pollution Load Index (PLI) was used to characterize the pollution status of the soil. Furthermore, the Ecological risk index (RI) is calculated to study the impact of soil pollution on mangrove ecosystems. The sample analysis of the sample found that mean concentrations of iron, copper, manganese, lead, and mercury are 14.78 mg/kg, 83.48 mg/kg, 259.80 mg/kg, 54.50 mg/kg, and 0.17mg/kg, respectively. pH ranged from 2 to 6, phosphate was up to 1 g/kg, the highest ammonium was observed up to 0.54 g/kg, and the carbon concentration was around 2.3%. The statistical analysis is carried out through XLSTAT and SPSS 26. The analysis shows that the Thai Binh mangrove ecosystem is between low to medium risk. It is hoped that the study will be helpful in preparing a strategic road map for natural resource management in the coastal region of Vietnam.

Estimation and modelling of groundwater contaminants in Uttarakhand's hilly state

Rahul Raj[1], Muskan Mayank[2], Laiju A. R.[3]
[1]Research Scholar, Department of Civil Engineering, NIT Uttarakhand, Srinagar, Garhwal-246174, India
[2]Assistant Professor, Department of Civil Engineering, NIT Uttarakhand, Srinagar, Garhwal-246174, India
[3]Assistant Professor, Department of Civil Engineering, NIT Trichy, Tamil Nadu-620015, India
*rahul.rajphd2021@nituk.ac.in

Abstract

Groundwater pollution is a major concern closely linked to environmental preservation and water needs. The Himalayan state of Uttarakhand's surface and groundwater quality is degrading due to development activities, geological factors, and the mixing of industrial wastes. During transport, soil water content and solute concentration distribution are mainly governed by the preferential flow paths in the unsaturated porous medium. The four harmful toxic metal ions viz. arsenic, cadmium, chromium, and lead have been found in the drinking water sources in most of the district for Uttarakhand State. Out of these, toxic lead and chromium are found mainly responsible for causing health problems. The health features of lead metal ions have been assessed through laboratory experiments in accordance with the stipulated limits as recommended by the Bureau of Indian Standards (BIS) and the World Health Organization (WHO). This paper also discusses the estimation of lead metal contamination by developing regional transport models for the movement of lead contaminants in both spatial and temporal domains.

Keywords: preferential flow, toxic metal ions, regional transport models

Correlation of Geogenic Iron concentrations in Groundwater with Groundwater level in the Kadalundi River Basin Kerala

Raicy M C[1*], P.V. Nihil[2], C D Aju [2], A L Achu[2], Priju Chungath[1], Arun P R[1]
[1]Centre for Water Resources Development and Management, Calicut, Kerala, India
[2]Department of Climate Variability and Aquatic Ecosystems, Kerala University of Fisheries and Ocean Studies, Kochi.
*raicymc@cwrdm.org

Abstract

Iron (Fe) is a common element found in natural water sources, including groundwater. The groundwater and river water in Kerala have a relatively high content of iron. This research abstract presents a comprehensive analysis of the spatiotemporal variations of iron in groundwater, and the processes governing the occurrence in groundwater systems. The study was carried out in the Kadalundi River Basin, North Kerala, India. The Kadalundi River is one of the four major rivers located in the northern part of the Indian state of Kerala, covering an area of approximately 1122 square kilometers. As Angadippuram, the type area of Laterite is located within the basin the aquifer formations are rich in iron and aluminum. The excess iron leaches into ground water as rainwater infiltrates the soil, and the underlying geologic formations dissolves the iron, resulting into the seepage or iron into the aquifers. As little iron concentration as 0.3 mg/l can cause the water to turn a reddish-brown color. As part of the study, the concentrations of iron in groundwater from open wells were observed during four seasons annually from 2018 to 2022 and two seasons in 2023. The overall iron concentration ranges from 0 to 12 mg/l with the maximum concentration observed during 2019. After the flooding in 2018, the iron concentrations in groundwater increased in the river basin, especially towards the western parts. Based on the findings of the study, the concentration of iron gradually increases immediately after the rainfall, which can be attributed to the redox reactions prevalent during the recharge process and the groundwater flow. However, based on the lithotypes in the basin, the rates of dissolutions processes vary with maximum dissolution observed in the lateritic soils. This study consolidates the available information on the geochemical processes governing iron occurrence, mobilization, and transformation in aquifer system which may be used for addressing iron-related challenges in drinking water supplies in North Kerala.

ater Quality Assessment and Designated Best Use (DBU) determination of Ganga River, Kanpur

Jaiprakash Nayak[1], Reena Singh1 & Rajiv Ganguly[2]
[1]National Institute of Technology, Patna, India, [2]Harcourt Butler Technical University Kanpur, Uttar Pradesh, India
*jaiprakashn.ph21.ce@nitp.ac.in

Abstract

There exist different water sources on Earth's surface like oceans, rivers, springs, lakes, and ponds, but not all of them are useable for all purposes. In Indian context, the Central Pollution Control Board (CPCB) has formulated the concept of Designated Best Use (DBU) wherein the surface water quality is classified in five categories (A to E) dependent on the fulfilment of criteria in that particular category. The current study's primary goal is focused on the determination of DBU on stretch of Ganga River in Kanpur city, India. For study purposes, monitoring was carried out in 8 locations of the selected stretch of the study for Ganga River. The samples were collected two times in the month during the IInd week and IVth week during the post monsoon season (November 2022 to February 2023) from the upper surface by using grab sampling of the eight selected monitoring locations covering the study stretch and were examined to determine the values of various parameters which help in DBU classification. It was observed that sampling sites cannot be classified for any of the existing DBU conditions because of high concentration of BOD which exceed permissible limits for all of the DBU classifications. This implies that without treatment of the existing organic pollution in the selected stretch of study, the surface levels of Ganga River are unsuitable for any practical use. The selected surface water stretches though unusable for any of the existing categories of DBU maybe used for non-contact recreational purposes like boating, but suitable treatment is required for the selected stretch of study.

Keywords: DBU, CPCB, Surface Water, River Water Quality Parameters

Satellite Based Water Quality Monitoring Using Google Earth Engine

Phani Srinivas Reddy Penumallu[1], Shashi Mesapam[2] , Ayyappa Reddy Allu[3]

[1]PG Student, Department of Civil Engineering, NIT Warangal, India,

[2]Associate Professor, Department of Civil Engineering, NIT Warangal, India,

[3]Research Scholar, Department of Civil Engineering, NIT Warangal, India,

*aa721015@student.nitw.ac.in

Abstract

Monitoring water quality is essential for maintaining and managing freshwater environments. Traditional field-based techniques for evaluating the quality of the water can be expensive and time-consuming. In this work, water quality for Waddepally Lake, Bhadrakali Lake, and Dharmasagar Lake is analysed and monitored using a satellite-based technique using Google Earth Engine (GEE). The study retrieves multispectral data for the study area using Sentinel2 satellite imagery that is accessible on GEE. In order to capture temporal variations in water quality, the imagery is filtered according to the borders of the lakes. Various parameters such as chlorophyll, suspended solids, turbidity which effect water quality are calculated using indices such as Normalized Difference Water Index (NDWI), Normalized Difference Chlorophyll Index (NDCI), Normalized Difference Turbidity Index (NDTI), Total Suspended Solids (TSS), and Colored Dissolved Organic Matter (CDOM) in GEE platform. A geographical representation of patterns and changes in water quality over time is possible through visualization of the estimated water quality indices on the GEE map interface. The findings show the potential for quick and affordable assessment of numerous water quality indicators in the research area using satellite-based water quality analysis and monitoring using GEE. The study established a relationship between surface reflectance and water quality parameters using different indices like NDCI, NDTI, CDOM and TSS.

Keywords: Water Quality, Indices, Google Earth Engine, Total Suspended Solids.

Automated Satellite-Derived Shoreline Change Analysis along the Coast of Andhra Pradesh using Public Domain Satellite Imagery

G.Bala Rajeev Sandeep Reddy[1] , Dr.Muni Reddy.M.G[2] & Aruna Kumar Avula[3]
[1]Scholar, Civil Engineering, Andhra University, Visakhapatnam, India.
[2]Professor, Civil Engineering, Andhra University, Visakhapatnam, India.
[3] Scientist-E, (Coastal and Environmental) National Institute of Ocean Technology, Chennai, India.
*balarajeev512@gmail.com

Abstract

This paper presents a fully automated methodology for extracting time-series of monthly shoreline changes along the sandy beaches of the Ongole coast in Andhra Pradesh, India, from 2000 to 2023 using publicly available satellite imagery. The methodology involves the identification of sandy coastline sections within the region of interest, creating cross shore transects automatically at each site, and utilizing the open-source global shoreline mapping toolbox called CoastSat. The CoastSat tool is employed to extract time-series of shoreline change at each transect. To account for variations in tide levels among satellite images, the final step includes tidally correcting the shoreline change time-series using predicted tide levels and an image-derived estimation of the average intertidal beach slope.

Keywords: satellite imagery, shoreline change, Ongole coast, Andhra Pradesh, CoastSat, automated methodology, timeseries analysis.

Coastal Vulnerability Assessment Along West Coast of Maharashtra India- Using Geospatial Methods

Jugdambe Sharma [1], R S Mahendra[3] and K Venkata Reddy[2]
[1]Indian Institute of Technology (Indian School of Mines) Dhanbad
[2]National Institute of Technology, Warangal
[3]Indian National Centre for Ocean Information Services
*bhanusharma@thdc.co.in

Abstract

The zones of coastal part of Maharashtra are spanning in the west central part of Indian peninsula, are potentially vulnerable to accelerated erosion hazard. Along the 720km of coastal Maharashtra, most of the areas, including tourist resorts, hotel, fishing villages, towns, are already threatened by recurring storm flood events and severe coastal erosion. The present study is therefore an attempt to develop Coastal Vulnerability Index (CVI) for the Maharashtra using eight risk variables, using geospatial methods. The base data for some of these parameters is from remotely sensed data and for others it is either from long term in-situ measurements or from numerical models. Vulnerability is identified and shown on a map. CVI map prepared for Maharashtra coast in this study can be used by the state and district administration involved in the disaster mitigation and management plan.

Keywords: Coastal Vulnerability Index (CVI), Coastal zone, Hazard, Sea level, Risk.

Crop phenology mapping and crop yield prediction using Satellite Images

Sunil Kumar[1], Shashi Mesapam[2], ~~Allu Pavan Kumar Reddy~~[3]
[1]PG Student, Department of Civil Engineering, National Institute of Technology, Warangal, India[2]Associate Professor, Department of Civil Engineering, National Institute of Technology, Warangal, India [3]Research scholar, Department of Civil Engineering, National Institute of Technology, Warangal, India
*ap22cer2r05@student.nitw.ac.in

Abstract

Crop yield prediction is very important for agricultural planning, allocation of resources, and food security. So correct information regarding crop growth stages and yield estimation is crucial for effective decision-making and to ensure sustainable agricultural practices. In recent years, remote sensing data and machine learning techniques have become the valuable tools for monitoring and predicting crop phenology and yield. The research location is situated in Sahori village, Alwar district in the state of Rajasthan. The target crop for this project is wheat, and it aims to develop a complete plan to map crop growth stages and forecast crop production using data from sentinel 1 and sentinel 2 and an artificial neural network algorithm. In order to identify the growth phases of the wheat crop, the Normalized Difference Vegetation Index (NDVI) time series and the backscatter time series for each cropping season from 2018 to 2023 were firstly analyzed. From sentinel 2 and sentinel 1 satellite data, the NDVI time series and backscatter time series were created in the google earth engine. The processed time series data were then used to extract phenological metrics including season duration, maximum NDVI and amplitude of NDVI curve. Insights about the duration of wheat cultivation's growing period were derived by determining the length of the growing season. Additionally, the maximum NDVI value, a vegetation health indicator, was obtained, enabling for the characterization of crop health during the growing season. An Artificial Neural Network (ANN) model was developed to predict crop yield using data from multiple cropping seasons from 2018 to 2022. The extracted data from NDVI time series and Backscatter time series was used to train and validate the model. Along with the obtained phenological metrics and other relevant environmental and meteorological variables were also included in the ANN model. By understanding the intricate relationships between these variables, the algorithm was able to forecast wheat production with an efficiency of 72.48%.

Keywords: Normalized Difference Vegetation Index (NDVI), Crop Phenology, Crop Yield, Time Series, Google Earth Engine, Artificial Neural Network (ANN).

Generation of High-Resolution Digital Elevation Model (DEM) of a Large-Scale Laboratory Setup for Hydraulic Simulations

R. Reshma[1] & S.N. Kuiry[1]
[1] Indian Institute of Technology Madras, Chennai, India
*reshmaradhakrishnan094@gmail.com

Abstract

Large-scale physical model studies are necessary to ensure the performance of prototype structures. Though laboratory constructions are usually carried out using several ground control points (GCPs), a high-resolution digital elevation model (DEM) of the physical model is required to perform numerical simulations for various scenarios to reduce the cost and time of physical model studies. In addition, they are also required for accurate and reliable simulation of real-time flood and storm events, hydrologic-hydraulic modeling of river flows, and morphological analysis of rivers. Photogrammetric techniques coupled with high-end image analysis technologies have made the generation of DEMs of required resolution less tedious. This work presents a detailed stepwise methodology to generate a very high-resolution DEM (i.e., three-dimensional model) of a large laboratory setup employing digital single lens reflex (DSLR) imagery, Structure-from-Motion (SfM) Multi-View-Stereo (MVS) processing, and welldistributed GCPs and check points (CPs). Good quality (image quality ≥ 0.5) and overlapped (about 80% in both directions) images are captured using overhung wide-angle lens DSLR cameras, which are later processed using the SfM-MVS approach in the commercial software package Agisoft Metashape. A 1 mm resolution DEM of the 15 m × 4 m laboratory setup is generated herein. A total of 80 GCPs and 32 CPs are used for proper orientation and fine refinement of the DEM. The 2.5D geometry in the form of DEM can be used to carry out numerical modeling. An illustration of the same is presented using HEC-RAS, one of the most adopted hydraulic simulation platforms.

Keywords: Agisoft Metashape, Digital Elevation Model, Ground Control Point, Physical model, Hydraulic Simulation, CloseRange Photogrammetry.

Optimization of Dredged Material Dumping Ground Location for Kokan Lng Private Limited

Shivani Sahu[1] V.B. Sharma[2] Dr. Prabhat Chandra [3]
[1]Scientist "C", Central Water and Power Research Station, Khadakwasla, Pune-411024;
[2]Scientist "C", Central Water and Power Research Station, Khadakwasla, Pune-411024;
[3]"Additional Director", Central Water and Power Research Station, Khadakwasla, Pune-411024;
*sahushivani.cwprs@outlook.com

Abstract

The challenge of finding suitable locations for dredged waste disposal facilities has intensified in recent times. The dumping ground is selected based on the crucial aspect that the dumping materials neither re-enter in the approach channel nor does it have any adverse impact on coastline or other marine facilities in close proximity. This paper focuses on the economic dimensions of the challenges related to dredged waste disposal for Kokan LNG Private Limited, located at about 4 km southward from the mouth of river Vashisthi at Anjanwel, Maharashtra. The regular dredging is carried out to maintain the -14.3m depth of approach channel. All the dredged material is being disposed at the existing dumping ground area located at about 9.5 km from the turning circle. Based on Mathematical model results, two proposed dumping ground locations were recommended at much shorter distances of 5.5 km and 4.7 km.

Keywords: Tide, wave induced currents, navigational channel, Dredged material and Dumping ground location

Oil Spill Modelling for Mormugao Port – A Case Study

V.B. Sharma[1]; Dr. Prabhat Chandra[2]

[1]Scientist "C", Central Water and Power Research Station, Khadakwasla, Pune-411024;
[2]Scientist "Additional Director", Central Water and Power Research Station, Khadakwasla, Pune-411024;
*vipin_bihari@yahoo.com

Abstract

It is proposed to develop a Petroleum Oil and Lubricant (POL) jetty in Vasco Bay at Mormugao Port, Goa. In this regard, the oil spill studies were carried out to simulate various scenarios which could be useful in case of any mishap. The currents in the vicinity of Mormugao Port are of the order of 0.3m/s and flow is unidirectional for most of the period. MIKE-21 HD software has been used to simulate the flow conditions. In order to incorporate wave induced currents, radiation stresses were supplied to MIKE-21 HD model and model was calibrated for field observed currents. The output of MIKE-21 HD model was supplied to Oil spill model MIKE – 21/3 OS. The field observations of oil trajectories caused due to collision of two ships in March 2005 in the vicinity of Mormugao port were used to calibrate the oil spill model. The studies were carried out for both monsoon and non-monsoon periods for oil spill at different locations in the Mormugao port area. The basic physical parameters of oil were considered; viscosity 365.8 cST (centistokes), density 997.9 Kg/m^3 and the API grade 13.12. The present studies for development of POL jetty in the Vasco bay indicated that within 12hrs of oil, about 27% oil gets evaporated while in next 12hrs the evaporation would be of the order of 3 %. It was also observed that 37% Heavy Fuel Oil (HFO) evaporates during period of 5days. The studies also indicated that about 65% water in oil emulsion takes place in 24hrs which goes up to 90% in 3 days. The accident locations for Oil spill were considered at Vasco bay near POL jetty which is enclosed from three sides and another at the entrance channel. The studies indicated that for Vasco bay location, the oil would remain in the basin for about 3 days and then after, it would come in an open sea, thus having minimum adverse impact on the environment. At the entrance channel, the oil trajectory would move along the coast and this would have the most adverse impact on the nearby areas too. These studies would help in deciding the appropriate mitigation measures.

Keywords: Trajectory, MIKE-21/3 Oil Spill, ADIOS, Flow Model

Assessment of the Water Quality of Important Wetlands in Tripura, India using the Water Quality Index

Diptanil Chakraborty[1], Tilottama Chakraborty[2], MD. Parvez[1], Abhijan Debbarma[1]& Koushik Dewan[1]
[1]Civil Engineering Department, National Institute of Technology, Agartala, India
[2]Hydro-Informatics Engineering (under Civil Engineering Department), [1]National Institute of Technology, Agartala, India
*tilottama86@gmail.com

Abstract

Wetlands play a crucial role in boosting biodiversity in diverse ecosystems and food accessibility. It supports numerous species and has economic, social, and ecological benefits. The wetlands are habitat for a wide variety of species, including a few rare and endangered ones. Through fishing, tourism, and the gathering of aquatic plants, the wetlands provide a living for a significant portion of the local population in Tripura. The wetlands' water quality in Tripura is crucial from an ecological and financial standpoint. In particular, wetlands are important for Tripura because the state is located in a region that is prone to flooding. Wetlands can help to mitigate the effects of flooding by absorbing excess water and releasing it slowly over time. This can help to protect people and property from damage. The present study analyses the water quality of the four important wetlands of Tripura, including one Ramsar site, during the last 3 years in terms of the water quality index. In this study, electrical conductivity, pH, temperature (T), total dissolved solids, dissolved oxygen (DO), turbidity, hardness, biochemical oxygen demand (BOD), chemical oxygen demand (COD), and chloride of four major wetlands were analysed. WQI was calculated using the weighted arithmetic index approach. The current study indicates that the wetlands (Rudra Sagar Lake (Ramsar Site), Sepahijala Lake, Laxmi Narayan Bari Lake, and M.B.B. College Lake) water quality is deteriorating and unfit for drinking without treatment. The statistical analysis of the parameter distribution has also been conducted in the present study.

Keywords: Water quality index, Water quality assessment, Statistical analysis, Wetlands, Tripura, India.

Analysis of oval shaped sewer system of proposed NIT campus at Bihta, Patna using SWMM

Malti Mardi[1], Sunil kumar Murmu [1]
National Institute of Technology Patna
*maltim.ph21.ce@nitp.ac.in

Abstract

Sewer system plays an important role in the modernization of a country. Sewers are designed to evacuate wastewater generated from different spaces to make the surrounding clean. Ananalysis on oval shaped sewer because lower section of it is used in case of less discharge or rainfall and upper section is used in case of high discharge or rainfall. In this study a SWMM model is used to study the drainage network for the BIHTA campus of NIT Patna, India. There are 12 sub-catchments that make up the entire campus. The model is run with a return period of 50 years and designed storm intensity intervals of 1 hour. Assisted frequency analysis using the most accurate distribution IDF curves employ the Gumbel distribution, which has a 50-year return period and frequency values. The IDF curves are used to find storm intensity and to evaluate peak runoff from each sub catchments. Comparison of oval shape sewer with other shape sewer i.e., circular and trapezoidal, it is observed that oval shape sewer gives slightly higher velocity at low flow condition. The calibration results confirmed the accuracy of the model simulations. The results indicate that the entire campus is not affected by floods when the study is conducted for a return time of 50 years at intervals of 1-hour planned storm strength. Additionally, the results show that there are no flooded nodes across the entire campus.

Keywords: SWMM, NIT Patna, IDF Curves, Storm intensity, Oval shaped sewer,

Development of an integrated design methodology for accelerated delivery of In-village water supply systems using PCSWMM and GIS techniques.

Sri Ranga K M[1] & Shyam Prasad S[1]
[1]Clear Water Dynamics, Bengaluru, India
*sriranga@clearwaterdynamics.com

Abstract

Jal Jeevan Mission (JJM), launched on August 15th, 2019, is an initiative of the Ministry of Jal Shakthi, Govt of India. This initiative has envisioned providing treated drinking water to all the rural households of 190 million through tap connections by 2024. The government agencies encouraged designers to conceptualize and develop integrated and innovative design mechanisms using emerging technologies to meet accelerated targets. The explanation contained within details an innovative design mechanism, enmeshing drone survey, digital elevation models, orthomosaic imagery, digital village maps, and pipeline network into a single geographic information system (GIS) enabled graphic user interface (GUI) in PCSWMM software to design water distribution network using US EPA EPANET engine. With this design methodology, detailed design reports for over 625 habitations were prepared in record time. The design reports submitted have positively impacted 750,000 people or 190,000 households.

Keywords: Drone Survey, Digital Elevation Model, Orthomosaic Imagery, Distribution Network Design, PCSWMM, and GIS.

Fabrication and Performance Analysis of Graphene oxide Based Polymeric Membranes in Water Desalination

Archana Janai[1], Veena S. Soraganvi[2*], N. A. Jayalatha[3]
Civil Engineering Department, Basaveshwar Engineering College, Bagalkote, Karnataka, INDIA,
*najayalatha@gmail.com

Abstract

Rapid population growth and industrialization had led to global water scarcity. Due to lack of long-term sustainable water management plans, both surface and availability of groundwater has been reduced, concerning to both quality and quantity. To overcome these problems there is a requirement for the improvement in technologies available for the treatment of water and desalination. Membrane-based technologies are attractive due to their most economical and efficient methods. Nowadays Graphene Oxide nanomaterials are popular in sectors of purification and separation and separation due to their tuneable unique properties. In the present work Graphene Oxide/Polysulfone (GO/PSF) and Graphene Oxide/Cellulose Acetate (GO/CA) membranes were prepared by non-solvent induced phase separation method and desalination experiments were performed. 2, 4 and 6 ml of GO concentration in the 20ml PSF-NMP solution were used in the GO/PSF membrane fabrication and 1wt % GO was used in GO/CA membrane fabrication. The GO/CA membrane with initial TDS of 10,000 mg/L resulted in 21.28% of salt removal, giving a flux of 19.70 L/m^2.h, and water uptake capacity of 94.5% with 0.0083 µm of pore size, whereas the GO/PSF performed in the range of 9-11 % removal for the same initial TDS. The PSF membrane with GO concentration of 2 ml shows maximum removal efficiency of 42.4% of TDS, when initial TDS was 1,000 mg/L giving a flux of 57.17 L/m^2.h. The membrane water uptake capacity was 98%, and its pore size ranges from 0.043 µm to 0.044 µm. From SEM images of the membrane, the solid particles accumulation is less in PSF membrane containing 2 ml of GO when compared to membranes containing 4 and 6 ml of GO.

Keywords: Desalination; Graphene Oxide; Polysulfone; Cellulose Acetate; Phase Inversion; Nanomembrane, Vacuum filtration

Investigation of Scour around Spur Dikes through Numerical Simulation using FLOW-3D

Guguloth Saikumar[1*], Vooke Sirivennela[2], Manish Pandey[3], Sanjeev Kumar[4]
[1*] Research Scholar, National Institute of Technology Warangal, Warangal, 506004
[2]National Institute of Technology Warangal, Warangal, 506004
[3]Assistant Professor, National Institute of Technology Warangal, Warangal, 506004
[4]Graphic Era Deemed to be University, Dehradun
*gs712006@student.nitw.ac.in

Abstract

Improper river training works can lead to hydraulic structural failure, which can be addressed by preventing bank erosion and enhancing river alignment. Several popular and cost-effective approaches to control scouring and protect against erosion include spur dikes, revetments, riprap constructions, concrete armor, gabion mattresses, and other hydraulic structures. This study focuses on developing a numerical model using FLOW-3D software to characterize the changes in the channel flow pattern and bed formation induced by spur dikes, which are commonly used hydraulic structures to prevent bank erosion and enhance river alignment. The simulations were conducted using three different turbulence models, namely the k-ε, RNG, and LES models, to solve the 3D Navier-Stokes equations. The numerical results were validated using data from experimental studies on a flat, scoured bed. The squared correlation coefficients between the simulated and observed scour depths were found to be 0.98, 0.97, and 0.92 for the RNG, k-ε, and LES models, respectively. The findings indicated that the simulated results of the mean flow field agreed well with the experimental data. The RNG model was effective in estimating the flow field around spur dikes compared with k-ε, and LES models. Further research and analysis using the validated numerical model could contribute to an improved understanding of hydraulic structural failure prevention and river alignment enhancement.

Keywords: River training works, Scouring, Spur dikes, Numerical model, FLOW-3D.

Storm Surge and River Flow Interaction during Cyclone Amphan in The Hooghly Estuary

Vikram Pratap Singh[1], B. Sridharan[2], Tirtha Roy-Biswas[3], Dhrubajyoti Sen[4] & Soumendra Nath Kuiry[5]*
[1]Indian Institute of Technology Madras, Chennai, India
[2]Indian Institute of Technology Madras, Chennai, India
[3]Indian Institute of Technology Bhubaneswar, India
[4]Indian Institute of Technology Kharagpur, India
*snkuiry@civil.iitm.ac.in

Abstract

The phenomenon of storm surge and river interaction in estuarine systems is a multifaceted process affecting both dynamics and behaviour of water bodies. The present investigation aims to scrutinize the interaction between the surge and river flow during Cyclone Amphan in May 2020 in the Hooghly Estuary. The influence of river discharge on the propagation of tidal waves during the event is also investigated. To this end, a shock-capturing finite-volume based in-house model IROMS-C2D is employed to simulate the surge-river dynamics during the cyclone event. The model solves the governing equations of shallow water equations for the river flow with additional forcing terms such as wind pressure and stress and Coriolis for surge propagation. Unlike the commonly adopted loosely coupled models for the two processes, IROMS-C2D simulates the river-surge flow interaction in an integral way. The model is set up for the Hooghly River from the Open Ocean to Triveni of the Bay of Bengal. The computational domain is defined by triangular grids with river and ocean bathymetry. The inflow at the upstream of Hooghly River, water level variation at the ocean boundary, and the Amphan track with its parameters are given as inputs to the model. The analysis reveals that the surge-river interaction in the Hooghly estuary during the Amphan cyclone was marked by a convoluted interplay between surge, river discharge, and tidal dynamics. Specifically, the discharge along the river significantly impacted the surge penetration along the river, with higher discharge rates leading to reduced surge penetration and vice versa. This behaviour can be attributed to the combined effect of river discharge and tidal dynamics, which regulate the magnitude and direction of the flow in the estuary. The model mimics the propagation of tidal waves and provides estimations of the velocity magnitude during a cyclone despite using a depth-averaged velocity profile. The research suggests that the developed model is a valuable and cost-effective tool for describing the surge-river interaction, coastal inundation, and complex flow dynamics in the estuary during a cyclonic event and could be used to support field observation. The present study contributes to a comprehensive understanding of the mechanisms underlying surge-river interaction in estuarine systems during extreme weather conditions. The findings have substantial implications for predicting and mitigating storm surge impacts in the Hooghly Estuary and other similar coastal-riverine systems. The outcome of the study can inform the development of more robust and effective early warning systems and disaster management strategies that safeguard people and coastal infrastructure during severe weather events.

Keywords: storm surge and river interaction, IROMS-C2D, shallow water equations

Sediment removal from Durgapur barrage pond, West Bengal using Physical model studies

Jotsana G. Ambekar[1], B. Raghuram Singh[2] & Dr. R. G. Patil[3]
[1]Scientist 'B', Central Water and Power Research Station, Pune - 411024, India
[2]Scientist 'C', Central Water and Power Research Station, Pune - 411024, India
[3]Scientist 'E', Central Water and Power Research Station, Pune - 411024, India
*jotsana.ambekar@rediffmail.com

Abstract

Sedimentation is one of the most severe problems that affects reservoir`s efficiency. The storage capacity and consistency of the water supply of reservoirs is reducing due to sediment deposition. The successful management and operation of water resource projects are essential to maintain their functions. This technical paper presents the studies conducted for various alternatives of gate regulation for removal of silt from the Durgapur barrage pond was constructed across river Damodar at Durgapur, Bardhaman district, West Bengal. The capacity of barrage pond has substantially reduced due to siltation which has adversely affected the functioning of the barrage as balancing reservoir. Over the period, the barrage pond has got silted up and large sized shoals are formed upstream of the barrage. Model studies were conducted on a physical model constructed with geometrically similar scale of 1:80 at CWPRS, Pune. The observed velocities near shoals at different gate regulations are not effective in achieving complete flushing of shoals from the pond. The shoals have hardened over years and thick vegetation with grass, trees and bushes have grown on shoals. It is very difficult to disturb material in these shoals by using gate regulation alone. Project Authorities are recommended to go for other alternatives of removing silt from the barrage pond like construction of pilot channel and dredging of silt by using mechanical dredgers. These alternatives would be studied after practical considerations by the project authorities including any other alternatives also.

Keywords: Balancing reservoir, water level, velocity, barrage, shoals, gate operations etc.

Quantification of Sedimentation in Reservoir Affecting Urban Water Supply Requirement

Tulshidas M. Jibhakate[1] &Yashwant B. Katpatal[1]
[1]Visvesvaraya National Institute of Technology, Nagpur, India
*tulshimj@students.vnit.ac.in

Abstract

Urban cities rely on reservoirs, lakes, and groundwater supplies for their household and industrial water needs. A reservoir is one of the most significant water bodies that meets the current water demand in cities. The population of cities is growing fast as a result of urbanisation, which raises the daily water consumption demand. Sedimentation is the deposition of silt or sand particles caused by a stream's or river's water flowing slower or becoming stagnant because of an obstacle like a dam, weir, or barrage. The reservoir's capacity for gross storage (dead and live) is being decreased by sedimentation. Reservoirs had some original storage capacity when first impounded, but that capacity will be reduced over time owing to sedimentation. To meet the demand of the current population, revised storage capacity, i.e., current water storage, should be taken into consideration. The spatial approach is widely used to estimate a reduction in live storage (also known as useful storage) capacity. Sediment deposition may be assessed, which helps determine the reservoir's current water storage capacity. A periodic comparison of the original and revised elevation capacity curves should be established. Based on the water availability in the reservoir, future planning can be made to supply the city's water demand.

Keywords: Urban city, Reservoir, Sedimentation, Spatial approach, Live storage capacity, Elevation capacity curve.

Siltation Study of Storage Reservoir at Ordinance Factory, Khamaria, Jabalpur, M.P using Hydrographic Survey System - A Case Study

M S. Bist[1], M. Selva Balan[2], Ajay Sonawane[3]and K Subbarao Murthy[4]
[1] Scientist-D, Central Water & Power Research Station (CWPRS), Pune, India
[2] Scientist-E Central Water & Power Research Station (CWPRS), Pune, India
[3]Assistant Research Officer, Central Water & Power Research Station (CWPRS), Pune, India
[4]Assistant Engineer, Central Water & Power Research Station (CWPRS), Pune, India
*msbist1974@cwprs.gov.in

Abstract

The storage reservoir in Ordinance factory Khamaria (OFK), Jabalpur, M.P is a natural pond having area 200 m x 200 m and average. depth of 4.00 m is located near Gate no. 3 in OFK campus. This storage pond has been catering the need of water supply needed for day-to-day activity in the ordinance factory. The Joint General Manager, Ordinance factory Khamaria (OFK), Jabalpur, Govt. of M.P. requested CWPRS, Pune to work out the modalities for carrying out hydrographic survey for siltation study of their storage reservoir. The study was required for planning of desilting, digging and augmentation of storage reservoir for enhancing their capacity. Consequently, the CWPRS team carried out hydrographic survey of storage pond located at OFK, Jabalpur during April 2022.

The hydrographic survey was carried out to estimate the reservoir storage capacity and other parameters such as sedimentation, depth capacity curve, etc. Accordingly, the hydrographic survey was conducted by using single beam dual frequency (210 KHz and 33 KHz) echo-sounder and Differential Global Positioning System. The studies were conducted using Integrated Bathymetric System (IBS) with 10 m grid interval covering an area of 40,000 sq.m. For data analysis, contours of reservoir bed at 0.5 m interval, Live capacity of the reservoir and Sediment Volume of the reservoir were plotted. The analysis was carried out using software such as Hypack, Eiva-Navisoft , Surfer, Google Earth, Auto-CAD etc. The contour @ 0.5 m interval was prepared till FRL. It was found that the present storage capacity of storage pond was 115057.7 m^3 at survey level and at maximum water level (i.e. 0.5 m more than surveyed level) it was 138839 m^3 which was found to be 13% loss in the storage capacity of the pond with respect to original storage capacity

Keywords: Bathymetry, DGPS, Echo-sounder, HYPACK, Surfer, Sedimentation, capacity elevation curve

Scour Reduction by Slits Around Bridge Piers

Mohd. Athar[1], Mohd. Luqman[2] and Humaira Athar[3]
[1]Professor, Civil Engineering Department, A.M.U., Aligarh, Uttar Pradesh-202002,
[2]M. Tech. student, Civil Engineering Department, A.M.U., Aligarh, Uttar Pradesh-202002
[3]Scientist, Innovative Building Materials Division, CSIR-CBRI, Roorkee, Uttarakhand-247667
*matharalam58@gmail.com

Abstract

One of the major factors in bridge collapses known as occurring globally is local scouring around bridge piers, which has a significant impact on the overall cost of construction and maintenance. The scour depth around bridge piers should be as minimal as possible for safe and cost-effective bridge design. An analysis of scour reduction/protection techniques such as riprap placement around piers, arrays of piles in front of piers, collars around piers, submerged vanes, fins that look similar delta wings in front of piers, slots through piers, partial pier groups, and hexagonal pattern frames placed around piers have been tested in recent past by many investigators. Many mathematical relationships and graphical results have been presented to get proper insight for scour reduction using field data and laboratory model testing.

In present investigation a new technique in the form of provision of slits in the body of piers facing the main flow has been proposed and tested in the small-scale model of bridge piers in the laboratory. For this purpose, a constant diameter circular cylindrical vertical pier mounted in the sandy bed of uniform sediment size. Data for scour was collected for a constant discharge in the channel using constant opening area of slit but locating in the pier at various vertical location one by one. The data were collected at various locations of slit at various faces of pier. The results were presented by means of graphs. It is found that scour is time dependent for all sets of runs. Also, it is found that certainly slits provision inside the pier is plays an important role in scour reduction. The best and optimum location of slits is either at the bed or one cm above the bed. The results of scour reduction by slits are also compared with that of collars.

Keywords: Scour depth, Scour reduction, Bridge pier, Slits, Collars.

Hydrodynamics and Sedimentation Studies for the Development of RO-RO jetty at Revdanda, Raigad district, Maharashtra

Meena B L[1], Sharma V.B [2], Dr. Prabhat Chandra[3]
[1]Scientist-C, Central Water and Power Research Station, Pune, India – 411024
[2]Scientist-B, Central Water and Power Research Station, Pune, India – 411024
[3]Additional Director, Central Water and Power Research Station, Pune, India – 411024
*meena.banwarilal@gmail.com

Abstract

Maharashtra Maritime Board, Mumbai have a proposal for development of a Ro-Ro jetty at Revdanda, Raigad District, Maharashtra, situated on the right bank of the Kundalika river on the west coast of India. At present, a Captive Jetty Facility by JSW in Revdanda Creek at Salav, is already operative. It was observed from the admiralty chart of the year 1986 that the natural available depths were in the range of -3 to -5 meter below CD in the navigational channel. The optimum breakwater of 510m length was evolved to meet the wave tranquillity requirements and for arrest of littoral drift to avoid sedimentation in the channel as well as at the development site. The spring tidal range is about 4.4m at the site. The sedimentation in the approaches and in the development area would occur mainly due to suspended sediments transported by the tidal currents. The depth requirement for the Ro-Ro vessels is about -3m below CD. The mathematical model studies were undertaken at CWPRS to examine the adequacy of the proposed breakwater layout of the Revdanda harbour in respect of hydrodynamics and sedimentation aspects. The simulation of the hydrodynamics and sedimentation at the proposed site is carried out with existing condition as well as with the proposed protection for the Ro - Ro jetty with the Groyne of length 510m. The impact of the proposed protection and development is assessed for hydrodynamics and sedimentation at the site. Hydrodynamics studies indicate that the average current during peak river discharge would be of the order of 0.60 m/s in the dredged area in front of Ro-Ro jetty for proposed condition and about 0.70 m/s in the main channel. The total quantity of capital dredging of about 35,000 cubic meters will be involved to make a dredged basin at -4 m in front of 230 m long RoRo jetty. Sediment studies indicated that the average loss of depth in dredged area is around 0.12 m annually. The proposed breakwater would not have any adverse effect on morphological changes in the harbour.

Keywords: Mathematical model, Hydrodynamics, sedimentation, RO-RO Jetty, currents.

Estimation of Bridge Scour using HEC RAS – A Case Study of Orsang Aqueduct

Aparna Rath[1] & Dr. H. M. Patel[2]
[1]Faculty of Technology & Engineering, The Maharaja Sayajirao University of Baroda,Vadodara, India
[2]Faculty of Technology & Engineering, The Maharaja Sayajirao University of Baroda, Vadodara, India
*aparnarath98@gmail.com

Abstract

Scour is a natural phenomenon that involves the removal of bed material by the action of flowing water, which eventually removes sediment around or near the structure and exposes the foundation of a bridge pier located in a flowing stream. Excessive scour may result in the failure of the foundation and collapse of the structure therefore, predicting the maximum scour depth is an important aspect of bridge pier design. This study uses the HEC-RAS Version 6.3.1 software to estimate the bridge scour of the Orsang Aqueduct built over the Orsang River. A one-dimensional hydraulic model of Orsang River reach using HEC-RAS is constructed for predicting flow parameters. With a design flood of 12063 cumecs, flow conditions were simulated, and maximum scour depths are predicted. The scour depths are also calculated for flood magnitudes i.e., 25%, 50%, 75%, 107%, 120%, and 136% of the design flood. A sensitivity study is carried out for different manning's values and different angles of attack to the pier. Orsang River is a source of good quality sand with varying depths about 10m to 25m to meet the construction demand of nearby areas. The riverbed degradation is observed due to sand extraction to a large extent. The scour depth is also predicted if the river bed is further degraded by 0.5 m, 1 m, or 2 m with the river under design flood. The predicted scour depth values are compared with different empirical equations for local scour. The total scour depth predicted is also compared with the result of model studies performed by GERI (Gujarat Engineering Research Institution). The HEC-RAS model appears to produce more realistic results since it incorporates more relevant elements such as angle of attack, bed conditions, piers shape, flow concentrations, flow depth, and Froude Number. Estimating scour depth helps to recommend appropriate scour protection measures to protect the structure.

Keywords: Scour Depth, HEC RAS, Bridge Pier, CSU Method.

The Role and Impact of Gabion Weirs in River Management: A Systematic Review

Sanjeev Kumar[a], Nikhil Garg[a*], Sourav Kumar Das[b] and Manish Pandey[c]
[a]Department of Civil Engineering, Graphic Era Deemed to be University, Dehradun, India
[b]Department of Civil Engineering, Manipal University, Jaipur, India
[c]Department of Civil Engineering, National Institute of Technology, Warangal, India
*nikhilhrg@gmail.com

Abstract

Gabion weirs are essential structures used in river management and erosion control. They have been increasingly utilized due to their cost-effectiveness, ease of installation, and adaptability to a wide range of environments. This systematic review aims to explore the role and impact of gabion weirs in river management by examining their design, construction, and ecological implications. A comprehensive analysis of peer-reviewed literature, case studies, and reports was conducted to assess the effectiveness of gabion weirs in addressing various hydrological and geomorphological challenges. The review demonstrates that gabion weirs can play a significant role in reducing erosion, stabilizing riverbanks, improving water quality, and facilitating sediment transport. Additionally, they offer a sustainable solution for flood control, stream restoration, and habitat improvement. However, the review also highlights the importance of proper design, site selection, and maintenance practices to optimize their performance and minimize potential negative effects on ecosystems and watercourses. In conclusion, this systematic review underscores the potential of gabion weirs as a versatile and environmentally friendly tool for river management. It provides valuable insights for researchers, engineers, and policymakers seeking to enhance the understanding and implementation of gabion weirs in various hydrological settings. Further research is recommended to explore the long-term impacts of gabion weirs on ecosystems and to develop innovative designs that maximize their benefits while minimizing potential drawbacks.

Keywords: Gabion weir, porous weir, river management, sustainability, sediment transport

Turbulence Structure and flow characteristic of the sinuous channel with flexible bed

W. Ghani1, A. Sayeed[2], S.R. Shah1 & B. Kumar[2]
[1]Department of Civil Engineering, National Institute of Technology Srinagar (NITS), India
[2]Department of Civil Engineering, Indian Institute of Technology Guwahati (IITG), India
*bimk@iitg.ac.in

Abstract

Laboratory experiments were conducted to examine the flow pattern in a sinuous curvilinear channel with erodible banks, which is a common feature in alluvial river systems consisting of a series of turns, loops, or bends along their course. The bursting events was analyzed to investigate the turbulent flow in a meandering river. In the present study, Quadrant analysis is performed to investigate the contribution of all four-bursting events to Reynold shear stress. From the quadrant analysis for hole size H=2, it is clear that there is intermixing of events in the apex region of a meandering river. While the contribution of events decreases with an increase in Hole size. The analysis results revealed that, for a hole size of H=0, there is an intermixing of events in the apex region of the meandering river, but this contribution decreases as the hole size increases.

Local Scour around Bridge Piers Placed in Transverse Direction to Flow

Akash Anand[1], Mubeen Beg[2]
[1]Aligarh Muslim University, Aligarh, India
[2]Aligarh Muslim University, Aligarh, India
*akashanand50@gmail.com

Abstract

Local scour around bridge pier has been considerably examined by various researchers in finer sediment bed. However, a limited information is available on scour at bridge piers placed in coarser sediment bed (gravel bed). Furthermore, a literature review reveals that many investigators applied flow-altering countermeasures like collar plates to control and minimize the maximum scour depth around an isolated pier. Scanty information on the application of scour depth countermeasures around a group of bridge piers founded in coarser sediment has been sighted in the literature. Keeping in view the aforementioned discussion, an experimental study was conducted to investigate the effect of mutual interference of two laterally placed circular cylindrical bridge piers founded in uniform gravel bed at varied pier spacing. Two cylindrical GI piers with and without collar were used at different spacing of piers. The data on temporal variation of scour depth, scour hole characteristics like scour hole dimensions, scour depth profile along and across the flow direction, sediment deposition around the piers and the areal extent of scour are collected. The collected experimental results provide very important information to the bridge engineers. When lateral clear spacing between the bridge piers (without collar) approaches to '6b' (b= pier width), scour depth approaches to the scour depth of a single pier. It is observed that when collar is used around two piers the effect of mutual interference on local scour diminishes and the scour depth approaches to that of an isolated pier at clear pier spacing of '4b'.

Keywords: Local Scour, Lateral Piers, Interference, Collar plate, Horseshoe vortex, Sediment transport

Temporal variation of scour depth around vertical wall bridge abutment

Damodar Lal Meena[1], Vikas Garg [2]
[1]Department of Civil Engineering, Central University of Haryana Mahendragarh, India – 123031
[2]Department of Civil Engineering, Central University of Haryana Mahendragarh, India – 123031
*d.l.meenanitdgp724@gmail.com

Abstract

One of the main causes of bridge collapse is abutment scour. Local scour near abutments is a complex issue that has received a lot of attention recently. For the design and security of bridge foundations, it is essential to take the temporal variation of scour depth into account. In this study, laboratory tests were conducted to examine the temporal variation of scour depth around vertical wall abutments in clear water conditions. To gather information for model application, a number of laboratory experiments were carried out. The scour depth was recorded at various time intervals during the experiment in clear water flow conditions. According to the findings, the scour depth first increased rapidly, then slowed down, and after some time, it stabilized. The results of this study offer insightful information about the temporal change in scour depth near vertical wall abutments in clear water conditions, which can be helpful for the development of strong and safe bridge foundations.

Keywords: Clear water, temporal variation of scour depth, vertical wall abutment.

River bank protection in hilly rivers

Arun Kumar[1], Naga Sai Viswanath[2], Patil. R. G.[3]
[1]Scientist ‘C’, Central Water & Power Research Station, Pune - 411024, India
[2]Research Assistant, Central Water & Power Research Station, Pune - 411024, India
[3]Dr., Scientist ‘E’, Central Water & Power Research Station, Pune - 411024, India
*arun.k@cwprs.gov.in

Abstract

Rivers in Himalayan region have a steep longitudinal slope with composition of fragile side slopes. Frequent occurrence of heavy rainfall in these regions result in flash floods. The flood water brings in the boulders and soil from the side slopes and bed which roll down with high intensity flow downstream. During the process, large agricultural land and other properties in the country side experience erosion during the floods. In order to protect the valuable land and other properties, various river training works are carried out by different agencies/ water resource departments of concerned state governments. The success of protection works is dependent on various factors as per the site condition. In most of the cases, the rolling boulders in the river damages the protection works by deep impact during floods. Therefore, the provision of protection works in such conditions has become a challenge to the river engineers. The improvisation in the protection work methods are under process based on the field experiences. Generally, the gabion stone filled crates are used for the protection works in the form of retaining wall along with launching apron in the hilly region. However, the toe protection to the retaining wall has become a complex matter due to the breaking of gabions mesh by the impact of rolling boulders. On the other hand, the width of the launching apron is presently computed based on the Lacey’s formula. Though, the scour computations for the bouldary rivers are being formulated to include in Indian standards, the present practice of scour depth computation is by Lacey’s formula which is on the conservative side. CWPRS had carried out various studies related to the bank protection works for the hilly regions particularly for the rivers in Himachal Pradesh. Based on the site conditions, bed material properties, discharge in the rivers, hydraulic properties of rivers, etc., suitable bank protection works were suggested. Depending on the site requirements, the modifications in the bank protection components such as improving the launching apron arrangements with CC blocks, protection to the gabion crate launching apron, centralizing the flow in the river, regarding the longitudinal slope of river, assessing founding level of the retaining walls, etc., are suggested. These aspects are elaborated in the present paper.

Keywords: Gabion stone filled crates, CC blocks, launching apron, retaining wall, flash flood

A Review on Bed Morphology in Compound Channels: Processes, Patterns, and Implications

Vijay Kaushik[1], Noopur Awasthi[2], Munendra Kumar[3], Bandita Naik[4]
[1]Research Scholar, Department of Civil Engineering, Delhi Technological University, Delhi, 110042, India.
[2]Research Scholar, Department of Civil Engineering, Delhi Technological University, Delhi, 110042, India
[3]Professor, Department of Civil Engineering, Delhi Technological University, Delhi, 110042, India
[4]Associate Professor, Department of Civil Engineering, Methodist College of Engineering & Technology, Hyderabad, 500001, India.
*banditanaik@methodist.edu.in

Abstract

This review paper presents a comprehensive analysis of the state-of-the-art research on bed morphology in compound channels. It begins by discussing the fundamental processes governing the formation and development of bedforms, including flow interactions, sediment transport mechanisms, and the influence of channel geometry. Various bedforms commonly observed in compound channels, such as bars, dunes, and secondary channels, are explored in detail, elucidating their characteristics, formation mechanisms, and morphological patterns. Moreover, this review examines the significant factors that influence bed morphology in compound channels. These factors include water discharge, sediment supply, channel slope, floodplain characteristics, and flow resistance. The complex interactions among these factors are discussed, highlighting their combined effects on the initiation, growth, and migration of bedforms. Furthermore, the influence of human interventions, such as channel modifications and floodplain encroachments, on bed morphology is also investigated. The implications of bed morphology in compound channels are then addressed. The effects of bedforms on flow patterns, channel stability, flood conveyance, and ecological habitats are examined, emphasizing the interplay between bed morphology and overall channel functioning. Finally, the paper concludes by identifying key research gaps and outlining potential future directions for advancing the understanding of bed morphology in compound channels. These include the integration of cutting-edge technologies such as remote sensing and numerical modelling, the incorporation of ecological considerations in morphological studies, and the development of robust management strategies for sustainable compound channel systems.

Keywords: Compound channel, Sediment transport, Bed morphology, Flow characteristics.

Soil erosion Potential Zone Mapping using Analytical Hierarchy Process and GIS

Shradhanjalee Pradhan [1]*, Abhishek Bibhar [2], Mani Bhushan[3], Shashi Shankar Ojh[4], Bibhuti Bhusan Sahoo[5], Sovan Sankalp[6]
[1]Veer Surendra Sai University of Technology,768018, Odisha India
[2,5] Department of Agricultural Engineering, Centurion University of Technology and Management, 761211, Odisha, India
[3]Department of Civil Engineering, GEC Khagaria,848203, Bihar, India
[4]Department of Civil 3Engineering, National Institute of Technology, Patna,800005, Bihar, India.
[6]Department of Civil Engineering, Centurion University of Technology and Management, 761211, India
*shradha4972@gmail.com

Abstract

This study focuses on the Soil Erosion potential zone in the Tel River basin, a tributary of The Mahanadi River. Sediment yield refers to the amount of sediment removed from a watershed through natural eroding agents. Identifying the sediment yield potential of an area is important for planning effective watershed management strategies. This reflects the impact of practices that reduce water runoff and sediment yield obtained from the slope using the raster calculator. The AHP pairwise matrix is used to evaluate the normalized weight of each thematic layer, and weighted overlay analysis is carried out on the GIS platform. The study results show that the Tel River catchment is classified into five potential sediment yield zones: very low, low, moderate, high, and very high. The study concludes that soil erosion is moderate in many areas, and appropriate land management practices are necessary to prevent high sediment yield.

Keywords: sediment yield, DEM, AHP process, Tel River.

Hydraulic Model Studies for Removing the Sediment Deposition in the Existing Tail Race Tunnel by Creating Turbulence: A Case Study

Ashish A. Doshi[1], Amruta S. Kore[2], Pramod B. Deolalikar[3]
[1] Director, Infraplan Hydraulic Laboratory, Pune, India
[2] Assistant Engineer, Infraplan Hydraulic Laboratory, Pune, India
[3]Independent Hydraulic Consultant (Former Jt Director, CWPRS), India
*ashishdoshi@infraplan.in

Abstract

The study includes Hydropower project located in Himalayan ranges in India. It has two power generation units with separate tail race tunnels. It is having closed loop water cooling system for the heat exchanger units placed in the tail race tunnel (TRT). The present arrangement was experiencing heavy sediment deposition around heat exchanger units which was affecting its performance and efficiency. Physical hydraulic model studies were conducted to assess the flow conditions in TRT for effective removal of the deposited sediments by creating turbulence in the vicinity. The studies indicated that due to the step in the layout of the TRT, low velocities and return eddy currents persisted in the vicinity of heat exchanger units. This was the major cause for deposition of sediments. In order to remove the deposition of sediments automatically different alternatives were studied on the model, such as, increasing the floor level of the tunnels, changing the location of heat exchanger units and reduction in width of tunnel. The studies indicated that none of this alternative was effective in removing of deposited sediments. These observations indicated that increasing the turbulence in the vicinity of heat exchanger units was the key to effectively remove the deposited sediments. As such many structural interventions were studied on the model. A combination of tee and beam arrangement at specific location was found to be most effective for entire removal of deposited sediments. The solution was cost effective, permanent in nature and would not require any maintenance.

Keywords: Tail Race Tunnel, Heat Exchanger, Froude's Similitude, Discharge, Sediment Deposition.

Prediction of Critical Shear Stress Using Machine Learning Algorithms in Mobile Bed Channels

Ayush Rathore[1], Sarvesh Kapoor [1], Shailza Sharma[1], Bimlesh Kumar [2] & Mahesh Patel[1]
1. Department of Civil Engineering, Dr. B. R. Ambedkar National Institute of Technology Jalandhar, Jalandhar, Punjab144008, India
2. Department of Civil Engineering, Indian Institute of Technology Guwahati, Guwahati, Assam 781039, India
*patelm@nitj.ac.in

Abstract

In fluid dynamics, incipient motion generally refers to the point at which sediment particles, such as sand or gravel, begin to move in the flowing water streams. In this regard, the critical shear stress is an important parameter that determines whether sediment particles will be eroded, transported or deposited in the fluid flow. By considering importance of incipient motion, machine learning algorithms such as the Extra Tree Regression (ETR), Decision Tree (DT) and Gradient boosting Regressor (GBR) are used in the present study for predicting the critical shear stress in an alluvial channel. Further, the prediction of critical shear stress is carried out while considering the input variables such as acceleration due to gravity (g), depth of flow (y), friction slope (S_f), specific gravity (G), size of sediment (d), kinematic viscosity (ν), and velocity (u) with the help of these machine learning models. Thus, the performance of models is evaluated on the basis of the coefficient of determination (R^2) where it was observed that the Decision Tree (DT) model performed better on the basis higher R^2 value of 0.92 in comparison to the reaming models. In addition to this, with the help of prediction of the critical shear stress, it may contribute significantly to researchers and professional’s community in order to estimate erosion rates, sediment deposition patterns, and potential impacts on infrastructure and ecosystems.

Keywords: Critical Shear Stress, Machine Learning Models, Incipient Motion, Mobile Bed Channels

Sediment Load Estimation Using Geostatistical Method

Om Prakash Biswal[a], Anindita Swain[b], Laxmipriya Mohanty[a*]
[a]Department of Civil Engg, VSSUT, Burla, Sambalpur, Odisha 768018, India
[b]Department of Civil Engg., GIET, BBSR, Khurda, Odisha 752060, India
*lmohanty_ce@vssut.ac.in

Abstract

Ungaged (data-scarce) basin lack access to daily sediment data and to estimate it, a popular technique is adopted in which the characteristics of a reference basin's sediment flow time series are transferred to the data-scarce one. In conventional methods, the data-scarce basin’s parameters are typically determined by using a reference station that is closest to that basin. The close neighbour station may not always be the one with the highest correlation, it is established in the current study. To find the reference basin which is the highest correlated, an approach known as the map correlation (MC) method is used. The current approach’s effectiveness is evaluated using daily sediment data collected over a five-year period at 17 sediment gaging sites in Krishna and Godavari watersheds. Pearson's r correlation coefficient's geographic structure is modeled using sample and model variograms. This method selects the highest correlated reference station for a data-scarce sediment site. Observed and estimated correlations resulting from the cross-validation of the variograms are in line with each other for most of the stations. This method selects the highest co-related reference station for an ungaged sediment site.

Keywords: Validation, Highest Correlation, Kriging, Map Correlation Method, Ungaged Basin, Variogram.

Flume Study on Evolution of Bed Form and Near Bed Flow Dynamics on a Gently Sloping Fine Sand Bed under the Influence of Pure Waves

Kaushik Mondal[1*], Susanta Chaudhuri[1], Koustuv Debnath[2], Vikas Kumar Das[3],
[1] Department of Geological Sciences, Jadavpur University, Kolkata - 700032.
[2] Department of Aerospace Engineering & Applied Mechanics, IIEST, Shibpur, India, 711103.
[3]Department of Earth & Atmospheric sciences, NIT Rourkela, Odisha, India- 769008
*km95053@gmail.com

Abstract

The beach environment is unique and important as it separates the continents from seas and may develop various geomorphic and sedimentological variants under the coastal hydrodynamic environment. Distinctively, a coastal beach is characterized by the combination of wide range of geomorphological, biological, ecological and anthropological factors that are immensely intercalated with each other for sustaining the steady state of environmental fluxes. Wave energy dominates the temporal dynamics of the beach which lead to continuous changes in bed morphological patterns arising from the migration of bed form structures such as dunes and ripples. Changes in coastal bed form led to significant variation in turbulence characteristics resulting in the modulation of the pressure coefficients i.e., drag and lift force that can have significant impact in the design of coastal structures. Erection of coastal structures, such as breakwaters, seawalls, port and harbor installations including fishing harbors in coastal zone are a common practice that affect the natural layout of the beach. On the other hand, hydrodynamics of ocean wave together with the strong sediment transport activity challenges the design of stable coastal structures.

Thus, a thorough understanding of the changing bed form and turbulence characteristics of the wave bedform interacting environment is essential for better engineering practices for the efficient and safe design of coastal structures in the surf zone of a beach. The formation and propagation of ripple marks on a sloping sand beach is a dynamic feature that plays a significant role in shaping the beach and near bed flow turbulence. The shape and size of the ripples depend on the various factors such as turbulent wave energy, near bed turbulence intensity, turbulent coherent structures, turbulent eddy scales, sediment characteristics and beach slope angle. The literature survey reveals that practically till date no experimental studies were reported on the variation of the bed morphological pattern along a sloping beach comprising of fine sand bed and associated flow turbulence of pure wave.

The present experimental study aims to comprehend the components of turbulent characteristics of ocean wave in the surf zone (sloping beach) and quantify its effect on sediment transport taking into account the tempo-spatial evolution of bed morphological structures such as ripple. Flume experiments under pure wave were conducted on a gently sloping fine sand bed. Turbulent 3-D velocity field for wave induced flow were measured continuously during experimental runs for three different wave frequencies using micro acoustic Doppler velocimeter at different positions on the sloping mobile bed. Detailed and continuous observations were made on diverse bed forms that evolved with signatures of ripple marks. Geometric parameters of the formed ripples at different locations of the slopes were measured and constituting grain size parameters were quantified at equilibrium. Results reveal a strong correlation between ripple geometric characteristics and the characteristics of wave induced turbulent flow. Considerable modifications of near bed flow turbulence parameters were noted with temporally evolving bed forms along the slope where the flow depth continuously decreased leading to wave breaking.

Keywords: Flume experiments, pure wave, flow turbulence, ripple marks, surf zone, coastal. Bed form

Studies for Hydrodynamics and Sedimentation for development of fishing harbour at Alvedande, Uttara Kannada Dist, Karnataka

Meena B L[1], Sharma V.B [2], Dr. Prabhat Chandra[3]
[1]Scientist-C, Central Water and Power Research Station,Pune, India – 411024
[2]Scientist-C, Central Water and Power Research Station, Pune, India – 411024
[3]Additional Director, Central Water and Power Research Station, Pune, India – 411024
*meena.banwarilal@gmail.com

Abstract

Ports & Fisheries Division, Ambalapady, Karnataka have a proposal for development of a fisheries harbor at Alvedande situated on the right bank of the Honmov river on the west coast of India. From the debuching point of Honmov river to 1.7 km upstream stretch of river in low tide, considerable sedimentation has occurred. Three jetties are existing in this stretch, which have become non-operational during low tide due to non-availability of required depths. The harbour is facing problem of siltation at the entrance of navigational channel for fishing boats also. The sedimentation in the approach channel is caused due to sediment laden river and long shore littoral drift. The optimum breakwater layout consisting of northern breakwater of length of 105 m and southern training wall of length 575 m with 100m wide opening was evolved as per the future requirements of having a larger safe area for parking of boats in the embayment and for possible berthing operations there with due consideration to wave tranquility and long shore drift studies. In the present paper, the impact of this optimum layout was assessed from the aspects of hydrodynamics and sedimentation. The model was simulated using MIKE-21 HD module considering both wave and tide induced currents as the site is influenced by both tide and wave. The Model was calibrated for the observed currents. The maximum currents during peak river discharge in monsoon season would be of the order of 0.95 m/s in between the breakwaters for proposed optimum layout, at the inlet these would be of order 1.52 m/s and near jetty the currents would be about 1.21 m/s. During average discharge and in non-monsoon period currents would be within 0.7 m/s and 0.4 m/s respectively. By sediment model, it was observed that during peak river discharge slight deposition can be observed in the approach

channel and slight erosion at the river mouth. During average discharge, the sediment pattern remains almost same and in low flows, sedimentation has been observed in approach channel as well as at river mouth. The annual sedimentation in navigational channel would be about 0.12 m. Overall the proposed breakwater would not have any adverse impact on the morphological changes in the harbour. Thus, the mathematical model studies were very useful in taking care of all present problems for this proposed development and in deciding the optimum layout and assessment of the possible morphological effects.

Keywords: Mathematical model, Hydrodynamics, sedimentation, Jetty, currents Introduction

Simulation of Suspended Sediments for Physical Model Studies

Ashish A. Doshi[1], Pramod B. Deolalikar[2]
[1]Director, InfraPlan Hydraulic Laboratory, Pune, India
[2]Independent Hydraulic Consultant (Former Jt. Director, CWPRS) Pune, India
*ashishdoshi@infraplan.in

Abstract

Physical Hydraulic Model Studies are essential especially when sediment transport is involved. There are many mathematical models to assess the sediment deposition and transport of material in a hydraulic system. The present set of equations that are used in available models have limitations as three-dimensional flow pattern involving sediment transport has not been fully understood. In view of this, a physical model on a suitable scale can be certainly useful, however, for these model studies simulation of sediment to model scale is very critical. One has to consider specific gravity of the material used in physical model. The size of sediment for the lower part of gradation curve becomes too small to be practically used in a hydraulic model. In practice, most of the time, coal ash and walnut shell powder having specific gravities of around 1.6 have been used almost all over the world. In recent times, plastic balls having specific gravity more than 1 have been fabricated and used in many laboratories. However, this also has limitations as the size becomes further smaller. Extensive studies were conducted at InfraPlan Hydraulic Laboratory in Pune, India, to evaluate suitable material to use as a sediment in physical models. These studies concluded that coconut shell powder having specific gravity of 1.2 was most effective and is also easily available in a crushed form having various particle sizes. The present paper highlights the evolution of coconut shell powder be reproduced as a sediment in physical hydraulic model studies and its application. Two case studies conducted on desilting basin and river morphology using coconut shell powder as a suspended sediment have been described in the paper.

Keywords: Sediment transport, sediment deposition, physical model studies, flushing, desilting, river morphology

Modelling of Scour Depth Using Multivariable Regression Analysis

Pragathi.C[1], Gouthami.K[2], Mahendar.G[3], Devi.K[4], Khuntia.J.R.[5]and Pallavi Badry[6]
[1]Student, Department of Civil Engineering, Vidya Jyothi Institute of Technology, Hyderabad-500075, India
[2]Student, Department of Civil Engineering, Vidya Jyothi Institute of Technology, Hyderabad-500075, India
[3]Student, Department of Civil Engineering, Vidya Jyothi Institute of Technology, Hyderabad500075, India
[4]Assistant Professor, Department of Civil Engineering, Chaitanya Bharathi Institute of Technology, Hyderabad-500075, India
[5]Assistant Professor, Department of Civil Engineering, Chaitanya Bharathi Institute of Technology, Hyderabad-500075, India
[6]Professor, Department of Civil Engineering, Vidya Jyothi Institute of Technology, Hyderabad-500075, India
*pragachilkamarri@gmail.com

Abstract

The lowering of bed levels below the natural levels due to sediment transport is referred to as scour. Scouring is the vital cause of failure in hydraulic structures; thus, it is important to know the extent of scour. Scour takes place due to the localized divergence in sediment transport due to the construction of an obstruction over the existing flow pattern. The study here presents a numerical estimation of the maximum equilibrium scour depth under existing conditions at the site. The various parameters that are affecting the rate of sediment transport are studied by investigating the data sets of previous researchers. The estimation of maximum equilibrium scour depth uses the Adaptive Neuro-Fuzzy Inference System (ANFIS) as a modeling technique. In the present study, various independent parameters such as pier diameter, sediment size, approach flow velocity, approach critical flow velocity, flow depth, Froude number, and the dependent parameter, i.e., equilibrium scour depth, are considered. An equilibrium scour depth model is constructed by making use of ANFIS. For that, 218 training datasets and 57 testing datasets are sorted to establish the ANFIS model from previous studies. A gamma test has been performed on all the input-output pairs to select the best input combinations to prepare an efficient model. The scour depth model is developed using ANFIS with an average MAPE of 17.5 for all data sets.

Keywords: scour, hydraulic structures, independent parameter, ANFIS, equilibrium scour depth, gamma test.

First-Flush Driven Soil Moisture Accountable Sediment Graph Modelling

S.A. Siddiqui[1], P.R. Patil[2], S.K. Mishra[3], S.K. Jain[4] & S. Kumar[1]
[1]Graphic Era (Deemed to be University) Dehradun – 248002, Uttarakhand, India
[2]National Institute of Hydrology, Roorkee, Uttarakhand, India – 247667
[3]Indian Institute of Technology, Roorkee, Uttarakhand, India – 247667 E-mail:
*shafiqah7@gmail.com

Abstract

First-flush is a disproportionately large concentrated load delivered rapidly at the watershed outlet at the onset of rainfall. Similar to the hydrological initial abstraction, first-flush is a useful concept in environmental engineering. First-flush investigations require monitoring, sampling and analysis of primary runoff due to storms of different durations and intensities to relate pollutant load and runoff. The development of sediment yield models (SYMs) is restricted due to nonlinearity of rainfallrunoff-erosion, unrealistic inputs and unsuitable assumptions. Precise estimates of first-flush driven temporal sediment rates are used for designing efficient stormwater management measures to isolate, store and handle definite volume or depth. The first-flush phenomenon is also useful in selecting or sizing cost-effective on-site treatment facilities like detention basins. An integration of the first-flush with sediment graph is essential for designing erosion control measures and to enhance the physical interpretability of the conventional SYMs. Hence, an improved first-flush driven soil moisture accountable sediment graph model (IFF-SMA-SGM) integrating first-flush with NRCS-CN method and Nash's IUSG considering initial-soil moisture and -abstraction is calibrated and validated over 16 rainstorm generated sediment events of W6, W7 and W14-GC experimental watershed of NSL, Oxford, MS, U.S.A. and Mansara watershed of U.P., India. The modelled sediment graphs are similar to actual as proved by the negligible relative errors observed in peak and total sediment load viz. RE(QPS)=5.96% & RE(QS)=0 during calibration and RE(QPS)=1.13 & RE(QS)=1.92% during validation, respectively. The efficiency in model validation varies from 77.62 to 97.91%. Thus, IFF-SMASGM proves its potential over proximate watershed as well.

Keywords: first-flush, initial soil moisture, initial abstraction, soil moisture accountable, sediment load, sediment graph model.

Quantification of Sediment Load Transport of A 90 Degree River Bend: A Case Study Of "Haora River"

Chakraborty, B.[1] Das, A.[2], Biswal, S.K.[3]
[1]MTech Scholar Hydro informatics Engineering (under Civil Engineering Department)-NIT, Agartala
[2]Phd Scholar Water Resources Engineering (under Civil Engineering Department)-NIT, Agartala
[3]Assistant Professor, Water Resources Engineering (under Civil Engineering Department)-NIT, Agartala
*bishal.ce29@gmail.com

Abstract

Quantification of sediment load transport is the process of measuring and analysing the movement of sediment through a body of water, typically a river or stream. Sediment load transport is an important aspect of fluvial geomorphology and environmental management, as it can impact water quality, stream morphology, and habitat for aquatic species. Understanding sediment load transport is essential for effective river management and sediment control, and can inform decisions related to erosion control, dam construction, and water resource planning. In a river, sediment transport can occur through a combination of bedload, suspended load, and dissolved load transport. Bedload transport occurs when sediment particles, such as gravel, sand, and pebbles, roll, slide, or bounce along the river bed. Suspended load transport occurs when finer sediment particles, such as silt and clay, are carried along in the water column. These particles are too small to settle to the bottom and are transported by the river flow. Dissolved load transport occurs when sediment particles are carried in solution in the water. Overall, the amount and type of sediment transport in a river depend on various factors, including the climate, geology, topography, vegetation, and human activities in the watershed. Sediment transport is an important process in river systems as it affects the river morphology, water quality, and ecosystem health. In this study a sharp river bend of Haora River near Khayerpur, Agartala has been considered. Where the suspended load and bed load has been measured and calculated from July, 2022 to February, 2023. In this period the measured maximum bed load and suspended load concentration were 545.2 gm/hr and 2880 mg/l respectively. And the minimum calculated bed load and suspended load concentration were 148.89 gm/hr and 1920.03 mg/l respectively. Then a statistical analysis has been done to check the validity of the study. The values of the Root mean square error (RMSE), Nash –Sutcliffe Efficiency (NSE), Linear Correlation Coefficient (r), Mean absolute error (MAE), Determination Coefficient (R^2) and discrepancy ration are well within acceptable range. Thus,

can be considered fairly satisfactory. Additionally, the degree of linear dependence between measured and calculated bed load and suspended sediment concentration is acceptable.

Keywords: Bed load, suspended load, Root mean square error (RMSE), Nash –Sutcliffe Efficiency (NSE), Linear Correlation Coefficient (r), Mean absolute error (MAE), Determination Coefficient (R^2), discrepancy ration and degree of linear dependence.

Reliability Analysis of Scour Depth Prediction at Culvert

Md Saddam Quamar[1], Javed Alam[2] & Mohammad Muzzammil[3]
[1]Research Scholar, Department of Civil Engineering, Aligarh Muslim University, Aligarh, 202001, India
[2,3]Professor, Department of Civil Engineering, Aligarh Muslim University, Aligarh, 202001, India
*msquamar1996@gmail.com

Abstract

The failure of culverts due to scour by flow at the outlet is a major concern for hydraulic engineers. However, existing deterministic equations for predicting scour depth at the outlet do not account for the randomness of parameters involved, making it difficult to assess the level of scouring risk. A probabilistic approach using a spreadsheet algorithm for the first-order reliability method (FORM) was used in this study to assess the reliability of scour depth prediction at culvert outlets. Sensitivity analysis was carried out to study the influence of various random variables on the reliability-based design. Reliability-based safety factors were proposed to achieve a desirable safety level in the culvert design. The uncertainties in model correction factor and flow velocity were found to have the most influence on reliability and risk assessment. This study highlights the importance of considering uncertainties in determining the reliability or safety of culverts against scouring.

Keywords: Culvert failure, scour, Probabilistic approach, Spreadsheet algorithm, FORM, Uncertainties.

Modelling of Temporal Clear Water Scour Depth around Bridge Piers using XGBoost and SVM-PSO

Prince Gaurav[1], G. Lohith Reddy[1], A. Baranwal[2]*, B. S. Das[3]
[1]B. Tech Student, Civil Engineering Department, NIT Patna, India
[2]Research Scholar, Civil Engineering Department, NIT Patna, India
[3]Assistant Professor, Civil Engineering Department, NIT Patna, India E-mail: *anubhavnitp18@gmail.com

Abstract

Scouring around a bridge pier means removing sediment from the riverbed and banks directly adjacent to a bridge pier due to water flow. Local scouring occurs because the water flow is accelerated as it passes through the narrow gaps between the bridge piers, causing a reduction in pressure caused by the erosion of the riverbed material around the bridge piers. In this paper, local scour depth around bridge piers has been modelled using XGBoost and SVM-PSO based machine learning approaches. Clearwater scouring (CWS) datasets are collected from the different literature based on bridge pier geometry, flow characteristics, and sediment properties and five different nondimensional influencing parameters such as the ratio of pier width to flow depth (b/y), ratio of approach mean velocity to critical velocity (V/Vc), Froude number (Fr), ratio of mean particle size to pier width (d_{50}/b), and standard deviation of bed material (σ) are selected as input parameters to model the CWS depth. A gamma test was performed to choose the best input parameter combinations. According to statistical measures, the proposed XGBoost and SVM-PSO models predict scour depth better than existing scour depth predictive approaches. The coefficient of determination (R^{2}) value was greater than 0.90 for CWS of the developed models. The results of the presently developed models are compared with popular four existing models based on statical indices and found that proposed XGBoost (present model) predict the better result compare to SVM-PSO (present model) and selected existing empirical models. Thus, XGBoost (present model) is more reliable and efficient, and suitable models are recommended for estimating CWS depth under temporal conditions around bridge piers.

Keywords: Local scour, Clearwater scouring, Temporal flow, Gamma test, XGBoost, SVM-PSO

Morphometric Analysis and Prioritization of River Pravara to Soil Erosion Using Edas Method

Shravan Kumar S M[1], Rajawarshini Kasarla[2], Manish Pandey[3]
[1 2] Sreenidhi Institute of Science and Technology, Hyderabad, India
[3] National Institute of Technology, Warangal, India
*shravankumarsm@sreenidhi.edu.in

Abstract

The degree of soil erosion has significantly increased as a result of the complexity of natural and human systems. As a result, in order to understand watersheds and predict future conditions using a watershed technique, a substantial spatial component must be created. It is crucial to comprehend the significant watershed areas with a history of soil erosion since these regions have issues with stream displacement and soil erosion. In order to rationalize decision-making processes with regard to the many accessible decision variables, multi criteria decision making (MCDM) approaches have been widely adopted. As a result, in this work, widely utilized MCDM approaches have been employed to rank the Pravara River sub basin according to a number of morphological features that are susceptible to soil erosion. The morphological factors, such as the linear, aerial, and relief parameters, are estimated using ARCMAP 10.8, and their potential to increase soil erosion is further examined. In order to avoid repercussions brought on by soil erosion as a result of variations in certain geomorphological characteristics, these metrics are employed as decision-making considerations. The MCDMs, EDAS, method has been adopted. The study's findings show that sub watershed 1 is significantly more prone to soil erosion than sub watershed 6, which is less prone to erosion and undergoes accretion.

Keywords: Morphological analysis, MCDM's, soil erosion, Remote sensing, EDAS.

Study of Effect of Geomorphology on Hydrological Response of a Basin: A Case Study of Ong Basin, Eastern India

Aankita Priyadarshini Bhoi[a], Janhabi Meher[b] and Swagatika Sahoo[c]
[a]Post-graduate Student, Dept. of Civil Engineering, Veer Surendra Sai University of Technology, Burla- 768018, India
[b]Assistant Professor, Dept. of Civil Engineering, Veer Surendra Sai University of Technology, Burla- 768018, India
[c]Research Scholar, Dept. of Civil Engineering, Veer Surendra Sai University of Technology, Burla- 768018, India
*bhoisonny@gmail.com

Abstract

Morphometry can be stated as measurement and quantitative analysis of landforms on the surface of the earth. Data acquisition, pre-processing, creation of drainage network, calculation of morphometric parameters, visualization of results, and planning and management of water resources are the steps to follow to analyze the morphometry of the river basin. Stream length, drainage density, stream frequency, bifurcation ratio, elongation ratio, texture ratio, form factor ratio, circularity ratio, river profile, and relief ratio evaluated to assess erosion susceptibility are some of the morphometric basin hydrology parameters that are assessed using techniques based on remote sensing and GIS. According to the research of river morphology and morphometry change in discharge fluctuation, the dynamism of river morphology is the result of both natural processes and artificial intervention. This study attempted to analyze the characterization and prioritization of surface of Ong basin, located in Eastern India, based on morphometric parameters, using GIS. The river basin involved the measurement and analysis of various physical parameters such as drainage network, relief, and shape. Geo-referenced drainage data was analyzed using remote sensing and ArcGIS tools to generate accurate and detailed information on the basin's morphology. According to the results, the study area has consistent underlying lithology, which means that the hydrological response is a direct function of the topography, geomorphology, and current vegetation conditions. As the basin is prone to flooding and soil erosion, more research using ground-based observed data and high resolution satellite data will assist create more efficient watershed management systems.

Keywords: Geomorphology, Topography, Lithology, River profile, Ong basin, GIS and remote sensing

A study on flocculation associated with structural properties of flocs

Mahesh[1], A.K. Patel[1]
[1]National Institute of Technology, Warangal, India
*akpcivil@nitw.ac.in

Abstract

The present study aims to evaluate the behavior of the flocs and associated structural properties of the aggregates of the flocs with respect to varying flocculation intervals at slightly alkaline condition by coagulation for water treatment. Kaoline was used to prepare synthetic turbid water for which average hydrodynamic diameter was 1.36 μm and a zeta potential of -12 mV. Jar test was performed to know the optimum coagulant dosage for the turbidity of 250 ± 25 NTU which was found as 250 mg /L, then the test was continued with optimum dosage for Particle size distribution (PSD) analysis and samples were collected at varying flocculation periods of 1, 3, 5, 10, 15 and 20 min. PSD test was conducted using Litesizer 500 and fractal dimension was computed by log-log relation of A~lDf . The average hydrodynamic diameter of the flocs after coagulation was found as 39.87 μm and a zeta potential of -10 mV. In the beginning 2 minutes fractal dimension was increased, then gradually decreased for 15 minutes and finally attained an equilibrium value of 1.78. There was a little difference in percentage distribution of size of particles before and after coagulation.

Keywords: Coagulation, PSD, Fractal dimension and Hydrodynamic diameter.

Predicting Daily Suspended Sediment Load Using Machine Learning Techniques

Sagar Kumar Ojha[1*], Neha Rani Samal[1], Bibhuti Bhusan Sahoo[2] Sujata Chakravarty[1]
[1]Department of Computer Science and Engineering in Centurion University of Technology and Management
[2]Department of Agricultural Engineering in Centurion University of Technology and Management
*200301120123@cutm.ac.in

Abstract

Suspended sediment load is a significant parameter that affects the quality of water bodies, as it carries various pollutants in different concentrations through the movement in the flow. Monitoring and modelling these loads is essential to develop, an accurate sediment reduction strategy. However, monitoring can be a time-consuming and laborious task, and modelling is a suggested alternative method. In this study, we employed four different methods of Machine Learning (ML) to predict suspended load (SSL) in the Röslau river in Germany. The methods used were random forest, support vector machine (SVM), XGBoost Regressor (XGBoost), and LightGBM. The predictive modelling results were evaluated based on R^2, RMSE, and NSE coefficient. Our results show that LightGBM had superior performance among the other methods. The ML models were able to predict the suspended sediment loads with high accuracy, indicating the potential of ML in predicting sediment loads in water bodies. The findings of this study have significant implications for water management and sediment reduction strategies. The ability to accurately predict suspended sediment loads using ML models can help develop effective management strategies to improve water quality. These strategies can be targeted to specific areas, such as those with high sediment loads, to reduce pollution and improve the health of water bodies. Overall, our study demonstrates the potential of ML methods for predicting suspended sediment loads in water bodies. The accuracy of the predictive models and their ability to capture the complex relationships between flow rate and suspended sediment concentration suggests that AI models can be valuable tools for water management and pollution reduction strategies. However, further research is needed to validate the findings and explore the potential of ML methods in other water quality parameters.

Keywords: Suspended Sediment Load; Machine learning Algorithm; Prediction.

Scour Reduction Around Bridge Piers A Review

Mohd. Athar[1], Faiz Alam[2] and Humaira Athar[3]
[1]Professor, Civil Engineering Department, A.M.U., Aligarh, Uttar Pradesh-202002
[2]M. Tech. student, Civil Engineering Department, A.M.U., Aligarh, Uttar Pradesh-202002,
[3]Scientist, Innovative Building Materials Division, CSIR-CBRI, Roorkee, Uttarakhand-247667
*matharalam58@gmail.com

Abstract

Local scour is defined as the lowering of sediment bed surface around the hydraulic structures like dam, weir, sluice gate, bridge piers etc. It has significant impact on the overall cost of construction and maintenance. The scour depth around bridge piers should be as minimal as possible for safe and cost-effective bridge design. In recent past various physical methods/techniques such as provision of collars around piers, riprap, placement around piers, arrays of piles in front of piers, submerged vanes, fins , slots through piers, partial pier groups, and hexagonal pattern frames placed around piers have been tested. by many investigators. Many mathematical relationships and graphical results have been presented to get proper insight for scour reduction using field and laboratory data. In this paper an attempt has been made to critically examine about various modes of reduction of local scour around bridge piers from literature. A comparative study regarding the scour reduction by slots and collars have been presented graphically as it was found that these two modes are more significant in scour reduction.

Keywords: Local Scour, Scour reduction, Bridge pier, Slots, Collars.

Transient bed profile for clay-silt-sand mixture

Umesh Kumar Singh[1], Sanjeet Kumar[2] and Ankit Chakravarti[3]
[1]National Institute of Hydrology Roorkee
[2]Koneru Lakshmaiah Education Foundation
[3]Koneru Lakshmaiah Education Foundation
*umesh.ais@gmail.com

Abstract

The resistance against the erosion is due to the submerged weight of particles in case of cohesionless sediment; however, surface physico-chemical forces are dominating factors against the erosion for cohesive sediment. When the shear stress due to stream flow exceeds the resistance force of the cohesive bed then detachment of sediment starts from the cohesive bed. Further increase in shear stress due to flow causes the transport of sediment along with the flow. The understanding of transport phenomena is important as it may result in harmful consequences. The transport of sediment in the channel may reduce the expected design life of hydraulic structures by damaging it. Deposition of sediment may block the navigation channel which may result in flooding. The deposition of fine sediment into gravel interstices acts to impede inter-gravel water flow which causes reduction in oxygen levels, vital to benthic organisms. The study is presented for transient bed profile experimental observations and its computation for cohesive mixture of clay-silt-gravel. Degradation in the channel bed occurs when the developed shear stress on the channel bed is sufficiently large enough to mobilize and transport the bed particles and this degradation continues till a stable bed condition is reached. The physical appearance of the channel bed was visualized at the end of the run which varied with the clay content in the mixture. The transient bed profiles were measured at the middle of flume width at a longitudinal interval of 50 cm along the flow direction for different percentage of clay in the sediment mixtures of clay-silt-sand. Transient bed profile i.e., degradation of bed varied with the clay percentage in the sediment mixture as well as with the excess shear stress. The variation of bed degradation with the clay percentage indicates that degradation of channel bed decreases with the increase of clay percentage. The variation of bed degradation with excess shear stress developed by the incoming flow indicates that the channel bed degradation increases with the increase of excess shear stress. The variation of bed degradation with time shows that the variation in bed degradation decreases with the increase of time interval i.e., higher variation observed in the initial interval of time and after that it decreases. It found that the maximum degradation occurred at 50 cm longitudinally from the entrance of upstream working section for the present cohesive sediment mixture. Bed

degradation studied in terms of dimensionless parameters which shows that the degradation in the channel bed decreases in an exponential fashion from upstream to downstream end i.e., more degradation occurs towards upstream compared to downstream of working section. The flowing water is clear at the entrance of working section, and it has eroding capacity and carry the sediment in downstream, however, its eroding capacity decreases as flow moves towards downstream end of working section due to transport of sediment with the flowing water. The relationship proposed for the computation of transient bed profile for the cohesive sediment mixture in the present study based on the functional relationship expressed in terms of dimensionless clay content, excessive shear stress, and time. The computed and observed transient bed profile found to be satisfactory and close to each other.

Spatio-Temporal Analysis of River Course Shifting Using Geo-Spatial Techniques: A Study on Pagladia River of Nalbari District, Assam.

Pranati Sarkar[1] and Dr. C Prakasam[2]
[1]Research Scholar, Department of Geography, School of Earth Sciences
Assam University Diphu Campus, (A Central University) Diphu, Karbi Anglong. Assam 782462
[2]Associate Professor, Department of Geography, School of Earth Sciences
Assam University Diphu Campus (A Central University), Diphu, Karbi Anglong, Assam, 782462
*pranati2709@gmail.com

Abstract

River bank shifting is one of the natural phenomena of the earth's surface, and it is considered one of the unpredictable natural calamities globally. Assam is a highly flood-prone and erosion-prone region of the world. Due to channel migration, many regions have been affected, and people are losing their habitat. The paper examines the spatiotemporal changes of the river course and how it's impacted on the environment. River flow is a dynamic process; hence, it tends to change its path and flow direction spatially and temporally. The present study tries to analyse the changing pattern of Pagladia River shifting and the rate of bank erosion using remote sensing and GIS. This study primarily used a topographical map of SOI and satellite imagery. The study focuses mainly on detecting the relationship between river bank shifting and population migration. Due to the changing course of river Pagladia, most of the local dwellers have suffered from various problems such as loss of agricultural land, homestead area, shifting their occupation, land is submerged due to course shifting, and bank erosion. The changing river course directly affects to environment, and environment effects on the floodplain dwellers of the study area. The study highlights the vulnerability of River Pagladia and also identifies the Geological, and Geomorphological instability of the basin.

Keywords: Course change, Remote-sensing & GIS, Environment, Bank erosion, Pagladia river

The Characteristics of fluid flow in Curved channel with movable banks

Waseem Ghani[1], Shagoofta Rasool Shah[1] & Bimlish Kumar [2]
[1]Department of Civil Engineering, National Institute of Technology (NIT) Srinagar (J&K) India
[2]Department of Civil Engineering, Indian Institute of Technology Guwahati (IITG), India
*Waseem_04phd19@nitsri.ac.in

Abstract

Flow patterns were investigated in sinuous curvilinear channels with flexible banks in laboratory tests. In the past, most tests were conducted in stiff banks with rectangular or trapezoidal cross-sections. The research delves into various flow properties, including velocity, Reynolds shear stress, turbulent intensities, turbulent kinetic energy (TKE), and higher-order correlations. Unlike straight flows, the velocity profile in sinuous channels is influenced by secondary flow and doesn't adhere to the typical logarithmic pattern. Notably, velocity changes are more pronounced at the bends' entry and exit compared to the bend's peak. The presence of helical flow is confirmed by negative Reynolds shear stress at certain bend points. TKE analysis and turbulent intensity measurements reveal that the inner bank of the bend experiences greater effects than the outer bank, a contrast to velocity magnitudes, implying that higher mean speeds don't necessarily equate to more fluctuations. Higher-order correlations indicate both positive and negative signs in the flow and diffusion of streamwise and vertical normal stresses, suggesting sediment movement within the channel. These analyses enhance our comprehension of sinuous channels with flexible banks, a less-studied aspect of fluid dynamics.

Keywords: Curvilinear channel, movable banks, Reynolds shear stress, higher order correlations.

Understanding the variability of precipitation and streamflow using entropy theory in Upper Bhima SubBasin

Siva Sai Syam Nandikanti[1], *, Chetan Kumar Salvadi[2] , Maheswaran Rathinasamy[1,2]
[1]Department of Civil Engineering, Indian Institute of Technology Hyderabad, India.
[2]Department of Climate Change, Indian Institute of Technology Hyderabad.
*ce22resch11004@iith.ac.in

Abstract

Understanding the spatial and temporal variability of hydrologic variables is inevitable in watershed management. Particularly in watershed modeling, quantifying temporal variability will help mitigate floods and droughts. In this study, marginal entropy is used to understand the inherent variability present in the precipitation and streamflow in the monsoon season (JJAS). The Upper Bhima Sub-Basin (UBSB) of the Krishna River Basin (KRB) is considered due to its diversified climate and uneven distribution of precipitation along space and time. This basin is highly prone to human intervention in terms of dams, reservoirs, and many artificial structures. Gridded precipitation and streamflow data are collected from Indian Meteorological Department (IMD) and Central Water Commission (CWC), respectively, from 1976 to 2015. Sarati, Takli, and Wadakbal streamflow gauge stations are considered for analyzing the streamflow variability in UBSB. At the subbasin scale, the Sarati subbasin is experiencing less precipitation variability in terms of entropy value ranging from (1.40 bits) compared to Takli (1.66 bits) and Wadakbal (1.45 bits). In contrast, streamflow is experiencing higher variability in Takli (1.25 bits) compared to Sarati (1.16 bits) and Wadakbal (1.04 bits), implying that the streamflow variability is getting reduced in downstream gauging locations due to the impact of dam operations. Further, spatial variation of the temporal rainfall variability in UBSB can be attributed due to diverse topographic conditions, such as western ghats on the upstream and plateau regions on the downstream. Additionally, the temporal evolution of the rainfall variability was tested using the Mann-Kendall test at the grid level. The results from the Mann-Kendall test showed that out of 61 gridded precipitation points in UBSB, 4 points show a significant (3 increasing and 1 decreasing) trend with a 95% confidence interval. The results from the study can be useful in investigating the rainfall-runoff dynamics due to changing climate and land uses.

Keywords: Marginal Entropy, Spatiotemporal variability, rainfall-runoff dynamics.

Analyzing Flood-Related Crop Damage in the Malaprabha River Basin: Integrated Hydrological and Hydraulic Approach

Kavya H Sankannavar
National Institute of Technology Karnataka Surathkal
*kuvisankannavar347@gmail.com

Abstract

The Malaprabha River basin, known for its crucial support to the livelihoods of the majority of people engaged in agriculture, experienced severe crop damage during the flood events in 2019. This study aims to investigate the extent of crop damage in the region by employing hydrological and hydraulic approaches. The HEC-HMS (Hydrologic Engineering Center's Hydrologic Modeling System) and HEC-RAS (Hydrologic Engineering Center's River Analysis System) software were utilized to simulate the hydrological and hydraulic characteristics of the flood events, respectively. Additionally, the Enhanced Vegetation Index (EVI) is calculated to assess the impact of flood-related factors on crop damage. Through the integration of HEC-HMS and HEC-RAS, the hydrological and hydraulic processes contributing to the flood events are evaluated. The analysis focuses on parameters such as flow duration, flow velocity, and flow depth obtained from HEC-RAS simulations. Furthermore, the EVI is calculated based on satellite imagery to assess vegetation health and its relation to flood characteristics. The EVI values are then analyzed and compared with the flood-related parameters obtained from the HEC-RAS simulations. This comprehensive analysis aimed to identify the correlation between EVI and flood characteristics, providing valuable insights into the impact of flow duration, flow velocity, and flood extent on crop damage The findings of this study are expected to contribute to improved flood risk management strategies and agricultural planning not only in the Malaprabha River basin but also in similar flood-prone regions. The integrated approach of hydrological modeling, hydraulic analysis, and vegetation indices offers a multidisciplinary perspective on understanding the relationship between flood characteristics and crop damage. The results and graphical representations of the correlation between EVI and flood-related parameters will provide valuable guidance for developing appropriate mitigation measures and enhancing the resilience of agricultural systems to future flood events. By investigating the crop damage in this important agricultural area, this study aims to inform decision-making processes and contribute to sustainable agricultural practices and disaster management efforts.

Keywords: crop damage, hydrological model, hydraulic model, EVI

Flood Risk Assessment Using Mcdm Technique and Geospatial Tool in Ajay Rier Basin West Bengal, India

Shanku Ghosh[1], C Prakasam[2]
[1]Research Scholar, Department of Geography, School of Earth Sciences,
Assam University Diphu Campus, (A Central University), Diphu, Karbi Anglong, Assam 782462
[2]Associate Professor, Department of Geography, School of Earth Sciences,
Assam University Diphu Campus (A Central University), Diphu, Karbi Anglong
Assam 782462,
*cprakasam@gmail.com

Abstract

This paper presents the overview of flood risk assessment in the Ajay River basin (ARB), a right bank tributary of the Bhagirathi-Hugli River system. The river originates from the Chakai CD block in the Jamui district of Bihar and it flows through the Jharkhand state and outlets in the Bhagirathi-Hugli River. The lower part of the basin under West Bengal is highly flood-prone. Risk is the combination of hazard, vulnerability, and exposure. Risk is the potential loss or damage of life, properties, and resources that could occur in a society or community in a specific period. Hazard is the process, phenomenon, and activity which may cause loss of life, injury, damage of property, social and economic disruption, or environmental degradation, which can be both natural and anthropogenic origin; vulnerability has been defined as how much an individual, society, community is susceptible to get affected by any hazardous events and lastly, exposure is the situation of people or any tangible asset located in the hazard-prone areas, the occurrence of hazard in no exposure zones defines there is no risk.

For estimation of flood risk in ARB, different physical and social parameters have been selected; physical parameters like elevation, slope, distance from river, river confluence, rainfall, flow accumulation, topographic wetness index, drainage density, SCS-CN, soil properties, evaporation, water body and social parameters like population density, household density, distance from the road, distance from flood shelters, literacy rate, female population, distance from health centers have been taken into consideration and given weightage to get the final flood risk map. The significant risk assessment tools were the analytic Hierarchy Process (AHP) and geospatial tools.

Key words: Flood, risk assessment, Analytic Hierarchy Process (AHP), Ajay River Basin (ARB).

Computational fluid dynamics modeling of scour around vertical-wall abutment with varying aspect ratios under combined wave–current flows

Lalit Kumar[1] & Mohammad Saud Afzal[2]
[1]Research scholar, Department of Civil Engineering, Indian Institute of Technology Kharagpur, West Bengal, India, Pin-721302
[2] Assistant professor, Department of Civil Engineering, Indian Institute of Technology Kharagpur, West Bengal, India, Pin-721302
*lkumar@iitkgp.ac.in

Abstract

The present study investigates the scour at vertical-wall abutment with varying aspect ratio (B/L=abutment width to abutment length) under strong current-dominated combined wave-current and current-only environment using computational fluid dynamics (CFD) modeling. The CFD modelling is performed using an open-source three-phase numerical model (REEF3D), which solves Reynolds-Averaged Navier Stokes (RANS) equations with k-ω turbulence closure. The Exner equation was used to compute alterations in bed elevation, while the Level-Set method recorded the free surface and bed topography in a realistic manner. The Sandslide algorithm and modified critical bed shear stress reduction formulation were used in the morphological model for deposition and erosion calculations accurately. The CFD model is first validated using the experiments and then used for further investigation. After validation, the numerical model is used to investigate the effect of aspect ratio (0.5 to 2) and the Keulegan–Carpenter (KC) number on abutment scour depth in a combined wave–current environment. The numerical findings demonstrate that the initial phase of scour development is more rapid under combined wave-current flow, but the equilibrium scour depth is higher in current-only conditions. The increase in Keulegan Carpenter (KC) number increases the scour depth at vertical-wall abutments for a specific relative flow velocity (U_{cw}). In contrast, a mild increase in vertical-wall abutment scour depth is observed with an increase in U_{cw}. It can be also observed that the increase in aspect ratio of abutment, results in wider and deeper scour depth formation around abutments. To the best of the authors' knowledge, the present work is the first of a kind of experimental and three-dimensional CFD study that estimates abutment scour with varying aspect ratios under strong current-dominated combined wave-current flows.

Keywords: Vertical-wall abutment, abutment scour, Aspect ratio, Keulegan–Carpenter number, Horseshoe vortex, and Combined wave-current flow

Scour Around Multiple Spur Dikes

Reshma Tabassum[1], Lav Kumar Gupta[1] & Manish Pandey[1]
[1]National Institute of Technology, Warangal, India
*rt712012@student.nitw.ac.in

Abstract

Spur dikes are instream hydraulic structures with one end at the riverbank and the other stretching into the river. They are extensively used to divert floodwater away from banks and to protect banks from erosion. The primary objective of this study is to examine the temporal variation in scour and morphological changes induced due to the presence of multiple spur dikes both experimentally and numerically. The experiments were conducted on a fixed rectangular flume with dimensions 10.3 m x 0.8 m x 0.4 m filled with uniform sand of 0.32 mm as mean grain size and 1.31 of sediment gradation. The temporal variation of scour with different spacings, discharge rates and spur dike lengths are examined, and the results are validated using numerical simulation. The experimental runs are carried out under clear-water conditions. In the case of two spur dikes placed at a spacing of two and three times the width of the spur dike, the maximum scour depth at the first spur dike was observed at the nose/ head and scour around the second spur dike is mainly influenced by deposition from the first spur dike. It is observed that scour depth around the first spur dike exponentially increases and becomes constant but scour depth around the second spur dike exponentially increases initially, then dynamically decreases and later increases with time. This study also plots the scour hole profile and morphological changes for single and multiple spur dikes.

Keywords: Multiple spur dikes**,** scour, morphological changes, numerical simulation.

Experimental Study of Dip Phenomenon in Narrow Channels

Pradip Kailas Gopal[1], Dr. Shiva Shankar Mali[1], Dr. Binit Kumar[2], Dr. Manish Pandey[3]
[1]M.Tech. Scholar, Department of Civil Engineering, National Institute of Technology Warangal, Warangal 506004, India,
[2]Post-Doctoral Fellow, Department of Civil Engineering, National Institute of Technology Warangal, Warangal 506004, India
[3]Assistant Professor, Department of Civil Engineering, National Institute of Technology Warangal, Warangal 506004, India
*shivashankarmali@student.nitw.ac.in

Abstract

Present study deals with a new analytical semi-empirical equation based on modified log-wake law and parameters of the equation for smooth and rough narrow channels. The experimental data were collected and empirical equation was developed using the regression technique in order to observe the velocity distribution in narrow channels. The experimental data is validated with CFD (Computational Fluid Dynamics) and with some existing literatures. Channels can be defined as Narrow and Wide based on the aspect ratio, i.e., aspect ratio less than 5 signifies a narrow channel whereas a value greater than 5 indicates a wide channel. It was noticed in the present study that secondary flow is dominant in low aspect ratio flows. Hence, it is required to understand the mechanism of the dip phenomenon in a narrow channel, which is defined as the phenomenon where the velocity in a channel is maximum below the free surface and reduces towards the free surface. An Acoustic Doppler Velocimeter (ADV) was used to observe the velocity distribution by taking two-dimensional velocity measurements along the streamwise direction. The comparison of equation and experimental data shows good agreement of the velocity distribution in a narrow channel. The R 2 (Coefficient of determination) for rough channel and smooth channel were found to be 0.91 and 0.87 respectively. The NSE (Nash Sutcliffe Efficiency) for rough channel and smooth channel were found to be 0.86 and 0.86 respectively. The CFD and experimental data error after validation was nearly 5%. This study will help to understand the sediment mechanism as well as the turbulence characteristics in narrow channels and streams.

Keywords: Aspect Ratio, MLWL, Secondary flow, Narrow Channels, CFD

Spacing Effect on the Equilibrium Scour and Turbulent Flow Characteristics around Three Pier group in Triangular Configuration

Sahu Chitrangini[1], & Eldho T.I.[1]
[1]Indian Institute of Technology Bombay, Mumbai, Maharashtra, India
*Chitrangini.1702@gmail.com

Abstract

Bridge piers often employ a group of piers in recent design techniques in order to alter the flow and reduce subsequent scour development in the vicinity of the piers. These pier groups exhibit various configurations, including different spacing between piers, skew angles, the number of piers, and the arrangement of the pier group. These distinct configurations interact with the flow field in unique ways, resulting in diverse scour patterns and equilibrium scour depths. Many prior studies have aimed to characterize the scouring phenomenon around pier groups, yet a majority of them have reported findings for array arrangements. In this study, experimental investigation has been carried out to understand the turbulent flow behavior in the vicinity of a three-pier group placed in a triangular configuration. In order to study the impacts of spacing, the face-to-face distance between the piers, G was varied to D, 2D, and 3D, where D is the diameter of the circular pier. Velocity data were collected along the center-plane using the Particle Image Velocimetry (PIV) after the equilibrium scour depth was achieved. Scour patterns show that the maximum scour depth (MSD) was obtained for spacing G equal to D. The threshold value of spacing for the smallest value of MSD lied between 2D and 3D for an approximate flow intensity of 0.9. Reverse flow and down-fall regions were observed in the contours of streamwise and vertical velocities. Turbulent kinetic energy results along center-plane indicate that the highest turbulence was produced in the middle region of the pier group when the spacing was equal to D.

Keywords: Three-pier group, Scour, Maximum scour depth, Turbulence characteristics, PIV.

Scour Analysis around Bridge Piers Using Machine Learning: A Review

Farooque Rahman; Prabhat singh; Dr Rutuja M Chavan
Maulana Azad National Institute of Technology
*frahman4575@gmail.com

Abstract

Scour analysis is a critical aspect of ensuring the safety and integrity of hydraulic structures, such as bridge piers and abutments, which are susceptible to soil erosion caused by water flow. Traditional methods for scour analysis, such as physical model testing and empirical equations, are often time-consuming, costly, and inaccurate. With the advancement of machine learning (ML) algorithms, new methods for scour analysis have emerged that offer a more efficient and accurate solution. This review article aims to provide a comprehensive overview of the recent developments in scour analysis using ML techniques. The article begins by defining scour analysis and outlining the traditional methods for scour analysis. It then goes on to discuss the advantages of using ML techniques for scour analysis. The article reviews various ML techniques for scour analysis, including supervised learning and unsupervised learnings algorithm. It also provides case studies of ML techniques applied to scour analysis for bridge piers. The review concludes with a discussion of the challenges and future directions for scour analysis using ML techniques. Some challenges identified include the lack of high-quality data for training ML models and the difficulty in interpreting ML models. Future developments in ML techniques for scour analysis may focus on improving model interpretability and addressing the challenge of limited data availability. Overall, this review article highlights the potential of ML techniques in improving the scour analysis process and identifies opportunities for future research.

Bathymetry and Sedimentation Studies of Mahi Bajaj Sagar Reservoir in Banswara, Rajasthan using Integrated Bathymetry System – A Case Study

M. Selva Balan[1], M.S. Bist[2], Ajit Singh[3], Sampath Sreekanth[4], Prabhat Chandra[5]
[1] Scientist-E, Central Water & Power Research Station (CWPRS), Pune, India
[2] Scientist-D, Central Water & Power Research Station (CWPRS), Pune, India
[3] Research Assistant, Central Water & Power Research Station (CWPRS), Pune, India
[4] Scientist -C, Central Water & Power Research Station (CWPRS), Pune, India
[5] Additional Director, Central Water & Power Research Station (CWPRS), Pune, India
*selvabalan_m@cwprs.gov.in

Abstract

NPCIL has proposed to install an interstate multipurpose Nuclear Power Project of Rajasthan & Gujarat states at Mahi Bajaj Sagar reservoir catchment in Banswara district, Rajasthan state.Tthe project authority refers the studies to Central Water & Power Research Station (CWPRS), Pune to evaluate present storage capacity, depth contour plots, find out deep pockets for intake for the proposed and estimate siltation pattern. The study also includes finding out the possible methods to enhance dam water storage capacity by means of siltation removal from reservoirs.

Instrumentation Division of CWPRS has carried out hydrographic survey of Mahi Bajaj Sagar reservoir during December 2019 by using dual frequency echo-sounder sensor, Differential Global Positioning System along with antenna and other auxiliary types of equipment firmly fixed to a survey boat. The IBS was expected to have depth accuracy in sub meters. The hydrographic survey was done at water level 280 m RL. FRL is at 281.50 m. Data was collected using a model of echo GPS and Hypack navigation software which generates data sheets having x, y, z data in excel format. Data analysis was carried out using various software viz. Surfer, Autocad, QGIS and results obtained such as live storage, silt quantity, deep pockets for intake and contour plot up to FRL. The reservoir live storage capacity is calculated for water spread area of 106.11 sq. km. at water level of RL. 280 m. Reservoir capacity at survey level is 1634.28 MCM and the same when extrapolated up to FRL is 1822.30 MCM. Loss of volume is calculated based on original capacity table provided by project authority. When extrapolated to FRL i.e 281.5m the loss of capacity is 358 MCM, which is 16 percent of original designed capacity.

Keywords: Bathymetry, DGPS, Echo-sounder, HYPACK, Surfer, capacity –elevation-area curve

Physical and Geomorphologic Characteristics Based Sediment Production Analysis of a Semi-Arid Watershed in Eastern India

Kumar Prabin Parida[a], Janhabi Meher[b] and Swagatika Sahoo[c]
[a]Post-graduate Student, Dept. of Civil Engineering, Veer Surendra Sai University of Technology, Burla- 768018, India
[b]Assistant Professor, Dept. of Civil Engineering, Veer Surendra Sai University of Technology, Burla- 768018, India
[c]Research Scholar, Dept. of Civil Engineering, Veer Surendra Sai University of Technology, Burla- 768018, India
*kumarprabin2014@gmail.com

Abstract

A watershed is a natural hydrological entity that allows surface run-off into a defined channel, drain, stream or river. Soil erosion poses a severe hazard to people living in the watershed and the hazard is more severe in arid and semi-arid areas, particularly on grazing land. Watershed management is a major challenge in India to protect soil and water resources. The average soil loss rate in India is 16.75 mm per year. To identify which watersheds should receive priority attention and to implement soil and water conservation measures based on physical characteristics such as channel length, channel network configuration, watershed slope and drainage divide location as well as geomorphologic characteristics such as shape factor, bifurcation ratio, circulatory ratio, drainage density, relative relief and hypsometric integral (HI) based equations are frequently used . This research examined the rate of soil erosion and sediment production in relation to the morphometric features of Tel river basin, a semi-arid watershed located in Eastern India. The sediment production rate of the Tel river basin was estimated by gathering data on key parameters such as precipitation, topography, land use, and soil type over a period of recent ten years. A sediment yield equations based on sediment load, drainage area, precipitation, slope and soil erodibility factor was used to estimate the sediment production rate, which varied depending on the time of year and weather conditions. It is important to collect high resolution digital data for the key parameters over a longer period of time to increase accuracy of estimation.

Keywords: Soil erosion, Morphometric features, Tel basin, Sediment yield

Estimation of Manning's roughness coefficient of alluvial river Ganga at CWC Gauging site at Gandhi ghat, Patna

Malti Mardi[1], Sunil kumar Murmu[2]
[1]National Institute of Technology Patna
maltim.ph21.ce@nitp.ac.in
[2]National Institute of Technology Patna
*Sunil@nitp.ac.in

Abstract

Manning's roughness Coefficient is One of the most crucial parameters for defining water flow over ground. To calculate the Manning's roughness co-efficient field measurement are required like measure the depth of river by echo-sounder and velocity by current meter etc. and use ADCP (Acoustic Doppler current profile) instrument to get the information of the study site. It is observed that there is a variation in manning's roughness coefficient in alluvial river Ganga at Gandhi ghat at Patna reach at North-Eastern region of India. Analysis is performed based on data from 2016-2021 by using two different methods, first one is Area velocity method which is conventional method for estimation of discharge and calculate the manning's roughness coefficient and the other method by the help of HEC-RAS software. In this study it is also observed that in river ganga number of tributaries or river meet at the CWC Gauging site at Patna and therefore silting and scouring is very common phenomenon at the observation site and these are the main cause of variation of Manning's roughness coefficient at the observation site at Patna.

Keyword: Area velocity Method, HEC-RAS, Manning's roughness co-efficient, CWC, Alluvial River, Gauging site, ADCP

A study on Hydrodynamic and Morphological Behaviour of Sarada River using Delft-3D Model

Gorle Giridhar[1], Dr. M. G. MuniReddy[2]
[1] Research Scholar, Department of Civil Engineering, Andhra Universitry, Visakhapatnam, India.
[2] Associate Professor, Department of Civil Engineering, Andhra Universitry, Visakhapatnam, India
*giridharlbc@gmail.com

Abstract

The River Sarada is a medium-sized river. The river's physical location is between 17- and 18-degrees north latitude and 82 to 83 degrees east longitude. The basin's catchment area is 2,665 square kilometres. It rises in the Eastern Ghats at a height of 1,000 metres. It travels 122 km in an easterly direction before joining the Bay of Bengal. River Nagavali, River Gosthani, River Gambiramgedda, River Megadrigedda, Bay of Bengal, and the Machhkund sub-basin of the River Godavari all encircle the basin. The largest city in the basin is Visakhapatnam. Important towns in the basin include Yelamanchili and Anakapalli.

Due to its extreme susceptibility to erosion and deposition, the Sarada river, which has historically been thought of as a river that primarily meanders, is transitioning into a braided river. By creating a 2D model with Delft3D, a hydrodynamic and morphological analysis of the Sarada River is carried out to determine its suitable behavior.

With the use of numerical modeling, we will build a semi-circular breakwater at the river's mouth where it entered the Bay of Bengal in this study. Different morphological and hydrodynamic properties, including sediment transport rate and cumulative erosion/deposition, are evaluated. Tidal effects can cause changes in water level, velocity changes, and discharge. The findings show that the tidal range is greatest during the dry season and increases from upstream to downstream of the river. The model confirms the phenomenon and demonstrates that during the rainy season high velocity leads in high sediment transport rate, which ultimately contributes to erosion/deposition of river bed. It is believed that this study's conclusions would assist people grasp the general hydrodynamic and the river's morphological characteristics and potential future development projects are suggested.

Keywords: Delft3D, hydrodynamic, morphological, Sarada river.

River Training Work using Submerged Vane- A Review.

Mohammad Ahmed[1], Zulfequar Ahmad[1]
[1] Indian Institute of Technology, Roorkee
*mohammad_a@ce.iitr.ac.in

Abstract

River channel stabilization techniques have been used for centuries and remain popular worldwide as a method for managing rivers. This study reviews some common river channel stabilization methods, summarize recent peer-reviewed articles on these techniques, and identify areas for further research. Understanding the impact of these practices on bank erosion, water flow, sediment movement, and habitat is crucial for improving river channel stabilization. The success of submerged vane technology in sediment management has generated interest in its broader application for addressing erosion, scour, and meander problems in rivers across the country. Ongoing research aims to examine its long-term effects and additional benefits, ultimately contributing to better river management and the preservation of sustainable river ecosystems.

Keywords: Delft3D, hydrodynamic, morphological, Sarada river.

Reduction of local scour using sacrificial piles in non-uniform sediment bed

Rahul Bharadwaj M[1], Manish Pandey[1] & Mohammad Saud Afzal[1]
[1]Indian Institute of Technology Kharagpur, India
* mrahulbharadwaj1996@kgpian.iitkgp.ac.in

Abstract

Scour is the erosion of the sediment material due to the action of flowing water. Bridges present across the river are supported by the piers and due to the flowing water, scour develops around them jeopardizing the safety of the bridge. Thus, protection of the pier against the scour is vital. Countermeasures against scour are primarily categorized into two main types: active and passive. Active countermeasures shied the bed materials, while passive countermeasures alter the flow characteristics around the pier. In the present study, sacrificial piles which are passive countermeasures are tested for scour reduction around a circular pier. The efficiency of the piles against scour reduction is tested in both transverse and staggered configurations. The effect of the longitudinal distance of the piles from the pier centre, x is tested with varying distances of 2b and 3b where b is the pier diameter. Experiments are conducted under clear water conditions with a constant water depth for non-uniform sediment under steady and uniform flow conditions. Temporal variation of scour depth is analyzed in transverse and staggered configurations. The efficiency of the sacrificial piles is reduced when the longitudinal distance from the pier centre is increased. The transverse configuration of piles can reduce the scour by 55% and 45% at x= 2b, and 3b respectively. Scour reduction of 53.33% and 50% is observed in the staggered arrangement at x=2b, and 3b respectively.

Keywords: Local scour, non-uniform sediment, sacrificial piles, clear water scour.

Numerical simulation of tsunami-like flow interaction with vertical seawalls with and without recurve on the top using OpenFOAM

S.Harish[1,2], V. Sriram[2,3], Holger Schüttrumpf[1] & S. A. Sannasiraj[2,3]
[1]Institute of Hydraulic Engineering and Water Resources Management, RWTH Aachen University, 52074 Aachen, Germany
[2]Department of Ocean Engineering, IIT Madras, Chennai-600036, India
[3]Center for Maritime Experiments to Maritime Experience (ME2ME), Indian Institute of Technology Madras, Chennai, India
*harish785351@gmail.com

Abstract

Seawalls, designed to protect coastal areas from the impact of waves and storm surges, failed during past tsunami events due to immense force and energy. The impact of a tsunami on seawalls depends on various factors, including the shape of the seawall. Hence, the present study is motivated towards understanding the difference in the force characteristics of the two types of seawalls (vertical seawall (VW) and vertical seawall with a recurve on top (LRC), which are common along many coasts) during tsunami-like flow interaction under different overtopping conditions. An open-source CFD solver called OpenFOAM is used for numerical simulations. A dam-break-like scenario replicated the tsunami inundation. The study findings revealed that during the flow interaction, both the seawalls experienced impulsive force followed by quasi-static force during the quasi-steady flow phase, with the low-height seawall experiencing maximum force during the initial impulsive force. Pressure distribution over the depth of the seawall revealed an enormous pressure at the recurve. Hence, LRC experienced comparatively a higher force and overturning moment than VW in all the force phases, despite LRC being recommended for reduced wave overtopping for normal wave conditions. In addition, the LRC experienced a significant uplift force due to the recurve; the dependence factors have been discussed in the paper. The present article identifies VW as a hydrodynamically efficient structure for tsunami-like flows compared to LRC.

Keywords: Tsunami, Vertical seawall, Vertical seawall with a recurve on the top, dam-break flow, impulsive force, quasi-static force.

Potential of ANN based Rainfall Runoff Modelling for Efficient Management of Water Resources in Himalayan River Basins

Archana Sarkar
National Institute of Hydrology
*archana_sarkar@yahoo.com

Abstract

Modelling rainfall-runoff at catchment scale is important for sustainable water resources management. The rainfall-runoff is a complex, dynamic, and highly non-linear process, which is affected by many and often interrelated, physical factors. In addition to rainfall, runoff is dependent on numerous factors such as initial soil moisture, land use, catchment geomorphology, evaporation, infiltration, temperature, distribution & duration of rainfall. In case of Himalayan Rivers, there is an added complexity of snowmelt component in the runoff. Numerous modelling options are available for continuous-time modelling of rainfall-runoff process ranging from the conceptual models to physically based distributed models to black box lumped models. The artificial neural network (ANN) approach is relatively new approach and it has found good number of applications in rainfall runoff modelling due to higher simulation as well as forecasting accuracy.

In the present paper, ANN models have been developed for rainfall runoff modelling in three different river basins of Indian Himalayan region. Single layer feed forward back propagation ANN models have been developed for the three basins namely, Satluj River basin of Western Himalayan region, Sharda River basin of the Ganges River system from Central Himalayan region and Subansiri River basin of the Brahmaputra River system from Eastern Himalayan region. The Satluj river rises in the lakes of Mansarover and Rakastal in the Tibetan Plateau at an elevation of about 4,572 m and forms one of the main tributaries of Indus river. Indian part of the Satluj basin is elongated in shape. For the present work, the Satluj River upto Kasol gauging site has been considered. Sharda River is a trans-boundary major sub- tributary of the river Ganges called Mahakali in Nepal. The Sharda River or Mahakali river demarcates Nepal's western border with India. Sharda River basin upto NHPC’s Tanakpur barrage has been considered in the present paper. The Subansiri River basin is a large transboundry eastern Himalayan River basin located within the Brahmaputra River basin. Subansiri basin has a complex and diverse hydrometeorology with upper 40% area in cold arid region of Tibetan plateau and lower area joining the floodplains of Assam in India. A large number of ANN models have been developed for the three river basins considering various combination of input data as well as various ANN architecture and the best performing model was identified for each basin. Results obtained indicate that the ANN approach for modelling the complex rainfall runoff process produces reasonably satisfactory results for all the three river basins. ANN models were found to be considerably better than the conventional regression and conceptual models.

Bridge pier Scour Mitigation with Submerged Vanes and a Triangular Prism

V. Chauhan[1], E. Padhi[1] & G.D Singhal[1]
[1]Shiv Nadar Institution of Eminence, Greater Noida, India
*vc651@snu.edu.in

Abstract

A proposed mitigation strategy uses submerged vanes and a submerged triangular prism structure to reduce local scour near bridge piers. Using the Flow3D Hydro CFD model, this work numerically evaluated the pier scour profiles. Together with a submerged triangular prism, submerged vanes can be tested to see if they can generate lift and change the flow field around bridge piers. It is anticipated that the flow field created by the convective momentum flux produced by submerged vanes and a submerged triangular prism will significantly lessen the local scour near bridge piers. To determine the proposed structure's potential for scour reduction, two numerical runs, including a baseline test, were conducted. It is anticipated that the proposed structure would lead to a decrease in the maximum scour depth and scour volume when compared to the scenario in which none of the mitigation structures are constructed. An earlier experimental study on flow dynamics by Odgaard and Spoljaric (1986) was utilized to verify the submerged vane's effect on flows and assess the model's accuracy. The study found that using submerged vanes upstream of a submerged triangular prism enhances erosion mitigation potential compared to using the structure alone. Another very significant finding of our analysis is that the proposed construction has a larger flow separation zone, resulting in a smaller gradient of unfavourable pressure and slowing flow reversal upstream of the bridge pier. The proposed hydraulic structure is a successful method for scour counteraction at both new and old bridges, according to the research reported here.

Keywords: Vortex, fluid dynamics, morphology, river training, hydraulic structure, sediment management

Influence of Octagonal collar in Reduction of Pier Scour

Lav Kumar Gupta[1], Rahul Bharadwaj[1] & Manish Pandey[1]
[1]National Institute of Technology, Warangal, India
*gk701902@student.nitw.ac.in

Abstract

When bridge piers are placed in flowing water, they are susceptible to scour, which can jeopardize the pier's foundation, and, ultimately, the bridge's structural integrity. Scour occurs due to a three-dimensional flow separation that includes the horseshoe vortex, flow acceleration along the sides of the pier, and wake vortices. Scour countermeasures are typically used to minimize the risk of failure caused by scour. There are mainly two scour countermeasures such as active and passive. Active countermeasures are used to resist bed materials, and passive countermeasures are used to alter the flow characteristics around the pier. This paper uses an octagonal collar as a passive countermeasure for scour protection around the pier. The performance of the octagonal collar is evaluated experimentally. Experiments are conducted under clear water conditions with a constant water depth for uniform sediment under steady and uniform flow conditions. Scour hole profiles are plotted when the octagonal collar is placed at four different elevations. It is observed that the percentage reductions in scour depth around the pier are 57, 23, 18 and 5.5% when the collar is fixed on the bed level, at y/4, at y/2, and 3y/4 above the bed level, respectively. This paper presents a new empirical equation for calculating the maximum scour depth around the pier in the presence of the octagonal collar. Sensitivity and statistical analyses are carried out to determine the influencing parameters.

Keywords: Scour protection, bridge pier, octagonal collar, protection efficiency, clear water scour.

CFD Simulations of Local Scour around Circular Piers using k-w Turbulence Model

A. Baranwal[1], B. S. Das[2]
[1]Reserach Scholar, NIT Patna, Patna, Bihar, India -80005
[2]Assistant Professor, NIT Patna, Patna, Bihar, India -80005
*anubhavnitp18@gmail.com

Abstract

The scouring effect at the base of the bridge piers causes the collapse of bridges worldwide. The passage of horseshoe vortices and strong turbulent oscillations around bridge piers are assumed to be the prime reasons for this complex phenomenon. ANSYS (FLUENT) software is used to solve the Reynolds Averaged Navier-Stokes (RANS) equation for the Eulerian multiphase and k-ω turbulence model which is coupled with sediment transport and bed deformation sub-models. Along with the typical bed shear stress, the strong vertical flow is developed and converts the turbulent kinetic energy into shear stress at the sediment surface. As a result, sediment particles are compelled to depart from the bed to the downward side of the bridge piers. In this paper, Melville (1975) experimental work on bridge pier scour depth is modelled using k-ω standard and k-ω Shear Stress Transport (SST) models. The variation of longitudinal velocity distribution, turbulent kinetic energy (TKE) and pressure distributions have been studied in six different sections near the upstream and downstream sides of the bridge pier. Both models provide nearly similar results, however, the velocity and TKE values obtained by k-ω standard model is found to be higher compared to the k-ω SST model.

Keywords: CFD, Three-dimensional flow, k-ω Turbulence model, Local scour.

Assessment of Technological Developments in River Morphology Analysis: A Comprehensive Review

S.A. Rather[1], A.A. Mir[1], K. Kapoor[1] & M. Patel[1]
[1]Dr B R Ambedkar National Institute of Technology Jalandhar, Jalandhar-14408, India
*shakeelar.ce.23@nitj.ac.in

Abstract

Rivers are vital natural resources that support varied ecosystems, provide water supplies, and facilitate transportation and economic activity. Understanding river morphology is critical for long-term river management, which necessitates a thorough examination of the intricate relationships between water flow, sediment transport, and channel shape. The analysis and engineering of river morphology have traditionally relied on empirical methods and manual measurements. This paper reviewed technological advancements that are allowing for more precise and complete analyses of river systems. Aerial and satellite photos have enabled large-scale data collection, providing precise information on river systems, floodplains, and adjacent landscapes. This high-resolution data, along with Geographic Information Systems and modern data processing techniques, has aided in creating digital elevation models and extracting topographic information important for river morphology studies. Incorporating fluvial hydraulics concepts into river morphology study may provide us with a thorough knowledge of the hydraulic processes that shape river channels and their related landforms. This paper has reviewed advancements in river morphology analysis and suggested possible methods for precise evaluation, predictive modelling, and informed decision-making for sustainable river management practices and assessment of river response to climate change, land use change, and extreme events.

Keywords: River morphology, remote sensing, predictive modelling, sediment transport

A Review of Models for Soil Erosion and Sediment Yield

Kumar S.[1] , Choudhary M.K.[2] , and Thomas T.[3]
[1]PhD Scholar, Civil Engineering Department, MANIT Bhopal-462003, INDIA
[2]Associate Professor, Department of Civil Engineering, MANIT Bhopal-462003, INDIA
[3]Scientist "F", NIH Bhopal-462003, INDIA
*sachinkumarphd003@gmail.com

Abstract

There are many models available for studying sediment-yield and soil-erosion world-wide, although there are no any model which are perfectly physically-based, the mathematical equations representing the individual methods in these models typically take a lot of assumptions and empirical or conceptual methods into account. Input requirements, complexity & capability, temporal & spatial scale, process re-presentation, and output types of these models differ significantly. The main objective of the present study is to scrutinize the physical models for soil-erosion. and sediment-yield. with respect to their strengths and mentioned factors. For investigations on soil-erosion and sediment-yield, the literature advises for the use of models like AGNPS, WEPP, SWAT, & SHETRAN etc. Mostly existing erosion and sediment-yield models can only simulate soil detachment and sediment delivery procedures at the hill-slope scale. The models for channel erosion and reservoir siltation processes have seen less development. The study also offers a set of guidelines for choosing an appropriate model for a particular application/case study. This study will be helpful to understand the principle, structure, application fields and future development trends of physically based model systematically for sediment-yield and soil-erosion.

Keywords: Soil-erosion, Sediment-yield, Physical Models, SWAT, AGNPS, WEPP

Strategies and Implementation for Achieving Sustainable Flood Risk Management

Neha Paswan[1*] & Litan Kumar Ray[2]
[1]Research scholar, Department of Civil Engineering, National Institute of Technology, Warangal, Warangal-506004
[2]Assistant Professor, Department of Civil Engineering, National Institute of Technology, Warangal, Warangal 506004
*ng22cer1r12@student.nitw.ac.in

Abstract

Floods are considered one of the most destructive and catastrophic phenomena among all-natural calamities. Flood risk is a function and a product of hazard and vulnerability. The selection of suitable measures for a flood management schemerequires a firm understanding of the risk mechanism. Proper Flood Risk Management (FRM) techniques are needed to control and minimize the severe effects of floods. FRM can be defined as the strategy, procedure, or methods adopted to reduce the direct or indirect severe impact on human health, the economy, and the environment. This event can occur regionally or globally. FRM has been established as a well-defined procedure for managing the risk due to floods. This paper explores the various methods of flood risk management (FRM) and the challenges, characteristics, and components involved. Furthermore, the article delves into the significance of remote sensing and Geographic Information Systems (GIS) in supporting FRM efforts. This will provide a better approach for stakeholders, urban planners, and watershed managers to take preventive actions to control and minimize the effects of floods.

Keywords: FRM, RS, GIS, Flood, Flood Damage, Flood Risk.

Dam Break Analysis using HEC- RAS: A Case Study of Kosi Barrage Dam

B. Brahmachari[1*], Dr. B. S. Das[2] and Dr. S.S. Kumar[2]
[1]National Institute of Technology, Patna, India
[2]National Institute of Technology, Patna, India
*bhineshwarb@gmail.com

Abstract

A dam is a barrier that is constructed across the river to fulfill various purposes like agricultural activity, flood control, electricity generation, navigation, water supply, water recreation, etc. The dam protects nature and human civilization near its vicinity by becoming like a living being. Even a dam is very beneficial for our society but if it fails it creates a devastating effect. It can extensively damage entire property and losses of human life within a very short period. Its failure is very dangerous for the environment, our society, and our lives. Hence it is very important to analyse and simulate the dam failure parameters that will help to redesign, modify, and plan an emergency response for engineers. The dam breach failure is caused by overtopping due to excessive inflow by heavy precipitation in any form, seepage, or pipping through the dam and due to mass movement landslides. Overtopping breaches develop very fast but seepage breaches take a long time to develop. The time is very crucial between initiation, detection, prevention, and flood warning. The prediction of seepage is more difficult even if it is detected, it is not possible to fully stop. In this paper, an attempt has to made the to study dam break analysis of Kosi Barrage using a 1D hydraulic model known as Hydraulic Engineering Centres River Analysis (HEC-RAS). The River Geometry data and inundation map are extracted from the RAS mapper with the help of the project file and digital elevation model. In this study breach parameters, velocity distribution, depth variation, and conveyance area of flow are considered. The dam break model simulated the unsteady flow conditions for overtopping and pipping failure cases. The probable maximum flood (PMF) corresponds to a failure condition, and at crucial downstream locations, the HEC-RAS tool is used to calculate the breach outflow condition. The results of a simulation of the HEC-RAS model for breach parameters were determined and compared to a case study of the Hidkal dam in Karnataka. A sensitivity study is also done to see how the breach parameters affect peak flow and maximum stage. The village and inundation area situated near the dam is impacted by the water that results from the dam breaking. The research demonstrates that failure caused by overtopping is more severe than failure caused by pipping.

Keywords: Dam break; emergency planning; hydraulic model; HEC-RAS; breach hydrograph, breach parameters

Impact of LULC on hydrological settings of Savitri River watershed at Raigad, Maharashtra using SWAT model.

Sudarshan Bobade[1*], Arun Dhawale[2], Ranjeet Sabale[3]
[1]Associate Professor & Head of the Civil Engineering Department, Pimpri Chinchwad College of Engineering & Research, Ravet, Pune, ORCID- 000-0001-7839-1855.
[2] Professor, Civil Engineering Department, Pimpri Chinchwad College of Engineering & Research, Ravet, Pune. ORCID- 0000-0001-7175-3809.
[3]Assistant Professor, Civil Engineering Department, Pimpri Chinchwad College of Engineering & Research, Ravet, Pune. ORCID- 0000-0003-4944-4625.
* sudarshan.bobade@pccoer.in

Abstract

Predication of hydrological parameters plays vital role in water resource management. Moreover, the success of any hydrological modeling is depending upon the accuracy of input data provided. The present work is organized to address the impact of Land Use Land Cover (LULC) on hydrological settings for Savitri River at Raigad, Maharashtra using robust agro-hydrological model SWAT i.e. (Soil and Water Assessment Tool). The meteorological data for research work was collected from IMD Pune for the period (2000-2020). The LULC data was collected from Bhuvan website, using maximum likelihood image classification in ArcSWAT that data was classified into five land use patterns. The SWAT model is processed on 580 sq.km area, after delineation process whole study area is divided into 42 sub-basins and in 212 HRUs. The SWAT model is calibrated (2003-2010) and validated (2011-2015) using observed stream flows which are collected from HDUG group Nasik in SWAT-CUP tool. NSE and R2 are used as the statistical parameters to check the sensitivity of work. It is observed that the NSE values are 0.74 & 0.78 in calibration and validation respectively. Similarly, the values of Coefficient of determination (R^2) are 0.81 & 0.84 in calibration & validation respectively. Altogether, the simulated data and observed data show good degree of fitness indicating the acceptance of SWAT model. The results show that from (2000-2020) the 8 % agricultural area converted to residential area, also 5% reduction in bare land is observed. The study concludes with as residential and infrastructure development changes the prevailing LULC pattern and thereby the alarming situation like flash flood, increased runoff, alleviated infiltration and lowered groundwater tables scenarios happen frequently which is also responsible for landslides and sedimentation in water bodies. The outcomes of this work will be helpful to water managers and policy makers to plan the sustainable agriculture and water resources management also to take corrective steps to mitigate the problems due to the influence of changed LULC.

Keywords: SWAT, LULC, Simulation, Irrigation, Surface water.

Correlation study between water yield and consumptive use by SWAT model: A case study of Darewadi, Maharashtra

Arun Dhawale[1*], Sudarshan Bobade[2], Ranjeet Sabale[3]

[1] Professor, Civil Engineering Department, Pimpri Chinchwad College of Engineering & Research, Ravet, Pune. ORCID- 0000-0001-7175-3809.

[2]Associate Professor & Head of the Civil Engineering Department, Pimpri Chinchwad College of Engineering & Research, Ravet, Pune. ORCID- 000-0001-7839-1855.

[3]Assistant Professor, Civil Engineering Department, Pimpri Chinchwad College of Engineering & Research, Ravet, Pune. ORCID- 0000-0003-4944-4625.

* awdhawale2009@gmail.com

Abstract

In arid and semi-arid areas water management is essential for maintaining a sufficient and dependable water supply. As India has uneven distribution of rainfall and also due to climate change the rainfall pattern is greatly affected. As results many places in India suffers from water scarcity issues. Hence, it is more important to have the correlation between water available and its consumptive use. Therefore, this study is devoted to estimate the water available in the Darewadi basin and its usage. To achieve the defined goal this study engages two powerful tools namely SWAT (Soil & Water Assessment Tool) and Modified Penman Method (MPM). To process the SWAT model, the meteorological data from IMD Pune was used for period (2000- 2020). The SWAT model is calibrated and validated using SUFI-II algorithm in SWAT-CUP. The methodology was adopted as, MPM results and the actual evapotranspiration values obtained from the SWAT model were compared. The findings indicate that the average curve number for study area is 79, and evapotranspiration was 561 mm. The maximum crop water demand was observed at 2009 and it was 561 mm, similarly water yield for year 2009 is 457.39 mm and Precipitation for year 2009 was 470.2 mm. additionally, it was found that the research area experiences salinization since the rate of evaporation is higher than the rate of precipitation. This study helps with future water demand predictions and management, as well as the identification of potentially salinized areas. The study's conclusions can be used by researchers and decision makers to manage and distribute water resources in a sustainable way.

Keywords: Modified Penman Method, SWAT, Water budget, Surface water, Irrigation.

Ranking Extreme Precipitation Events over Brahmaputra River Basin during the Indian Summer Monsoon

Hariom Gupta[1], Akash Singh Raghuvanshi[1*], Ankit Agarwal[1]
[1]Department of Hydrology, Indian Institute of Technology Roorkee, Roorkee, Uttarakhand, India - 247667
*akash_sr@hy.iitr.ac.in

Abstract

Extreme precipitation events have become more frequent over the Indian subcontinent in recent years. The natural ecosystem and human society are negatively impacted by variations in the frequency, intensity, and duration of extreme precipitation events. Multi-day extreme precipitation that occurs on consecutive days are a primary source of floods, and they have increased significantly in recent years and are expected to continue in the future. The Brahmaputra River basin faces higher flooding risk in India, primarily during Indian summer monsoon, due to its vulnerability, hazard probability, and transboundary nature. Therefore, it becomes essential to rank such extreme events based on their characteristics. In this study, we ranked multi-day precipitation extremes (1-,3-,5- and 7- days) on the basis of intensity and spatial extent during the Indian summer monsoon (ISM) season over the Brahmaputra basin in India using a high-resolution daily precipitation dataset for 71 years period (1951 - 2021). Our findings highlight the robustness of the method adopted to accurately detect, rank and pinpoint the locations of multi-day extreme precipitation events in Brahmaputra River basin. Assessing the characteristics of multi-day precipitation extremes could aid in timely forecasting and mitigating risks.

Keywords: Multi-day ranking, precipitation extremes, Brahmaputra River basin, Indian summer monsoon (ISM).

Assessment of Flow Regimes and Water Temperature: A case study on Yamuna and Bhadra River Systems

Satish Kumar Mummidivarapu[1], Jaya Bharat Reddy B.[1], Taha B.M.J Ouarda[2], Shaik Rehana[1]*
[1]Hydroclimatic Research Group, Lab for Spatial Informatics, International Institute of Information Technology, Gachibowli, Hyderabad, Telangana – 500032
[2]Canada Research Chair in Statistical Hydro-Climatology, Institut national de la recherche scientifique, Centre Eau Terre Environnement, INRS-ETE, 490 De la Couronne, Québec City, QC, Canada
* rehana.s@iiit.ac.in

Abstract

Risk assessment is vital for comprehending and managing river water quality control. By ensuring a systematic approach for evaluating potential risks, it encourages the adoption of efficient management strategies, the use of informed decision-making, and maintaining of river ecosystems. An effective framework is developed by integrating the empirical based approach with Gumbel-Copula function to estimate the river water quality risk under high water temperatures and low flow rates. Based on Akaike Information Criterion (AIC) among Copula based Gumbel, Gaussian, t, and Clay-ton functions, the Gumbel-Copula function was utilized in the study. The percentiles ranging from 5 to 95 with 5 percentile interval of Stream Flows (SF) and reverse order percentiles of Water Temperatures (WT) are employed in the estimation of risk of river water quality. The current risk quantification approach was implemented using observed datasets on Yamuna (2000 to 2015) and Bhadra (2006 to 2017) river systems. The results reveal that at 50 percentile (SF=380 m3 /s and WT=27.38 °C) the join risk is about 75.29% for Yamuna River and similarly for Bhadra river the risk is about 77.62% (SF=7.20 m3 /s and WT=25 °C).

Keywords: Risk assessment, copula, Gumbel, water quality.

Optimal Reservoir Operation using Rao Algorithms

V. Paliwal[1*], A.D. Ghare[2] and A.B. Mirajkar[2]
[1]Moze College of Engineering, Pune, India
[2]V.N.I.T, Nagpur, India
*vartikapaliwal19@gmail.com

Abstract

In this study, Rao algorithms (metaphor-less heuristic algorithms) are applied to derive the optimal operational releases of the Mula reservoir, Upper Godavari basin. The optimal operation releases for 75% probable inflows are compared to the optimal operational releases obtained from Jaya Algorithm (JA) and Non-Linear Programming (NLP). Simulation studies are carried out using real inflows corresponding to 75% probable inflows. The results show that Rao algorithms provided better and comparable results to the result obtained from JA and NLP. Rao algorithms are found to be suitable in application to reservoir operation studies.

Keywords: Reservoir operation, optimization, simulation, metaphor-less algorithms.

Design of Water Distribution Network Using EPANET Software

S.R. Phulpagar[1*]; R.M. Sawant[2]; J.R. Gaikwad[2] ; V.V. Gangawane[3] ; A.K. Ghate[3] ; P.A. Paikrao[3] ; S.N. Gaikwad[3]
[1]Assistant Professor, P.E.S. College of Engineering, Aurangabad, E-mail ID:
[2]Associate Professor, P.E.S. College of Engineering, Aurangabad, E-mail ID:
[3]B. Tech final year student, P.E.S. College of Engineering, Aurangabad
*sanjup1213@gmail.com

Abstract

The inability to supply sufficient water to meet the demands of the continually growing population is one of the biggest challenges to the development of an effective water supply system. Around the world, the population is increasing rapidly as technology is advancing, which drives up the demand for drinkable water. Water supply is the process of supplying an adequate and consistent amount of water through a planned network of pipes in order to meet the demands of a population that is always expanding. EPANET is a public domain software using which we can design any sort of water distribution network (WDN). In this study, EPANET software is used to design and analyse the hydraulics of the WDN. In the present study, the WDN is designed for the Jubilee Park region, Aurangabad district of Maharashtra, India. System In the present study, the WDN has been designed with the help of EPANET in which we use the number of nodes, elevation, and number of pipes and demands of the study area. Keywords: EPANET, Water Distribution Network (WDN)

Design of Water Distribution System for Nandanvan Colony, Aurangabad, Maharashtra State Using EPANET

S.R. Phulpagar[1*]; R.M. Sawant[2]; J.R. Gaikwad[1]; S.N. Gaikwad[3]; V.V. Gangawane[3]; A.K. Ghate[3]; P.A. Paikrao[3]
[1]Assistant Professor, P.E.S. College of Engineering, Aurangabad
[2]Associate Professor, P.E.S. College of Engineering, Aurangabad,
[3]B. Tech final year student, P.E.S. College of Engineering, Aurangabad
*sanjup1213@gmail.com

Abstract

Basic infrastructure, like water supply, is growing more and more necessary for supporting this development in nations like India as they continue to urbanize and develop. Maharashtra State in India is one such region where water distribution systems (WDS) are crucial for providing potable water to end-users. The software used to develop water distribution networks (WDNs) is essential, and this study reviews the use of Environmental protection agency network evaluation tool (EPANET), a public domain software that can design any type of WDN. The current work utilizes EPANET to design the hydraulic aspects of the WDN for the Nandanvan Colony, Aurangabad, Maharashtra, India. This study utilizes various factors such as the number of nodes, elevation, pipes, and demand of the study area to develop the WDN. The study offers a novel approach to designing and analysing the WDS using EPANET software, offering insights into the design and planning of effective water supply systems.

Keywords: EPANET, Water Distribution Network, Nandanvan colony.

Optimize the Water Distribution System Network by Considering Future Demand by Using EPANET

S.R. Phulpagar[1*]; R.M. Sawant[2]; A.K. Ghate[3]; S.N. Gaikwad[3]; P.A. Paikrao[3]; V.V. Gangawane[3]
[1]Assistant Professor, P.E.S. College of Engineering, Aurangabad
[2]Associate Professor, P.E.S. College of Engineering, Aurangabad,
[3]B. Tech final year student, P.E.S. College of Engineering, Aurangabad
*sanjup1213@gmail.com

Abstract

This study aims to optimize the water distribution system (WDS) network by considering future demand scenarios and varying hydraulic parameters such as velocity, headless, discharge, etc. The study area is Padegaon, Chhatrapati Sambhaji Nagar (Aurangabad) region in Maharashtra. The proposed WDS network is laid out based on tentative street layouts obtained from Google Street Maps, and geographic information system (GIS) technology is applied. hydraulic software EPNAT is used for simulation, and various pipe materials are considered, considering the demand pattern. This research study provides peak values for various parameters for different demand patterns using different roughness coefficients, i.e., different pipe materials, thus providing economic results in different ways. The study offers insights into optimizing WDS networks by considering various factors to improve the reliability and cost-effectiveness of water supply systems.

Keywords: EAPANET, Water Distribution Network, Hazen-William's, Padegaon.

Water Distribution Network using EPANET: A Case Study of the Pethe Nagar

S.R. Phulpagar[1*]; R.M. Sawant[2]; Gaikwad P.A. Paikrao[1]; A.K. Ghate[3]; S.N. Gaikwad[3] & V.V. Gangawane[3]
[1]Assistant Professor, P.E.S. College of Engineering, Aurangabad
[2]Associate Professor, P.E.S. College of Engineering, Aurangabad,
[3]B. Tech final year student, P.E.S. College of Engineering, Aurangabad
* sanjup1213@gmail.com

Abstract

To fulfil the water demand of the continuously growing population, it is essential to provide a sufficient and uniform quantity of water through the designed network of pipes. In this research, the analysis of existing network was studied and concludes the reliability of the network using EPANET software. EPANET software is a simulation tool that is used for the efficient distribution of water supply. For the analysis of the existing water distribution system, various data are required the primary water source, the population of the area, demand for water, the requirement of the pumps, distribution network, and water tanks. The google earth image of the Pethe Nagar located in the Aurangabad district of Maharashtra is downloaded and all necessary data is taken manually. These data were used in EPANET software for analysis of pressure, head loss, and elevation. This analysis resulted in pressure and elevation at various nodes and head loss at various pipes.

Keywords: EPANET, Water Distribution Network, Pethe Nagar.

Enhancement of profile design in Pump as Turbine (PAT)

Naveen Kumar Bhukya[1*], Ali Abbas [2], Anant Kumar Rai [1]
[1]Department of Mechanical Engineering, NIT Warangal
[2]Flovel Energy Private Limited, Faridabad – 121003, Haryana, India
*bn21merer11@student.nitw.ac.in

Abstract

Pumped storage hydropower plants (PSP) play a crucial role in energy storage, load balancing, grid stability, integration of renewable energy, peak power generation, and long duration of storage. A major component in a PSP is Pump as Turbine (PAT) which has lower efficiency compared to a conventional turbine during turbine mode operation. This is because a PAT is primarily designed for working as a pump around a narrow range of operating conditions. Thus, the operation of PAT in turbine mode leads to low efficiencies, flow instabilities, etc. To improve the pump as well as turbine performance characteristics of a PAT, one of the most influencing parameters is the blade profile. The optimization of the blade profile can lead to better characteristics of a PAT; however, blade profile optimization often leads to thin sections in the profile which are prone to failures due to stresses during operation. Here, a stress analysis is considered on the blade profile of a PAT, and specific failure zones were identified. In the failure zone, the blade profile was modified to reduce the stresses while optimizing the performance using Solid Works and Ansys software. In the Solid Works simulation, the maximum value of pressure observed on the blades was 0.5 MPa during pump mode operation. This study will be useful in enhancing the overall efficiency of a PSP as their role in integrating renewable energy storage is going to be critical in the future.

Keywords: pumped storage plants, pump as turbine, blade profile, stress analysis, optimization

Spatial Propagation of Soil Moisture Drought in India: Application of Complex Network Theory

Kasi Venkatesh[1], Bellie Sivakumar[1*]
1Department of Civil Engineering, Indian Institute of Technology (IIT) Bombay, Mumbai, India
*b.sivakumar@iitb.ac.in

Abstract

Drought can have serious consequences for our water resources, agriculture, and environment often covering hundreds of kilometre's in space and can last for several months or years. Understanding the propagation of droughts is therefore crucial for devising and undertaking drought mitigation and adaptation measures, especially in a high-risk region like India. We use complex network theory to investigate the spatial propagation of soil moisture drought in India. We construct spatial drought networks using event synchronization (ES) for mild drought condition derived using the Standardized Soil Moisture Index (SSMI) at an aggregated scale of 3 months (SSMI-3). The proposed framework is applied to identify critical source regions responsible for large-scale drought onsets during 1950–2014 using the SSMI. Network divergence, Indegree, and Outdegree network metrics are applied to identify locations (source and sink regions) where the drought onsets further propagate to other areas within the regional spatial networks. The results indicate that the western regions (Rajasthan, Gujarat, and Madhya Pradesh) as the source regions that are prone to mild drought events that can propagate to farther regions in the south and east (sinks). The proposed framework could help in developing an early warning detection system for droughts.

Keywords: Drought Propagation, Soil Moisture drought, Standardized Soil Moisture Index, Event Synchronization, Complex Networks.

Heavy Metal Pollution Index and Health Risk Assessment for the Yamuna River, India

Abdul Gani[1], Shray Pathak[2], Athar Hussain[1*]
[1]Department of Civil Engineering, Netaji Subhas University of Technology, New Delhi-110073, India
[2]Department of Civil Engineering, Indian Institute of Technology Ropar, Rupnagar 140001, Punjab, India
* athar.hussain@nsut.ac.in

Abstract

The River Yamuna in Northern India carries significant mythical and sociocultural significance. It serves as a vital water resource, originating from the northern Himalayan region of India and flowing through the city of Delhi. The primary cause behind the water pollution in the Yamuna River is the discharge of untreated residential and industrial wastewater in the vicinity of the capital city of Delhi. The present study is focused on evaluating the pollution levels of heavy metals in drinking water, a consequence of extensive industrialization, through risk assessments and the examination of their occurrence in water sources. Specifically, four sampling locations were selected with 25 samples each along the 22-kilometer stretch were collected in January 2022. Subsequently, we computed the modified heavy metal pollution index (mHPI) which consists of positive index (PI), and negative index (NI). Our analysis revealed elevated concentrations of heavy metals, such as arsenic, lead, and mercury, signifying a critical state of the river. At the sampling sites, the lead concentration exhibited a range, with the highest concentration recorded at Wazirabad (2332 µg/L) and the lowest at Okhla Barrage (1092 µg/L). However, when it comes to the PI and NI values, the highest values of 2639.97 and -0.02 were found at Wazirabad and Okhla, respectively. Conversely, the lowest PI and NI values of 31.21 and -0.79 were detected at the Nizamuddin sampling location. Moreover, we have assessed the health hazards associated with exposure to heavy metals using exposure measures like the Hazard Quotient (HQ) and the carcinogenic risk (CR) models. Persistent exposure underscores the need for robust measures to mitigate heavy metal contamination in river water by implementing stringent controls on waste discharge by adopting sustainable agriculture practices.

Keywords: Water Quality, Heavy metals pollution index, contamination, carcinogenic risk.

Assessment of Surface Water Quality of River Yamuna, India using Qual2k Software

Abdul Gani[1], Mohit Singh[1], Shray Pathak[2], Athar Hussain[1*]
[1]Department of Civil Engineering, Netaji Subhas University of Technology, New Delhi-110073, India
[2]Department of Civil Engineering, Indian Institute of Technology Ropar, Rupnagar 140001, Punjab, India
* athar.hussain@nsut.ac.in

Abstract

Rivers are regarded as one of the planet's most essential sources of water for agriculture needs, industrial demands, and other purposes. River systems are particularly prone to the adverse effects of environmental pollution due to their dynamic character and simple accessibility for the disposal of waste materials. Dumping of sewage, inadequate treatment of waste from both big and small corporations, land clearing, and construction activities are the primary sources of pollution in rivers. As a consequence of these pressures, rivers have become saline and alkaline, nutrients have been released leading to the formation of algae blooms and eutrophication, and there is chronic pollution in rivers from organic pollutants, pesticides, and toxic metals. The town and its surrounding environment rely heavily on the Yamuna River in India for their existence. However, the river is regularly contaminated with different types of toxins due to evolutionary, ecological, and environmental factors, and the harmful effects of these toxins are becoming more significant over time. Decision-making guided by water quality statistics is critical in the context of water quality evaluation since a variety of aspects impact its quality. Modelling the water quality characteristics is essential when undertaking a study of any aquatic system. Surface water quality evaluation and prediction are required for successful river basin management so that adequate actions may be implemented to guarantee that pollution levels remain below allowable limits. The essence of good water resource management is precise forecasting of future occurrences related to water quality. As a result, the Water Quality Model, Qual2k, was utilized to replicate several water quality variables namely electrical conductivity, dissolved oxygen, carbonaceous biochemical oxygen demand, NH_4-N, NO_3-N, and pH. The observed data from January 2012 to August 2022 were used to calibrate and validate the Qual2k model. As a result, the Qual2k model was established as a useful tool for future water quality evaluation and forecasting.

Keyword: Surface water, Qual2k, Water Quality, Yamuna River.

A Review of Various Scouring Phenomenon's in Open Channel

Pallavi, T[1], Pasha, Md[1], Sathwika, S[1], Sravan, K[1], Devi, K[2], Pallavi, Badry[3]
[1]Student, Department of Civil Engineering, Vidya Jyothi Institute of Technology, Hyderabad-500075, INDIA
[2]Assistant Professor, Department of Civil Engineering, Chaitanya Bharathi Institute of Technology, Hyderabad-500075, INDIA
[3]Professor, Dept. of Civil Engineering, Vidya Jyothi Institute of Technology, Hyderabad-500075, INDIA
* thumupallavireddy2003@gmail.com,

Abstract

Scouring is the phenomenon that is caused by erosion of soil particles from the riverbed. Basically, the scouring occurs when the erosion shear stress exceeds the critical shear stress. The size, shape and density of sand particles, flow velocity, flow depth, turbulent intensity and shape of scour hole influence the complex process of transportation and deposition of sediments. There are many types of scouring like local scouring, general scouring, contract scouring, abrasion scouring, degradation scouring and lateral scouring. Previously many researches are done on local scouring such as identifying the scour depth and flow characteristics by using models, understanding the flow behaviour by considering the flow conditions like waves and currents, determining the depth of scour with the use of empirical formula that depends upon parameters like diameter of particle (D), diameter of pile (b), hydraulic gradient (i), water depth (do), mean velocity of the undisturbed flow (v), critical velocity (v*), froude number (Nf). The empirical formulae are developed by considering flow parameters and geometrical parameters. Scour under wall jet is a phenomenon occurs due to the difference in the flow velocity between wall of the channel and centre of the channel. However, the scouring can be prevented by methods like protective mattress, rock protection, block mattress. Further various research techniques are used to reduce the scouring near the hydraulic structures such as reducing flow velocity of water, Riprap or Rock Armor, gabions, erosion control blankets/mats, pile/sheet pile foundations. In this research various previous literatures have been extensively studied on scouring which can be useful in designing the hydraulic structures.

Keywords: Erosion shear stress; Critical shear stress; Turbulent Intensity; Wall jet.

Utilizing IOT Based Low-cost Temperature Sensors in Sewage Treatment Plants: An Essential Approach for Enhanced Monitoring and Operational Efficiency

Satish Kumar Mummidivarapu[1], Thomas David Tency[2], Rehana Shaik[1*], Avantika Latwal[1], Rajesh Maddu[1], Sachin Chaudhari[2], K S Rajan[1]
[1]Lab for Spatial Informatics, International Institute of Information Technology, Gachibowli, Hyderabad, Telangana, India – 500032
[2]Signal Processing and Communication Research Centre, International Institute of Information Technology, Gachibowli, Hyderabad, Telangana, India– 500032
*rehana.s@iiit.ac.in

Abstract

Sewage treatment plants (STPs) play a critical role in maintaining public health and preserving the environment. Effective monitoring of key parameters within these facilities is vital for ensuring optimal plant performance and compliance with regulatory standards. Among various parameters, temperature is a fundamental parameter that provides valuable insights into the treatment process. Temperature serves as a key indicator of the biological and chemical processes occurring within an STP. The utilization of dedicated temperature sensors offers several advantages over alternative monitoring approaches. Compared to manual temperature measurements, automated sensors provide continuous and real-time data, enabling prompt responses to temperature fluctuations. These sensors leverage advanced technologies to ensure accurate measurements while maintaining a low overall system cost. Additionally, advanced sensors equipped with wireless connectivity and Internet of Things (IoT) capabilities facilitate remote monitoring and data collection, reducing the need for on-site personnel and enabling proactive maintenance strategies. The implementation of temperature sensors in STPs can lead to significant improvements in operational efficiency, energy optimization, and cost-effectiveness. The deployed Internet of Things (IoT) based, cost-effective temperature sensor was installed in the treated tank of STP with a capacity of 400 Kilo Liters per Day (KLD). The STP is situated at the International Institute of Information Technology Hyderabad. The water temperature data delivered from sensor to cloud and then to user is varying from the 23℃ to 28℃. The integration of temperature sensors in STPs paves the way for improved sustainability, reliability, and environmental stewardship in wastewater treatment operations.

Keywords: Water quality, IOT, Temperature sensors, STP, Efficiency

Changing Characteristics of Extreme Precipitation in India at Sub-daily to Daily Time Scales for Current and Future

Yaswanth.P[1*], Balaji Narasimhan[1]
[1]Indian Institute of Technology Madras, Chennai, India
*yaswanthpulipati@gmail.com

Abstract

India has historically experienced numerous floods that have impacted millions of people, resulting in loss of lives, and damaged infrastructure and agriculture. Moreover, climate change exacerbates the frequency and intensity of extreme rainfall, especially at sub-daily time scales. Although substantial analysis of extreme precipitation has been investigated daily, limited studies have explored changes at fine resolution time scales due to a lack of observations. The current research explores the differences in extreme rainfall variability across India from sub-daily to daily time scales. Daily and sub-daily rainfall data from India Meteorological Department (IMD) and gridded rainfall products from IMD are utilized in the current study. The study employs a connected component analysis to understand the changes in the areal extent of extreme precipitation using different rainfall thresholds. Generalized Extreme Value (GEV) distribution is utilized for sliding window time series to understand changes in the distributional parameters over time. The trend analysis is conducted to understand the differences in extreme rainfall. The results reveal a positive trend for most of the study regions in both temporal and spatial dimensions. The magnitude of the trend is noticed to be higher for hourly rainfall than at daily time scale in the majority of the regions. Three General climate models (GCMs) from the CMIP6 group are selected to project future daily rainfall changes. A distribution mapping approach on a sliding window time series is followed to bias correct the rainfall data from GCMs. Ec-Earth3, Ec-Earth3-Veg and GFDL-ESM4 are the three GCMs employed in the current study owing to their high spatial resolution among all the GCMs available in the CMIP6 consortium. Results reveal a substantial increase in the extreme precipitation for the future in spatial-temporal scales, with the highest notices observed in the end-century. The current study provides an understanding of the changing characteristics of extreme rainfall in the Indian region and assists in adaptation planning and implementation.

Keywords: Extreme precipitation, climate change, spatial-temporal analysis, GEV distribution

Modeling and Prediction of Feature Centric River Water Temperature using Machine Learning Algorithms in Data Scarce Regions

Rajesh Maddu[1], Mohammed Lokhman Rizwan[2], Jaswanth Nidamanuri[2*], Shaik Rehana[1]
[1]Hydroclimatic Research Group, Lab for Spatial Informatics, International Institute of Information Technology, Gachibowli, Hyderabad, Telangana, India
[2] Centre of Excellence – AI & Robotics School of Technology, Woxsen University, Hyderabad, Telangana, India
* jaswanth.nidamanuri@woxsen.edu.in

Abstract

Though process-based models could give very accurate results, it requires large amounts of site-specific detailed data, including stream geometry, a complete set of meteorological variables, and the hydraulic properties of the river, which are unavailable for many river systems. To overcome this, due to its capability to simulate complicated and non-linear relationships between the response variable (such as River Water Temperature, RWT) and its few explanatory input variables (such as Air Temperature, AT), machine learning (ML) has become more and more popular. The primary focus of this work is twofold: Initially, to investigate and demonstrate how new hybrid ML approach, that is Support Vector Regression (SVR), to predict accurate RWT estimates with minimal explanatory variables in the form of AT. Secondly, to provide a detailed ablation study on performance metrics on selected feature importance. Importantly, the proposed modeling framework's effectiveness is demonstrated by considering near real-time data with river system located in India as case study. The most reliable ML model for RWT prediction has been identified as the SVR.

Keywords: Air Temperature, Machine Learning, River Water Temperature, Support Vector Regression.

An Overview of Studies on Sustainable Shore Protection using Chrysopogon Zizanioids (Vettiver)

Shankar Ganesh M[1] and Sannasiraj S. A[2]
[1] Research Scholar, Department of Ocean Engineering, IIT Madras,
[2] Professor, Ocean Engineering, IIT Madras, Chennai, India
*shankarganesh1993@gmail.com

Abstract

Coastal protection is an important parameter which is meant for protecting coastal structures from Environmental parameters such as Waves, Currents, storm surge and Tsunami. For preventing or protecting human beings, infrastructure during extreme events it is mandatory for providing adequate coastal protection measurements like Breakwater, Seawall, Sea dikes, Revetments and Geotextiles. But the Coastal protection measures with the help of above said measures like Breakwater and Seawall construction will become more expensive. In order to achieve the Shore protection in a techno economic feasible manner, we will be going for sustainable measure like Vegetation.

In this paper, Shore protection with the help of vegetation will be described for better understanding of ecofriendly shore protection measure which safeguard the Shore without disturbing the Shore. The Stiffness property of vegetation plays a crucial role in preventing the shore from preventing wave overtopping, erosion on coastal structure. In this paper Shore protection is carried out by Vettiver plant (Chrysopogen zizinoids). Tensile strength test done for dry and wet vetiver grass and roots. Slenderness ratio studies done for a correlation study of Vettiver resistance against wind speed. A Comparative study done for root and grass tensile strength. Field study done for vetiver growth in Saline environment and Coastal Sand at Northeast coast in Chennai. Vettiver's resistance against ocean waves were checked with Field studies. Flow resistance test done for Vettiver to check its suitability against disasters like Tsunami as well as Storm surge. The Satellite and Field based studies done for Vettiver planted Tsunami affected area at Nochikadu Cuddalore were examined before and after Tsunami to prove its suitability as Coastal protection as a replacement to conventional methods like Sea Wall and Groynes.Field study done for Embankment protection at Chennai Corporation Park near Kotturpuram railway station for Adyar river. A Validation study for Experimental Physical modelling results by Norayan et.al will be compared with the software PC Overtopping. A Proposal study of Floating vetiver system done to dissipate Wave as well as Sea water purification.

Variable Response of Ecosystem Productivity towards Agricultural and Meteorological Drought over India

Akshay Pachore 1*, Anjali C V 2, Suyog Khose 3, Renji Remesan1
1 School of Water Resources, Indian Institute of Technology Kharagpur, India
2 Indian Institute of Technology Palakkad, India
3 Agricultural and Food Engineering Department, Indian Institute of Technology Kharagpur, India
* abpachore@kgpian.iitkgp.ac.in

Abstract

Ecosystem productivity has a direct connection with the food security of the region, which is highly influenced by the meteorological and agricultural drought conditions. In this analysis, the connection between ecosystem productivity, agricultural drought, and meteorological drought is analyzed for all 34 meteorological sub-divisions of India. GPP anomaly, which is a representative of the ecosystem productivity is observed to have a declining trend from winter to pre-monsoon, and further, it shows an increasing trend till post-monsoon season for most of the regions. The connection of the regions with different climatic conditions is explored with the ecosystem productivity (GPP anomaly) and Standardized Soil Moisture Index (SSMI) in response to Standardized Precipitation Index (SPIn). It was observed that the soil moisture is having more control on GPP anomaly than SPI, showing the significance of soil moisture for the carbon sequestration of the region. The seasonal analysis has highlighted that, the GPP anomaly has a stronger correlation with SSMI during the Winter (e.g., correlations for SK:0.7877, MMRH:0.5985, and WRJ:0.7474) as compared to other seasons. This investigation has identified the contrasting behaviour of arid and humid climatic zones in terms of the correlation between water stress across various domains. It has also highlighted the influence of the seasonally dynamic weather on this inherent relationship. The study’s findings provided valuable insights for the policymakers and stakeholders, enabling them to understand the diverse impact of meteorological water stress on ecosystem productivity and agricultural drought. This knowledge may be used to develop more robust water policies in India, with a focus on enhancing the ecosystem resilience.

Keywords: Ecosystem productivity, GPP anomaly, SPI, SSMI, Meteorological Drought, Agricultural Drought.

Development of Local Meteoric Water Line for Kanpur, Uttar Pradesh

Singh, P.[1], Balan D.[1], Ojha, R.[1], Srivastava, R.[1], Tripathi S.[1], Guha,S.[1]
Krishan, G.[2], Rao, MS.[2]; Thakur, P.[2],
[1]Department of Civil Engineering, Indian Institute of Technology Kanpur, Kanpur, India
[2]National Institute of Hydrology, Roorkee, India
*praveshs21@iitk.ac.in

Abstract

Local meteoric water lines (LMWLs) provide essential information about the isotopic characteristics of local precipitation, serving as a benchmark for characterizing various hydrological processes and moisture sources and degree of sub-cloud evaporation. Different forms of precipitation occurring at a site should be included in developing an LMWL. However, most studies only use rainwater, while other meteoric water sources are excluded as they are not easily available. Once isotopic compositions ($\delta^{18}O$ and $\delta^{2}H$) of precipitation are available, LMWLs are developed using ordinary least square regression, which assumes that the predictor variable ($\delta^{18}O$) is error-free, while the predicant variable ($\delta^{2}H$) may contain known errors. However, this assumption is invalid since commercially available water isotope analyzers have a reported uncertainty of about ±0.3‰ and ±0.1‰ for $\delta^{2}H$ and $\delta^{18}O$, respectively, which may be higher in actual conditions depending on the analysis sequence and operating procedure at labs. In this study, we developed an LMWL using isotope values of rainwater (58) and dew-water (35) samples collected between 2022-2023 at an experimental plot located in IIT Kanpur. The slope and intercepts of developed LMWL ($\delta^{2}H=7.84\pm0.29\ \delta^{18}O+ 8.27\pm2.63$, $R^2=0.98$) is slightly lower than the global meteoric water line ($\delta^{2}H =8\ \delta^{18}O +10$), which may be due to the evaporative enrichment of raindrops or evaporative losses during the rainout process. Finally, the effects of dew water and measurement uncertainty on LMWL will be explored.

Keywords: Stable isotopes, Local meteoric water line, Rainfall, Dew

Analysis of Rainfall Events and Modelling of Urban Hydrology for Effective Flood Management in Hyderabad, India

Padmini Ponukumati1, Saipriya S R[1], Sneha Yakurke[1], Azharuddin Mohammed[1], Satish Kumar Regonda[1,2]
[1]Department of Civil Engineering, Indian Institute of Technology, Hyderabad, India
[2]Department of Climate Change, Indian Institute of Technology, Hyderabad, India
*ce19resch11009@iith.ac.in

Abstract

Urban flooding poses a significant challenge for cities, leading to hindrance in daily life activities thereby posing socio-economic losses. The chief causative factor for pluvial flooding is the rainfall, and high intense short duration rainfall exacerbates flooding issues with reduced response time. Further, high spatial and temporal variability in rainfall increases flood modeling complexity. Understanding of meteorological drivers and hydrological response of catchment assists in effective management of floods. In this regard, the current study aims to analyze flood event(s) of the year 2022 and run an urban hydrological model for a part of the region in the city of Hyderabad, India. In this regard, flood event(s) were selected based on rainfall magnitude and flooding incidents reported across social media and newspapers, and then an exhaustive analysis was performed. The analysis included a) understanding of atmospheric drives causing rainfall over the city for the selected flood event(s), b) assessing of spatio-temporal variability of the rainfall, c) analyzing the rainfall from the best alternative data sources i.e., Integrated Multi-Satellite Retrievals for GPM (IMERG), d) developing the EPA Storm Water Management Model (SWMM) model on the event-scale approach. This enables the detailed examination of a flood event and allows for a holistic understanding of the event characteristics as well as response of the catchment to the rainfall. Thus, it helps in flood mitigation efforts.

Keywords: Urban floods, Atmospheric drivers, IMERG Rainfall, SWMM, Hyderabad

Watershed Modelling Using HEC-HMS & QGIS In Teesta River Basin in West Bengal, India

Preeti Mondal[1*], Riya Banerjee[1], Swagoto Sarkar [1], Shouvik Roy[1],
Susmita Bakshi [2], Sheak Hasim[3]
[1]Student, Dept. of Civil Engg., Meghnad Saha Institute of Technology, Kolkata-700150, India
[2]Assistant Professor, Dept. of Civil Engg., Meghnad Saha Institute of Technology, Kolkata-700150, India
[3]Associate Professor, Dept. of Civil Engg., Meghnad Saha Institute of Technology, Kolkata-700150, India
*munupreeti@gmail.com

Abstract
Simulation of watershed models for conversion of precipitation to stream flow, have been a major focus of hydrological research and investigations. In developing countries like India, operational and maintenance cost of gauging on small and medium rivers is quite high. The runoff estimation from ungauged or poorly gauged catchment is therefore a major challenge. The objective of this study was to develop a watershed model of the Teesta River Basin at Kalimpong, Jalpaiguri, Kurseong & Siliguri District of West Bengal, India by using HEC-HMS hydrological model version 4.10. The study area is situated between 88° 23′E – 88° 49′E longitude and 26° 34’N - 26° 59’N latitude. The area covered by the model is 1254.37 Sq.Km. The Digital Elevation Model (DEM) used in this study was extracted from the website, Bhuvan. The basin model was created in HEC-HMS and Curve Number (CN) calculation was done by using QGIS. The Soil Conservation Service – Curve Number model was used to estimate the rainfall losses and the Soil Conservation Service Unit Hydrograph model used to transform the excess rainfall into a direct runoff hydrograph. Base flow was estimated by using Recession method. Muskingum method was used to achieve the Routing of the total runoff from the outlet of the sub-basin to the outlet of the whole basin. The Curve Number which is a function of hydrologic soil type and land use land cover was estimated in QGIS, based on which the loss, time of concentration & lag time has been calculated. The Hydrologic Soil group data was collected from ORNL DAAC and the land use land cover data was collected from ESRI website. The simulation of the model was performed using the rainfall data of Darjeeling and Jalpaiguri in the months of July, August, and September in the year of 2019 to 2022. The rainfall data was obtained from India-WRIS website. The model performance was evaluated based on the computed statistical parameters and visual examination of the hydrograph. The result obtained through the calibration of the model is quite satisfactory. The peak discharge, time of peak, and the runoff volume hydrograph was obtained from HEC-HMS.

Keywords: Peak discharge, Hydrograph, SCS curve number, Muskingum K and X, HEC-HMS, QGIS.

Quantifying the impact of storage volume and catchment area on reliability of rainwater harvesting system for various demand situations across India.

T.J. Prasad[1], T. Panging[1], K.K. Medida[1], A. Kumar[1], A.B. Gohain[1], C. Raj Kumar[1], A. Narayan[1] , T. Kumar[1] , K. Kashyap[1] , G. Swarnkar[1] , N. Baruah[1] , R. Buragohain[1]
[1]Tezpur University, Tezpur India
*rbgn@tezu.ernet.in

Abstract

A rainwater harvesting system typically comprises of a catchment area, pipe or channels, and a reservoir with optional overhead tank and pumping arrangement. The dependability of the system is a function of temporal distribution of rainfall, the available catchment area, the storage capacity, and many other variables. A mass balance method is developed and applied to determine reliability of a rainwater harvesting system for available catchment area and storage. Calculations involve analysis of historical rainfall data with respect to a demand schedule using storage volume and catchment area as variables and yields the annual reliability of the rainwater harvesting system. The analysis is done for different demand situations across 20 Indian cities using historical daily rainfall data. To generalize the output, the results are presented corresponding to per capita roof area and per capita storage volume. The calculations can be presented as a simple tool to be used by a prospective user to decide the optimal capacity of the storage to achieve a desired reliability. It can also be adopted by policy makers to assess and project the economic viability of rainwater harvesting systems based on location, demand and use case.

Keywords: Optimal storage capacity, Rainwater Harvesting, Reliability

Comparative Study of Geomorphological Instantaneous Unit Hydrograph (GIUH) models in the Banas River basin

G. R. Chauhan[1*], H. Sharma[1] & M. N. Langhi[1]
[1]Institute of Infrastructure Technology Research and Management, Ahmedabad, India
*Gunjan.chauhan.22pc@iitram.ac.in

Abstract

Ephemeral streams are often characterized by their limited flow time and flow length. These are often dry and only carry discharge due to very high precipitation upstream. However, due to temporal and spatial variations of such rainfall events, it is very hard to predict the runoff in such cases. Also due to economic reasons the in-feasibility of gauging such streams with measuring devices results in limited or no data availability which directly affects the calibration of hydrologic models. To overcome this difficulty one way is to develop a theoretical model which does not rely on past rainfall-runoff data. One such model is the Geomorphological Instantaneous Unit Hydrograph (GIUH) which solely relies on the geomorphology of the catchment hence omitting the need for past data. This model uses Horton's laws. GIUH is represented by the probability distribution function (PDF) of the drop's travel time. By convoluting PDFs one can determine the response of the basin to the precipitation. Since the determination of the probability distribution function is very difficult for higher-order streams. Many researchers have tried to combine the Nash model of a cascade of reservoirs and the Clark unit hydrograph model with the GIUH parameters. The present study aims to develop various GIUH models for the Banas River basin, an arid region of Rajasthan state of India. To determine the runoff generated, three types of GIUH models were developed namely GIUH with PDF, GIUH Nash model, and GIUH Fractal model and they are compared with the hydrograph generated by HEC-HMS Clark model. The hydrographs generated using conventional Horton's ratios fail to match the one given by the Clark model. However, the models generated by the modified GIUH Nash model and fractal model perform better and show a better fit to the Clark hydrograph than the GIUH PDF model. It is concluded that for better characterization of the channel network, modified Horton's laws give a more reliable estimate than the conventional one.

Keywords: Rainfall-runoff modelling, ungauged basin, geomorphology, probability distribution function, unit hydrograph, path probability

Trend Analysis of Precipitation and Drought Characteristics over Churu District of N-E Rajasthan, India

Shahid Patel[1], Darshan Mehta[1*], Dr. Hazi Azamathullah[2] & Shakera Patel[3]
[1]Dr. S. & S. S. Ghandhy Government Engineering College, Surat, Gujarat, India
[2]The University of the West Indies, Trinidad and Tobago, West Indies
[3]Prime College of Diploma, Navsari, Gujarat, India
*darshanmehta2490@gmail.com

Abstract

Drought is one of the most destructive natural disasters which becomes more extreme and less predictable due to climate change. Drought directly affects a region's water resources, leading to inadequate water availability and have adverse impact to crops, animals, and humans. Therefore, drought forecasting is crucial for proper planning and management of water resources and to minimize its negative effects. The objective of the present study is to assess the long-term trends of precipitation and drought characteristics for the Churu district of N-E Rajasthan, India. For this purpose, mean monthly precipitation data is collected through the India-WRIS from 1901 to 2022 (122 years). The trend analysis is carried out using statistical method (MK test & SS estimator) and the results are compared with graphical method (ITA). While, drought events are found using precipitation-based drought indices. i.e., Standardized Precipitation Index (SPI), Z Score Index (ZSI) and Percentage of Normal Precipitation Index (PNPI). Interestingly, the results of statistical method are well matched with the results of graphical method. The study concludes that the during the annual precipitation rising trend is observed, which can help to mitigate the severity of drought. Also, it is found that moderately dry droughts occur most frequently as compare to other drought events. This study will help policy makers and local administrators to take necessary action to mitigate the severity of drought as well as better management of water resources in the Churu district.

Keywords: Climate change; Trend analysis; Precipitation; Drought; Churu

Impact of land use land cover and climate change on evapotranspiration and potential evapotranspiration in a semi-arid region of southern India

Nathi Ajay Chandra[1*], Sanat Nalini Sahoo[2] & Anisha Das[3]
[1]Research Scholar, Department of Civil Engineering, NIT Rourkela, Odisha, 769008, India
[2]Assistant Professor, Department of Civil Engineering, NIT Rourkela, Odisha, India
[3]M. Tech Scholar, Department of Civil Engineering, NIT Rourkela, Odisha,769008, India
*nathi.ajaychandra@gmail.com

Abstract

This study examines how changing climate and LULC in southern India's semi-arid Chitravathi basin affect evapotranspiration (ET) and potential evapotranspiration (PET) in the near future (NF) (2015-2030). The future LULC map is produced using cellular automata and artificial neural networks (CA-ANN). ET and PET were estimated using the hydrological model SWAT (Soil and Water Assessment Tool). This study used the meteorological data (precipitation and temperatures) with a resolution of 0.25˚x0.25˚from ten gauging stations across the basin. Based on the Coupled Model Intercomparison Project 6 (CMIP6), Global Climate Model (GCM) MPI-ESM1-2-LR, the NF climate under the socioeconomic pathway SSP2-4.5 is projected. The SWAT model is calibrated for discharge data at a gauging station. SUFI-2 algorithm was used in the SWAT-CUP for the automation calibration of the SWAT model. Statistical measures were used to assess model performance, including coefficient of determination (R2) and Nash Sutcliffe efficiency (NSE). The model demonstrates an overall accuracy with R2=0.83 and NSE=0.81. The estimated future parameters were compared with the baseline (1985-2014) parameters. Results revealed that ET is 332 mm during the NF, and PET is 1683 mm. Compared to baseline values, 13.5% decreased ET and 37.5% increased PET were observed. This research will help design and implement adaptation measures to mitigate the effects of land cover and climate change on Chitravathi basin's water resources.

Keywords: Climate change, CA-ANN, ET, PET, SWAT, SUFI-2

Experimental and Numerical investigation of free decay motion of a wave energy converter model

K. Aiswaria[1], Balaji Ramakrishnan[1]
[1]Department of Civil Engineering, Indian Institute of Technology Bombay, Mumbai, 400076, India.
*aiswariaaa@gmail.com

Abstract

Physical experimental and numerical free decay tests are performed for a cylindrical wave energy converter device and the results are verified. The experiments are performed in a wave flume equipped with Qualisys motion-capture cameras which capture the heave decay motion of the model at high accuracy. The model is dropped freely from three known drop heights. The findings of the test can offer benchmark data for the validation of numerical models. The natural frequency and the equivalent linear damping of the model are estimated using the logarithmic decrement method. The experimental test results are compared to the numerical model simulation results obtained based on linear potential flow theory using WEC-Sim software. The results of the study will be valuable for acquiring a physical understanding of the system parameters and achieving higher device performance.

Keywords: Physical model tests, heave decay, wave energy converters, linear potential flow, numerical modelling.

Fluid Pineapple

Vijayakumar Mathaiyan[1*]
[1]Senior Software Engineer, Accenture, Bangalore, India
*vijayakumarmathaiyan@gmail.com

Abstract

Fluid phenomena called Fluid pineapple (FP) is actually a resultant of interaction of multiple laminar jets. The study of these properties is important for hydrodynamics because these underlining structures can be employed in construction of spillways and many other. This fluid phenomena are not only important in fluid mechanics but also in biology. Detailed parametric study is presented in this work with appropriate comments.

Keywords: Fluid Pineapple, Fluid flow, laminar jets, interaction

Establishment of Hydro-climatic Teleconnections for Monthly Indian Summer Monsoon Rainfall by Using ANN Model

Prajakta Jadhav[1*], Ganesh Kale[1]
[1]Sardar Vallabhbhai National Institute of Technology, Surat
*jprajakta2151@gmail.com

Abstract

Indian summer monsoon rainfall (ISMR) is a crucial factor, which affects country's economy. Prior knowledge about monsoon behaviour will be helpful for Indian farmers as well as for the policy makers. Hydrological variates are significantly associated with the atmospheric circulation. Statistical association among oceanic/atmospheric variates and hydrologic variates from different parts of the world is known as 'Hydro-climatic Teleconnection' (HCT). In the current study, the assessment of HCT between eleven circulation indices (each index having four lags) and monthly ISMR corresponding to two-time periods (two models) viz. 1950-2000 and 1950-2016 is performed by using mutual information (MI) criteria for input variable selection, interleaved data division method and combination of best performing algorithm and optimum number of hidden neurons in the final artificial neural network (ANN) model development. Significant inputs are selected for June, July and September rainfall corresponding to both the model by using MI technique, no significant indices are selected for August rainfall for both the models. Comparison of average correlation coefficients between observed and simulated monthly ISMR obtained in the current study and that obtained in the study by Singhania et al. (2018), clearly shows that, HCT assessment performed by using non-linear technique like ANN is superior to that of performed by multivariate linear regression. Present study concluded that, monthly ISMR is also affected by other lagged circulation indices in addition to ENSO. HCT between monthly ISMR is found to be constant for the months of June and September while for the July month it is changing with the time.

Keywords: ISMR, Artificial Neural Network, Hydro-climatic Teleconnection

Dam Break studies of Khadakwasla dam

Neha S. Burele[1] & Sanjay A. Burele[2]
[1]VIIT student, Pune, India
[2]Central Water Power & Research Station, Pune, India
*burelenehal011@gmail.com

Abstract

Dam's plays important role for providing benefits to living organism present on earth. On the other hand it may be possible that floods results in failure of constructed dams, which further produce disasters in the plains. About 34 percent dam fails due to inadequate spillway capacity which may create situation of overtopping, 30 percent due to foundation defect and 28 percent due to piping and seepage. A dam break may result in the formation of flood wave traveling along a valley/plains with a high speeds, effect's on high devastation. Here a case study is taken of Khadakwasla dam for dam break analysis. In the early hours of July 12th, 1961, Panshet Dam (situated 8 km. upstream of Khadakwasla dam), a dam on Ambi River around 50 km from Pune, burst right in its first year of storing water, after a heavy night of rainfall and after a little while, the smaller Khadakwasla dams would have broken down. It simply collapsed at the point of greatest impulsive force, unable to withstand the destructive forces generated by three times the quantity of water gushing in from upstream than it was meant to store at peak capacity as placid water. While Punekar was asleep, the water would come at night, and the Pune people would have resulted in great loss of life. Now huge civilization has been taken place at the downstream of Khadakwasla dam. This paper focuses on study carried out to estimate the effect of flooding in the downstream of the Khadakwasla dam in case of eventuality failure of the dam. A generalized flood routing model, HEC-RAS has been used to simulate the problem.
Keywords: Dam Break, HEC-RAS, Inundation map, Cross-section, 1-D mathematical model, Flood routing.

Quantifying Flow in an Open Channel with Depth-Averaged Velocity and Boundary Shear Stress Distribution

R.P.Muduli[1*] , S.Sahoo[2] & K.K.Khatua[3]
[1]National Institute of Technology, Rourkela, India
*prabha.rp99@gmail.com

Abstract

The distribution of depth-averaged velocity in open channel plays a crucial role in understanding flow patterns and hydraulic behavior. Depth-averaged velocity refers to the average velocity of water over the vertical extent of the channel cross-section. On the other hand, boundary shear stress is the tangential force generated at the point where flowing water meets the channel bed. It is a crucial parameter in assessing sediment transport and bed stability. This paper demonstrates the variation of observed data of depth averaged velocity and boundary shear stress with numerical models. In order to forecast the depth-averaged velocity along the lateral direction in an open channel flow, numerical models have been used in this paper. The method begins by collecting data on depth-averaged velocities at various locations within the channel. These velocity measurements are then correlated with hydraulic parameters such as water depth, bed slope, and channel width. This technique is innovative in that it uses geometrical parameters at a portion of an open channel flow to estimate the discharge capacity and determine the point velocity. In order to observe the fluctuation of local velocities along both the vertical and transverse directions at testing sections, experimental studies in a rectangular channel have been conducted. Using micro-ADV three-dimensional instantaneous velocity data sets have been collected. The measurements are done for different flow depths under various geometric, hydraulic, and roughness conditions. Numerical models like ANSYS and CES have been used for comparison purposes. K ϵ model is used in ANSYS and Shiono and Knight method is used in CES. It is observed that the numerical model i.e. ANSYS gives better results and shows good accuracy as compared to CES. Additionally, the distribution of boundary shear stress has been calculated using ANSYS and CES.

Keywords: Depth averaged velocity, Boundary shear stress, CES, Shiono and Knight Method, ANSYS, K ϵ model.

Soil erosion Potential Zone Mapping using Analytical Hierarchy Process and GIS

Shradhanjalee Pradhan[1*], Abhishek Bibhar [2], Mani Bhushan[3], Shashi Shankar Ojh[4], Bibhuti Bhusan Sahoo[2], Sovan Sankalp[6]
[1] Veer Surendra Sai University of Technology,768018, Odisha India
[2]Department of Agricultural Engineering, Centurion University of Technology and Management, 761211, Odisha, India
[3]Department of Civil Engineering, GEC Khagaria,848203, Bihar, India
[4]Department of Civil Engineering, National Institute of Technology, Patna,800005, Bihar, India.
[5]Department of Civil Engineering, Centurion University of Technology and Manag
*shradhanjaleepradhan94@gmail.com

Abstract

This study focuses on the Soil Erosion potential zone in the Tel River basin, a tributary of The Mahanadi River. Sediment yield refers to the amount of sediment removed from a watershed through natural eroding agents. Identifying the sediment yield potential of an area is important for planning effective watershed management strategies. This reflects the impact of practices that reduce water runoff and sediment yield obtained from the slope using the raster calculator. The AHP pairwise matrix is used to evaluate the normalized weight of each thematic layer, and weighted overlay analysis is carried out on the GIS platform. The study results show that the Tel River catchment is classified into five potential sediment yield zones: very low, low, moderate, high, and very high. The study concludes that soil erosion is moderate in many areas, and appropriate land management practices are necessary to prevent high sediment yield.

Keywords: sediment yield, DEM, AHP process, Tel River.

Influence of land cover changes on improving the regional water and agricultural resources in KUDA, Telangana

S. Vinay[1,2], T. Hemasri[1], T. Praneeth [1]& J. Jyothi[2]
[1]SR University, Warangal, India
[2]Alvas Institute of Engineering and Technology, Moodbidri, India
* vinay86169@gmail.com

Abstract

The societal oriented developmental activities in the Anthropocene pertaining have caused disturbance in the functioning of landscapes. In exceptional cases, engineering efforts and policies have resulted in improved functionality of landscapes, leading to improved water reserves, agricultural yields, thus improving the regional ecosystem services. This necessitates a thorough investigation into the variations in land cover and their impact on regional water resources. In the present study, we examine the Kakatiya Urban Development Authority in Telangana State, India, which has numerous lentic ecosystems that have provided water to both aquatic and terrestrial life for aeons. Land cover indices namely NDVI and mNDWI were used to evaluate vegetation and water change patterns between 1977 and 2022 in summer season. Area under water increased from 14.07 to 36.7 to 57.9 sq.km in the summer season with commission of lower and mid Manair in 1986 and 2018 respectively, likewise cultivated area under increased from 152 to 360 to 671.8 sq.km. Analysis of the Ground water in pre monsoon post implementation of lower manair between 2018 and 2022 indicates an increase in Ground Water table in the range of 1.5m to 5.5m. The analysis revealed considerable increase in water availability as lentic ecosystems tend to become perennial and area under rabi crops increased to a large extent. The outcome of the study shows that, by progressively blue cover in the semi-arid zones can aid in improving the availability of water for irrigation, fisheries and other socio ecological benefits thus improving regional economy.

Keywords: Manair Reservoir, NDVI, mNDWI, CGWB, Rabi Cropping Pattern.

Turbulent Flow Properties with Flexible Emergent Vegetation in Straight Channel

Pritam Kumar[1], Vangapandu Deepak[1] & Anurag Sharma[1*]
[1]National Institute of Technology, Rourkela, India
*sharmaan@nitrkl.ac.in

Abstract

Presence of flexible vegetation has a notable impression on flood control, ecological restoration, aquatic life and flow structure. In sedimentary process and fluvial geomorphology, vegetation is an important factor to determine sediment transport through its influence on local hydraulics. The effect of flexible vegetation on natural flow is significant objective in recent scientific study. In this investigation, the effect on turbulent flow properties caused by natural emergent flexible vegetation in staggered pattern was studied in a partially vegetated sand-bed channel. Experimental work was carried out in straight tilting flume having 12 m x 0.6 m x 0.9 m. The vetiver grass is used for flexible vegetation at distance of 12 cm in staggered pattern. Three-dimensional velocities were recorded by using a 5 cm down-looking 3-D Acoustic Doppler velocimeter (ADV). The study will be helpful for finding the three-dimensional velocity and turbulent kinetic energy for non-vegetated side, interface of vegetated side and vegetated side. Analysis and comparison of the results obtained by the vegetated, interface of vegetated and the non-vegetated side with this experimental investigation was performed. The findings in this study revealed that emergent flexible vegetation had a large flow resistance which rapidly decreases the longitudinal velocity. This experiment provides a vital interpretation to understand flow characteristics in non-vegetated, interface of vegetated and vegetated side.

Keywords: Flexible vegetation, emergent, sand bed, 3D-velocity, Turbulent Kinetic Energy.

Spatial variation of rainfall and parameters of Intensity Duration and frequency curves for analyzing Burhi Gandak drainage area

Kumar Lal Babu[1] , Ashok K. Keshari[2*]
[1]Research Scholar, Department of Civil Engineering, Indian Institute of Technology, Delhi, New Delhi, 110016, India.
[2]Professor, Department of Civil Engineering, Indian Institute of Technology, Delhi, New Delhi, 110016, India.
*Kumarlalbabu72@gmail.com

Abstract

The rainfall Intensity-Duration-Frequency (IDF) relationship curves are commonly required for planning and designing of various water resource projects and especially urban drainage systems and flood plain management. Many sets of relationships have been developed and used in several parts of the world. The IDF relationship is a mathematical relationship between the rainfall intensity, the duration, and the return period. This relationship is determined through statistical analysis of samples of records at proper meteorological stations. Using rainfall data at various locations, IDF curves and empirical equations of IDF curves can be derived for specific locations using appropriate probability distribution function and spatial variations in the rainfall depths can be better represented by iso-pluvial maps. The main aim of this paper is to construct IDF curves for the region using rainfall frequency analysis techniques. An attempt has been made to develop IDF curves for Burhi Gandak region of Bihar, India, at three rain gauge stations (India Meteorological Department (IMD) Sikandarpur, Samastipur, and Rosera), form a spatial rainfall depth pattern. Further, IDF parameters for specific return period and iso-pluvial maps were elucidated to illustrate the variability.

Keywords: Rainfall intensity, iso-pluvial maps, intensity-duration-frequency relationship (IDF).

Temporal variation of bed morphology and local scour around oriented spur dikes

H.K. Patel[1*], S. Arora[1] & B. Kumar[1]
1 Indian Institute of Technology Guwahati (IITG), India
* harish_kumar@iitg.ac.in

Abstract

Spur dikes are erosion-protective structures that protrude outward from the river bank in different orientations to deflect the flow away from the riverbank. The present experimental study provides insight into the temporal variation in bed morphology and scours around rectangular-shaped spur dikes with different orientations. The laboratory tests examined the suitability of various spur dikes orientation configurations. The study focused on three different angles, 60º, 90º, and 120º and analysed the scour development over time, specifically at intervals of 2 h, 12 h, and 24 h. Results showed that the orientation angle of 90º generated the highest scour depth, while the least scour depth was found with an orientation angle of 120º. Compared to the 60º and 120º orientations, the 90º orientation produced a maximum local scour depth that increased by 32% and 43% after 2 h, 24.5% and 41.7% after 12 h, and 30.9% and 46.4% after 24 h. The development of scour depth is initiated from the spur dike tip, and the maximum scour depth is observed at the spur dike tip. The diameter of scour hole extended downstream, and a dune-like structure formed between the first and second spur dike. The longitudinal extents of scour diameter was expanded downstream of the spur dike-1 and were found to be 19 cm, 21 cm and 16 cm, and the transverse extents of the scour hole at the spur dike tip were found to be 38 cm, 40 cm and 26 cm with the orientation of 60º, 90º and 120º respectively.

Keywords: Spur dikes, Temporal variation, Bed morphology, Scour depth

Local scouring around rectangular-shaped spur dike with downward seepage

Kumar Chandramauli Shah[1*], Harish Kumar Patel[2] & Bimlesh Kumar[3]
[1] Indian Institute of Technology, Guwahati, India
*kumar.chandramauli@iitg.ac.in

Abstract

Spur dikes are one of the most important and widely used guide bank structures which are mainly used to redirect the flow to the mainstream from the banks, preventing the erosion of the riverbanks. Their presence along the riverbank significantly affects the flow field, influencing the bed morphology and sediment conveyance. This paper deals with the local scouring around the erosion protective structure with downward seepage. In this study, experiments were conducted with the rectangular spur dikes in a laboratory flume under clear water conditions to examine the maximum local scour depth in the vicinity of the spur dike. The experiments were conducted by placing three spur dikes in a series on one side of the channel bank with proper spacing. The experiments were performed with different conditions such as no-seepage, 5 % seepage, and 10 % seepage. The result shows that Seepage in the downward direction weakens the stability of particles resting on the boundary and can cause them to initiate motion, which results in increases in near-bed velocity. In addition, Seepage (downward movement) shifts the depth of flow and velocity downward, causing an increase in relative-bed velocity and more sediment transport at the near bed. As a result, the depth of the scour hole at the spur dike tip increases. The maximum scour was observed around the first spur dike and deposition occurs downstream of the spur field.

Keywords: Bed morphology, local scouring, spur dikes, seepage.

Temporal celerity of migrating scour depth around erosion protective structure with seepage

Joychen Kenglang[1], Harish Kumar Patel[2] & Bimlesh Kumar[3]
[1] Indian Institute of Technology Guwahati, Guwahati, India
*jkenglang@iitg.ac.in

Abstract

Experiments were conducted using three rectangular shape spur dikes to analyse seepage behaviour around the spur field. Spur dikes are arranged in a series and provided outward from the bank to protect it from erosion. Experiments were performed on no seepage, 5% seepage, and 10% seepage. The migration of bed particles and the stability of the channel bank are affected due to seepage. Alluvial channel seepage losses are reportedly between 15 and 45 percent of total intake (Van der Leen et al. (1990)). Thus, it is crucial to research and examine seepage mechanisms in alluvial channels. Seepage increased channel mobility by changing the bed stability conditions, and as a result, the channel's hydrodynamic characteristics changed. Seepage in the downward direction decreases the stability of particles resting on the boundary and can cause them to initiate motion, which increases near-bed velocity. The increase in seepage percentage leads the scoured section's bed elevation to rise, and as time passes, the scour depth expands until the channel attains equilibrium. The celerity of scour depth for time scale increases with increasing downward seepage and decreases with time until it achieves constant.

Keywords: spur dikes, seepage, time scale celerity, scour depth.

Analysis of drought in Ganganagar District of Rajasthan using Standard Precipitation Index

Darshan Mehta[1]*, Hazi Azamathulla[2], Jinal Pastagia[3]
[1]*Assistant Professor, Civil Engineering Department, Dr. S. & S. S. Ghandhy Government Engineering College, Surat, Gujarat, India
[2]Professor, Civil and Environmental Engineering Department, University of the West Indies, St. Augustine Campus, Trinidad and Tobago
[3]Assistant Professor, Civil Engineering Department, S. S. Agrawal Institute of Engineering & Technology, Navsari, Gujarat, India
*darshanmehta2490@gmail.com

Abstract

Drought is defined as a prolonged period of absence of precipitation. It is one of the most important water-associated hazards. Drought affects agricultural, hydrological, economic, environmental, and social systems. The study aimed to analyze the severity of drought events in the Ganganagar district of Rajasthan using the Standardized Precipitation Index (SPI). Both the long-term (12 and 9 months) and short-term (6 and 3 months) SPI were calculated to identify the drought events. The SPI index is used as a drought index parameter in drought monitoring systems for water resource planning and management. Monthly precipitation data for 121 years (i.e., 1901–2021) were used for the analysis. Temporal analysis is carried out to predict the severity of drought in the study region. The analysis of various graphs shows that the 3-month and 12-month indices are more accurate in comparison to the 6-months and 9-month indices. Due to the unequal distribution of precipitation, frequent droughts occurred in the Ganganagar district. The finding of this study will assist planners in developing water resource policies and forecasting systems in providing advanced warnings.

Keywords: Drought analysis, Precipitation, Standardized Precipitation Index, Temporal.

Assessment of groundwater vulnerability of Haridwar district, (Uttarakhand), India, using GIS and DRASTIC approach

Himanshu Patel[1], Pramod Kumar Sharma[2]
[1]Postgraduate, Department of Civil Engineering Indian Institute of Technology Roorkee
[2]Associate Professor, Department of Civil Engineering Indian Institute of Technology Roorkee
*pramod.sharma@ce.iitr.ac.in

Abstract

The demand for aquifer vulnerability maps has grown because of two primary factors. Firstly, since groundwater is a significant source of drinking water, it is essential to assess its vulnerability to pollution. Secondly, due to an increase in human and economic activities, like agriculture, industry, and households, the risk of groundwater contamination has risen, emphasizing the need for such maps. Haridwar district is considered as a study area situated between latitude 29°37′N–30°9′N and longitude 77°51′E–78°21′E and has a total area equal to 2300 km^2. The objective of this study is to identify areas of vulnerability in an aquifer using DRASTIC(where D stands for Depth to water table, R for Net recharge, A for Aquifer media, S for Soil media, T for Topography, I for Impact of vadose zone and C for hydraulic Conductivity) and DRASTIC-LU models (where LU stands for Land Use) within a Geographic Information System (GIS) environment. According to DRASTIC model 4.73% of the area falls under low vulnerable zone, 34.71% area fall under medium vulnerable zone and 60.56% area fall under highly vulnerable zone. And according to DRASTIC-LU model 16.77% of the area falls under low vulnerable zone, 50.35% area fall under medium vulnerable zone and 32.88% area fall under highly vulnerable zone. These models can be used as a groundwater management tool by local authorities. By identifying areas that are most vulnerable to contamination, authorities can prioritize monitoring and management efforts to protect the groundwater resource. The results of this study can also be used to guide land-use planning and development decisions in the study area to minimize the risk of groundwater contamination. Overall, this research work is important for effective groundwater management in Haridwar district and can be used as a template for similar studies in other regions.

Keywords: Groundwater, Vulnerability assessment, GIS, DRASTIC, DRASTIC-LU, Hydraulic conductivity.

Flood Susceptibility Mapping in Shetrunji River Basin of Saurashtra Region in Gujarat

Vrushti Soni[1*], Suvarna Shah[1] and Hiteshri Shastri[2]
[1]Department of Civil Engineering, Faculty of Technology & Engineering, The Maharaja Sayajirao University of Baroda, India – 390002;
[2]Department of Civil Engineering, CSPIT, Charotar University of Science and Technology (CHARUSAT), CHARUSAT Campus, India – 388421
* vrushtisoni21@gmail.com

Abstract

The peninsular region of Gujarat is popularly known as Saurashtra region. It is one of the most water scarce regions of India. The region at the same time often experiences flash flooding problem because of extreme rainfall events. The frequency on flooding events has increased in past two decades capturing attention to workout flood susceptible area over Saurashtra region. The present study is an attempt to prepare a flood susceptibility map of the major river basin of this region using 'Multi-Criteria Decision Making (MCDM) – Analytical Hierarchy Process (AHP)' model in Geographic Information System (GIS) environment. The flood susceptibility maps are prepared based on six criteria: Elevation, Rainfall, Land use Land cover (LULC), Flow Accumulation, Soil and Normalized Difference Vegetation Index (NDVI). Flood susceptibility index map was prepared from AHP method and after applying Natural Break Classification approach as well as Geometric Break Classification approach, flood susceptible zone identified as Very Low, Low, Medium, High and Very High. As a result, approximately 16%, 34%, 32%, 17% and 0.09% flood susceptible zone classified as Very Low, Low, Medium, High and Very High using applying Natural Break Classification approach whereas 22%, 7%, 40%, 30% and 0.09% flood susceptible zone classified as Very Low, Low, Medium, High and Very High using Geometric Break Classification approach. The high-risk areas of the basin were identified using a flood susceptibility map. Furthermore, the Receiver Operating Characteristic (ROC) curve method is used to validate flood susceptibility map. The validation results show very good prediction efficiency with AUC values 0.802. AHP in combination with the GIS can be used as a potential method for developing flood zonation maps for data-scarce river basins. This study will help in preparation of mitigation and prevention strategies for future flood situations.

Keywords: Flood Susceptibility, MCDM, AHP, GIS, Saurashtra, India

Statistical Downscaling of CMIP6 Projections for a Hyderabad City

Aadhi Naresh[1], & M. Gopal Naik[2*]
[1]Research Scholar, Department of Civil Engineering, Osmania University, Hyderabad, Telangana State, India
[2]Professor, Department of Civil Engineering, Osmania University, Hyderabad, Telangana State, India
* mgnaikc@gmail.com

Abstract

There are numerous ways to predict the values of meteorological variables in the future and to determine their impact on local climate change. One popular technique used for this purpose is the Change Factor Methodology (CFM), which is also known as the delta change factor methodology. Despite the availability of more advanced techniques, the Change Factor Methodology (CFM) is still extensively employed in impact analysis investigations. Although there are several alternative approaches to calculating change factors (CFs) and estimating future climate scenarios, there are no established criteria in the literature to determine the most appropriate methodologies for specific applications. In this study, the multiple change factors method, and gamma distribution bias correction methods are used to downscale and bias correct the General Circulation Model (GCM) simulated climatic variables of the latest Coupled Model Intercomparison Project Phase 6 (CMIP6) datasets to precipitation on a regional scale respectively. The study employed a frequently flooding city of Hyderabad in India due to the impact of climate change observed over the decade. The method applied for 40 years of observed data by dividing 20 years (1981 to 2000) as calibration and the remaining 20 years (2001 to 2020) as validation. Results show that the Cumulative Distribution Function (CDF) plots of GCM downscaled, and bias-corrected precipitation values were closely matched with the observed rainfall data. It is concluded from the results that the CDF method is well-suitable and can use for future rainfall prediction.

Keywords: Downscaling, Bias Correction, Change Factor, CMIP6, GCM

CFD Analysis of Sloshing in a Sway-Excited Rectangular Tank with Porous Baffle at L/2 Location.

A. Keerthana Reddy[1*], Nasar T[1] & Sahaj K. V.[1]
[1]National Institute of Technology Karnataka, Surathkal, India
*keerthanareddy4544@gmail.com

Abstract

Sloshing is a phenomenon seen in spacecraft, trucks, and ships, in which the liquid move violently and leads to instability of structure or structural damage. In general, horizontal, vertical, and horivert baffles are utilized to reduce the sloshing effect, however, vertical baffles offer better performance in rectangular tanks. To improve the efficiency of the vertical baffles, porosity is introduced. In this study, a three-dimensional numerical model is modelled to study the liquid sloshing in a sway-excited rectangular tank with a porous baffle placed at l/2 location using VOF (Volume Of Fluid) method, and RNG k-ε model in ANSYS FLUENT. Simulations are carried out for the vertical baffle with 4.4%, 6.8%, and 9.2% porosities, and for chosen liquid fill levels of 25%, 50%, and 75% that corresponds to the aspect ratio (h_s/l, h_s – the static height of the liquid and l - length of the tank) = 0.163, 0.325, and 0.488 respectively. The numerical results show good agreement with the experimental results. As the fill level and excitation frequency increase, the percentage reduction in force on the porous baffled tank wall decreases as compared to the unbaffled tank. The porous baffles are found to be effective in mitigating the sloshing oscillation. In the proximity of the first mode of excitation frequency the percentage reduction in the normalised maximum oscillation (η_{max}/A) is 94% at 25% fill level, 93% at 50% fill level, and 88% - 85% as the porosity increases at 75% fill level.

Keywords: Sloshing, porous baffles, sway-excited rectangular tank, VOF.

Ground water quality assessment of Vapi region using GWQI

Gohil Mitali Bhupendra[1*], Dr Narendra Shrimali [2]
[1]Faculty of Technology and Engineering, The Maharaja Sayajirao University Baroda, Vadodara, Gujarat, India
*mitaligohil799@gmail.com

Abstract

Groundwater demand in India has significantly increased as a result of country's fast population development, industrialization and urbanization. The contamination of groundwater quality is due to the adverse effect of human's hazardous activities. Using water quality index, or WQI helpful mathematical tool for deriving complex information from any water body for analysing it. WQI is essentially a mathematical method for calculating a single value from a set of samples of water quality parameters. The study area included various residential and industrial areas that do get their water from groundwater resources. This study evaluates when compared to BIS 10500:2012 drinking water criteria (WQI), the physio-chemical properties of various ground water samples. The study's goal is to determine the WQI of ground water if it is fit for human consumption in the study area using the GIS technique.

Keywords: GWQI, Ground water, physio-chemical, Water Quality

Investigation of Three-Dimensional Flow characteristics in a Meandering Channel under Sub-Critical Flow Conditions

Biswajit Pradhan[1*], Sarjati Sahoo[1] Kishanjit Kumar Khatua[1]
[1]PhD Scholar, Department of Civil engineering National institute of technology Rourkela, India769008
[1]PhD Scholar, Department of Civil engineering National institute of technology Rourkela, India 769008
[2]Professor Department of Civil engineering National institute of technology Rourkela, India 769008
* biswajitpradhan030@gmail.com

Abstract

This study presents an analysis of the three-dimensional flow properties in a meandering channel under sub-critical flow conditions. The experiment was conducted using an Acoustic Doppler Velocimeter (ADV) to measure the flow characteristics at seven different sections along the flow path. The meandering channel was carefully designed to replicate natural river systems, with sinuosity value of 1.35. The ADV was employed to record the three-dimensional velocity components (u, v, and w) at different points within the channel cross-section, allowing for a comprehensive assessment of the flow field. The obtained data revealed significant variations in the flow properties within the meandering channel. The velocity profiles exhibited a complex pattern, with variations in both the longitudinal and vertical directions. The velocity profiles were found to be asymmetrical, and the maximum velocity was observed on the outer bank of the channel. Moreover, the results indicated that the flow was more turbulent near the outer bank, which resulted in higher levels of shear stress. These findings highlighted the intricate nature of the flow in meandering channels and the importance of considering three-dimensional effects for accurate flow characterization. The understanding of these processes is crucial for the management and restoration of river systems, as well as for the design of hydraulic structures and flood management strategies.

Keywords: Meandering channel, Three-dimensional flow, subcritical flow, Velocity profile, turbulent flow

Feasibility & Design of Rainwater Harvesting System for Kattamanchi, Chittoor, AP

Senthamizh Selvan[1], B. Damodhara Reddy[1], S. Aruna Jyothy[2], Panga Narasimha Reddy[1], N. Kiran Kumar[1], Bode Venkata Kavyatheja[3], Aklesh Chaudhary[1]
[1]Civil Engineering Department, Sri Venkateswara College of Engineering and Technology (Autonomous) (SVCET), Chittoor, India.
[2]Civil Engineering Department, Sri Venkateswara University College of Engineering, Tirupati, India
[3]Civil Engineering Department, JNTUA College of Engineering, Kailkiri, India
*aruna_jyothy@yahoo.co.in

Abstract

Detailed questionnaire survey was conducted in the study area to know the current scenario of source of water for domestic use and status of storm water drainage. By using 2011 census data population of the study area was projected and LPCD (Liter Per Capita Demand) was calculated. Rainfall data was collected to estimate the runoff by using rational formula. Survey was conducted in the study area to redesign the drainage and suitable places were selected to construct rainwater harvesting structures at suitable intervals. This study shows that rainwater harvesting will reduce the gap between demand and supply of domestic water.

Landfill Leachate Treatment using ANEC Reactor

V Ektha[1*], A B Biji[2], M Devika[2,] R Shalini[2], B Rhul Krishna [2], S Bhuvaneshwari[2], S K Pramada[1]
[1]Department of Civil Engineering, National Institute of Technology Calicut, Kozhikode, Kerala, India673601.
[2]Department of chemical engineering, National institute of technology Calicut, Kozhikode Kerala, India -673601.
* ektha_p220193ce@nitc.ac.in, 9400783682.

Abstract

Solid waste generation is increasing worldwide due to the rampant population and economic growth. Sanitary land filling is the most common, cheap and effective method and approaches that are used for managing municipal solid wastes (MSWs). The study area selected in this study is located in Njeliyanparamba, one of the largest waste dump sites in Calicut district, Kerala.The MSWs does contain serious environmental risks due to the generation of landfill leachate (LL).Contamination by leachate can be prevented by reducing leachate level before the wastewater reaches the ground. One of the methods used is electro coagulation. Electro coagulation is a water treatment technology that uses electricity to remove contaminants from wastewater and other fluids. Batch tests were conducted using 0.25 L of leachate sample collected from the study area with different dilutions. The electrochemical cell consistsof a submerged anode and cathode made of steel in the form of flat sheets, in the 0.25L borosil glass reactor. The electrode dimensions are 2.5 cm wide by 10 cm deep and 2 mm thickness, resulting in a dipping area of 25 cm2 . In the study, a digital dc power supply was utilized to power the EC operation. For a dilution of 200 ml leachate with 200 ml distilled water, the rate of reaction was very less. In every 6 minutes interval the pH, TDS, Conductivity, Turbidity and Zeta potential has noted. The pH increased from 5 to 6.37. The total dissolved solids decreased from 1994 to 1888 ppm upto a time period of 30 minutes after that it was above 2000 ppm. The electrical conductivity decreased from 1984 mS/cm to 1955 mS/cm for the first 30 minutes. After that the electrical conductivity was above 2000 mS/cm. The turbidity increased from 121 NTU to 217 NTU up to a time of 126 minutes. The electro chemical treatment process is efficient and cost effective as it does not require the use of any chemicals or expensive equipment. It is also scalable technology that can be used in different settings, from small-scale applications to large industrial operations. It can treat TDS, Conductivity and Turbidity from wastewater, providing a suitable solution for water treatment and reuse. Moreover the process is environmental friendly, as it produces no harmful by-products or residuals.

Keywords: Groundwater contamination, Leachate, Wastewater treatment, pH, Turbidity, TDS, Conductivity

Experimental study of Riverbank Flow Structure with Upstream Mining Pit

Sukhjeet Arora[1]*, Harish K Patel[1], Abhijit D Lade[2] & Bimlesh Kumar[1]
[1] Indian Institute of Technology Guwahati, Guwahati, India
[2]Visvesvaraya National Institute of Technology Nagpur, Nagpur, India
* sukhjeet@iitg.ac.in

Abstract

Sand dredging from the rivers has become an uncontrolled practice which harms the river's ecology. It affects the river's flow structure, leading to further deterioration of the river morphology Several field investigations and experimental studies have conformed the erosive effects of sand mining pits, both upstream and downstream of mining locations. We conducted laboratory scale flume experiments to study the effect of a mining pit on the secondary flow structure across a riverbank cross section. Three bank slopes were tested namely 25°,31°, and 40° and gravity flow experiments were conducted with and without a mining pit. Turbulent velocity data across the cross-section was analyzed to study the transverse and velocity distribution across the riverbank for both with pit and without mining pit case. Results show that dredging an upstream mining pit significantly affects the transverse and vertical velocities especially on the bank slopes and near the bed in the main channel portion. The turbulent kinetic energy in the flow region on the bank slope as well as near the bed in the main channel portion significantly increases because of the pit excavation. These alteration in the secondary flow within the riverbank can lead to morphological changes and may affect the bank stability of rivers.

Keywords: Dredging, Riverbank, Secondary Flow, Turbulent Kinetic Energy.

Vertical accuracy assessment of open-source Digital Elevation Models in Upper Swarnamukhi Basin, Andhra Pradesh, India

R. Suragamallika[1]*, W. Makhdumi[1] & G. S. Dwarakish[1]
[1]National Institute of Technology Karnataka, Surathkal, India
* suragamallika@gmail.com

Abstract

Digital Elevation Models (DEMs) play a crucial role in hydrology by providing essential topographic information that is fundamental for various hydrological analyses and modelling. The reliability of hydrological analyses and modelling highly depends on the resolution and vertical accuracy of the DEM. Assessing the accuracy of the DEM is important for the specific area owing to the fact that accuracy of DEM is not uniform over the globe. This paper aims at evaluating the vertical accuracy of the open-source DEMs taking Survey of India (SOI) toposheet as reference and identifying the best performing DEM for Upper Swarnamukhi basin (1612 km^2), Andhra Pradesh, India. The DEMs considered are SRTM (30m), ALOS PALSAR (12.5m), CARTOSAT (30m), ASTER GDEM (30m), TanDEM-X (90m). After bringing all the 5 DEMs to common vertical and horizontal datums, their elevations are compared with elevations of 210 vectorized triangulated stations from SOI toposheets. Statistical measures like Mean Error (ME), Standard Deviation (SD) and Root Mean Square Error (RMSE) were used for comparative assessment. It is observed that SRTM (30m) is outperforming with ME, SD and RMSE values of -8.79 m, 14.80 m and 17.21 m respectively. CARTOSAT was performing lowest with ME, SD and RMSE values of -9.55 m, 22.18 m and 24.15 m respectively. These findings aid researchers in the selection of appropriate DEM for various hydrological applications in the basin.

Keywords: Digital Elevation Models (DEMs), Vertical Accuracy Assessment, Survey of India Toposheets, RMSE

Comparing Daily Flow Simulations from SWAT, ANN, and LSTM Models in Tropical Watersheds

Siddik Ahmed Barbhuiya[1*], Dr Meenu Ramadas[2], Dr H L Tiwari[3], Ankita Manekar[4]
[1,4]PhD Student, School of Infrastructure, Indian Institute of Technology Bhubaneswar, Odisha, India
[2]Assistant Professor, School of Infrastructure, Indian Institute of Technology Bhubaneswar, Odisha, India
[3]Associate Professor, Department of Civil Engineering, Maulana Azad National Institute of Technology Bhopal, Madhya Pradesh, 462003, India
*sab12@iitbbs,.ac.in

Abstract

Simulation of streamflow is fundamental to hydrological studies, that has further applications in managing and planning water resources. The accuracy of flow predictions significantly affects the decision-making capabilities of stakeholders including policy makers. The present research study scrutinises and contrasts popular methods for streamflow prediction in an eastern Indian watershed, namely, the Soil and Water Assessment Tool (SWAT), Artificial Neural Network (ANN), and Long Short-Term Memory (LSTM) models. While the SWAT offers a descriptive semi-physical modelling approach for simulation of hydrological response of the watershed by incorporating soil characteristics, land use, and climatic factors, the ANN and LSTM models use machine learning strategy to extract patterns that can predict flows with even lesser input data. LSTM, is a recurrent neural network that excels at capturing patterns over extended periods of time when provided with sufficient high-quality data. Results of the study highlight that LSTM model is best performing in terms of the Nash-Sutcliffe efficiency and root mean square error (RMSE) values when compared to other models, and an input combination that contained rainfall at different lags led to this performance. However, when it comes to flow duration curve modelling, the traditional SWAT model offers promising application as it captures the distinct features of the curve perfectly well, among all models considered.

Keywords: Soil and Water Assessment Tool (SWAT), Artificial Neural Network (ANN), Long Short-Term Memory (LSTM), Hydrological Models, Streamflow

Modeling and Prediction of Feature Centric River Water Temperature using Machine Learning Algorithms in Data Scarce Regions

Rajesh Maddu[1], Mohammed Lokhman Rizwan[2], Jaswanth Nidamanuri[2*], Shaik Rehana[1]
[1]Hydroclimatic Research Group, Lab for Spatial Informatics, International Institute of Information Technology, Gachibowli, Hyderabad, Telangana, India
[2] Centre of Excellence – AI & Robotics School of Technology, Woxsen University, Hyderabad, Telangana, India
*jaswanth.nidamanuri@woxsen.edu.in

Abstract

Though process-based models could give very accurate results, it requires large amounts of site-specific detailed data, including stream geometry, a complete set of meteorological variables, and the hydraulic properties of the river, which are unavailable for many river systems. To overcome this, due to its capability to simulate complicated and non-linear relationships between the response variable (such as River Water Temperature, RWT) and its few explanatory input variables (such as Air Temperature, AT), machine learning (ML) has become more and more popular. The primary focus of this work is twofold: Initially, to investigate and demonstrate how new hybrid ML approach, that is Support Vector Regression (SVR), to predict accurate RWT estimates with minimal explanatory variables in the form of AT. Secondly, to provide a detailed ablation study on performance metrics on selected feature importance. Importantly, the proposed modeling framework's effectiveness is demonstrated by considering near real-time data with river system located in India as case study. The most reliable ML model for RWT prediction has been identified as the SVR.

Keywords: Air Temperature, Machine Learning, River Water Temperature, Support Vector Regression.

Extracting and Detecting Dynamic Wetland Changes through Spectral Indices using Google Earth Engine

Ashok_Amgoth[1], H.P. Rani[2] & K.V. Jayakumar[1]
[1]Research Scholar, Department of Civil Engineering,
[2] Professor, Department of Mathematics
[3] Emeritus Professor, Department of Civil Engineering
National Institute of Technology, Warangal, India
*ashoka6@student.nitw.ac.in

Abstract

Long-term surface water changes are investigated in terms of vegetation and water indices, obtained from the Landsat 8, Sentinel-2 and MODIS satellite imageries, using Google Earth Engine (GEE) algorithms for Pakhal Lake, located in the southern part of India. The indices, NDVI and NDWI, were used to extract the statistics of water bodies over the lake using the Landsat 8 imagery for the period from 2013 to 2020. Harmonic time series models were used for estimating the missing data of these indices and the noise in data series were reduced. The suitability index (SI) was calculated based on the area and perimeter of the water body. The value of SI obtained was less than 0.18, which makes the Pakhal Lake to be classified under the category of wetland. Further the 10m Sentinel-2 imagery was used to obtain the spectral water indices like MNDWI and NDWI. The surface mask of the lake was computed by using the Otsu Thresholding and Canny Edge Detector. By applying the direct change detection method, it was observed that the lake got shrunk by 18% between the years 2016 and 2020. The multi-temporal analysis of MODIS-based Standard Vegetation Index (SVI) was carried out to support drought monitoring and early warning. The SVI-based Enhanced Vegetation Index (EVI) was used to calculate the variation in strength characteristics of LULC from the Landsat 8 imagery using a supervised image classification approach, namely, the Random Forest classifier. The accuracy of image classification between the training and validation sets was calculated using the Kappa coefficient, whose value was found out to be 90%.

Keywords: Wetlands, Google Earth Engine, Image Classification, Change Detection, Harmonic Time Series, Sentinel-2.

Flood Inundation Mapping of Middle Tapi Basin Using Sentinal-1 SAR Data with Google Earth Engine

P.S. Jangle[1] & Dr. R.V. Shetkar[2]
[1]M.Tech student, Government College of Engineering Aurangabad-431005, India
[2]Professor of Civil Engineering, Government College of Engineering Aurangabad-431005, India
*prathmesh.jangle123@gmail.com

Abstract

The availability of pre-processed data and powerful computational capabilities offered by the Google Earth Engine (GEE) platform have revolutionized flood inundation mapping. This study utilizes the capabilities of GEE and Sentinel-1A synthetic aperture radar (SAR) GRD data to assess and map flood-prone areas in the middle Tapi basin. The analysis reveals that the majority of floods occurred between July and September, with a maximum inundation extent of 362.207 square kilometers in the basin. The floods affected approximately 170,307 individuals, with villages near Nandurbar district experiencing the greatest impact due to their proximity to the backwaters of Ukai dam and the river. Furthermore, flooded water submerged 5442 hectares of cropland. The integration of SAR data processing within the GEE platform has proven invaluable for conducting large-scale flood mapping. Evaluating the full extent of flood consequences, such as the impact on agricultural lands and people, can aid authorities and decision-makers in enacting measures to reduce flooding and evaluating risks in highly populated areas prone to floods.

Keywords: Flood frequency analysis, Flood impacts, Flood risk assessment, Sentinel-1 SAR data, Google Earth Engine, Flood extent mapping.

Ground water quality assessment of Vapi region using GWQI

Gohil Mitali Bhupendra[1]*, Dr Narendra Shrimali [2]
[1]Faculty of Technology and Engineering, The Maharaja Sayajirao University Baroda, Vadodara, Gujarat, India
*mitaligohil799@gmail.com

Abstract

Groundwater demand in India has significantly increased as a result of country's fast population development, industrialization and urbanization. The contamination of groundwater quality is due to the adverse effect of human's hazardous activities. Using water quality index, or WQI helpful mathematical tool for deriving complex information from any water body for analysing it. WQI is essentially a mathematical method for calculating a single value from a set of samples of water quality parameters. The study area included various residential and industrial areas that do get their water from groundwater resources. This study evaluates when compared to BIS 10500:2012 drinking water criteria (WQI), the physio-chemical properties of various ground water samples. The study's goal is to determine the WQI of ground water if it is fit for human consumption in the study area using the GIS technique.

Keywords: GWQI, Ground water, physio-chemical, Water Quality

Optimization of Water Distribution Network System by Genetic Algorithm with EPANETPYTHON Toolkit and Pump Scheduling tool with SolveXL

M.N. Pavansimha[1*] & Yusuf Javeed[2]
[1]The National Institute of Engineering, Mysuru, India
[2]The National Institute of Engineering, Mysuru, India
* p.simha19@gmail.com

Abstract

Water distribution systems (WDS) are essential for supplying water to urban and rural areas in an effective and consistent manner. WDS networks can be optimized by combining Genetic Algorithms (GA) with the EPANET Python Toolkit and the SolveXL with Pump Scheduling Tool (PST). In order to provide optimal or nearly optimal solutions for large-scale and complicated WDS networks, the GA algorithm is used to efficiently search across the enormous solution space. The optimization of pipe diameter is obtained with respect to total network cost by combining Genetic Algorithm (GA) with the EPANET Python Toolkit for the Koodlahalli Network which is the Real-World Network made of High-Density Polyethylene (HDPE) pipes and total network cost is lowered from Rs. 7,75,989.42 to Rs. 6,90,540.27, around (11%) has been reduced with minimum pressure of 7m. Further, Typical Network has been adopted to optimize pipe diameter which is made of Mild steel (MS) pipes and the total network cost from Rs. 2,34,40,05,701 to Rs. 2,23,67,29,396, around (4.6%) has been reduced with minimum pressure of 7m. To increase the effectiveness of the system, the Pump Scheduling Tool (PST) is incorporated to determine the best pump operations. According to the findings, the ON & OFF schedule type exhibits more optimal pump and an optimal energy cost is 2359.8 in currency units, whereas the tank water level schedule type exhibits less optimal pump scheduling and costs is more compared to the ON & OFF type. Keywords: EPANET-Python Toolkit, WDS, Optimization, Pump Scheduling, and Genetic algorithm.

Flow Field and Bed Morphology around different shape of Spur Using FLOW 3D

Manjeet Dehariya[1*], & Dr. Rutuja M Chavan[2]
[1]Maulana Azad National Institute of Technology, Bhopal, India
[2]Maulana Azad National Institute of Technology, Bhopal, India
*dehariyamanjeet199@gmail.com

Abstract

A spur dike is often formed by a series of vertical or angled constructions made of concrete, rocks, or other strong materials that are positioned along a river or coastal bank. These characteristics can help to reduce erosion, reduce water flow, and avoid silt formation. Spur dikes have been employed in a variety of methods for many years and in a variety of locations with varying geographies around the world. Spur dikes were initially used in the United States in the 1930s to prevent the Mississippi River from eroding. They are currently employed in a number of other rivers and coastal areas across the country. Spur dikes have the advantage of being relatively quick and inexpensive to construct when compared to other erosion control measures. They can, however, have some negative consequences, such as altering the natural flow of a river or coastal area and hurting wildlife habitats. Overall, the installation of spur dikes is one strategy that can be used to manage erosion and protect rivers and coastal areas. The optimum course of action must be determined based on a number of factors, including the particular qualities of the site, the desired outcome, and environmental issues. Flow-3D software is a good model for solving difficult fluid dynamics problems since it can mimic a wide spectrum of flow. There are numerous uses for software that models unstable three-dimensional free surface flows with complex geometry. The program can handle complex geometries, turbulence, and multiphase flows, and it uses a finite-volume numerical approach to solve the governing equations of fluid dynamics. FLOW-3D also provides pre- and post-processing tools to help users build up simulations and analyze the results. Following a review of all literature and the conclusion of simulation, we discovered some relative data indicating that, for all three types of spurs, the first spur has the deepest scour of the two spurs. All spurs have T, L, and rectangular forms. These findings indicate that the T shape spur is superior to the rectangular and L shape spurs. Because of the flanges in the spur, which distribute the velocity, the velocity in the region of the T-shaped spur is lower than that of other types. As a result, the score depth in the T-shape spur is diminishing.

Keywords: Spur dike, Local scour, Numerical simulation, Flow-3D, sedimentation, Van Rijn

Analyzing the Impact of compound extremes on Rice yield over Uttar Pradesh.

A. Mishra[1*], L.K. Ray[2] & S. Kumari[3]
[1]National Institute of Technology, Warangal, India
* amce21412@nitw.ac.in

Abstract

Rice is one of the staple food crops of India consumed by majority of population throughout the country. In Uttar Pradesh rice is mainly grown under rainfed conditions. Recent studies have identified the dependency of crop yields on meteorological conditions through statistical and process-based models. However, most of the studies have used seasonally averaged metrics rather than daily metrics. In the present study statistical models have been used to check the dependency of rice yield on hydrological variable using both seasonally averaged and daily metrics. To get a deeper insight of rice yield behaviour to climate change the response of yield to compound climate extremes have been studied. It is found that excess heat is damaging to rice yield and the damages is further enhanced when the excess heat is accompanied by rainfall scarcity. However, excess soil moisture can offset the damage due to excess heat.

Keywords: Rice yield, crop, rainfed, models, India.

Hydrokinetic Technology and Hydrokinetic Turbines: A Review

Upkar Singh[1*], Vishnu Prasad[1] & Priyanshu Jain[1]
[1]Maulana Azad National Institute of Technology, Bhopal, India
*upkar196@gmail.com

Abstract

The Government of India (GoI) has set a target to add 450 GW by 2030 through renewable energy resources. The development of renewable energy-based technologies is heavily influenced by the energy crisis and high fossil fuel emissions. Considering the abundance of flowing water network in India and some specific studies done, the potential of Hydro Kinetic Turbines in India appears to be on GW scale, however, reasonable exploitable potential in MW (Demand) and MWh (Energy) can be assessed based on actual study considering the information on hydrology, Geographical Information Survey (GIS), etc. In this paper, an effort has been made to review the hydrokinetic energy theory for systems that convert energy from water currents into electrical energy, much like a wind power system. This article includes a thorough discussion of hydrokinetic turbines' (HKTs) ability to harvest power from moving water. In-depth discussion of the hydrokinetic turbines' operating principles, classifications of HKTs and their uses, terminology for HKTs, the impact of the structure on the aquatic environment, and the turbine selection have all been done to gather information about the state of the art and current status of cutting-edge technology. The design parameters of HKTs, such as solidity, power coefficient, tip speed ratio (TSR), angle of attack, number of blades, kind of blades, performance curve, Reynolds number, aspect ratio, blockage, augmentation, and rotor mounting, have all been covered in detail. These factors will make it easier to choose HKT for a certain context.

Keywords: Hydrokinetic turbine, Power coefficient, Aspect ratio, Savonious Hydrokinetic turbine, Gorlov Hydrokinetic turbine

Bed Level Variation in the Upstream of Hydraulic Structure: A Study of Singanpore Weir, Surat, India

Rahul Dasari[1*], P. V. Timbadiya[2] & Gurugubelli Yatirajulu[3]
[1]M. Tech Scholar, Sardar Vallabhbhai National Institute of Technology Surat, Surat-395007, Gujarat, India.
[2]Associate Professor, Sardar Vallabhbhai National Institute of Technology Surat, Surat-395007, Gujarat, India.
[3]Ph.D. Research Scholar, Sardar Vallabhbhai National Institute of Technology Surat, Surat-395007, Gujarat, India.
*rahuldasari61@gmail.com

Abstract

The rapid growth of the population leads to urbanization that requires the construction of various structures such as roads for transport, hydraulic structures for storage, and diversion of water for drinking water and other basic needs. The construction of these hydraulic structures leads to the bed level change in the upstream of the structure. The Singanpore weir was constructed across the lower Tapi River in Surat city, India in the year 1995. The current study focuses on the change in bed levels due to construction of the weir in the lower Tapi River between the Singanpore weir and Ghala gauging station using MIKE 21C. The two-dimensional hydrodynamic model of the said portion of the lower Tapi River was developed using surveyed bathymetric data considering the discharge at Ghala as the upstream boundary condition and the water level at Nehru bridge as the downstream boundary condition. The two-dimensional hydrodynamic model was calibrated by comparing the observed and simulated water levels at Singanpore weir. The calibrated two-dimensional hydrodynamic model was coupled with the morphological model where suspended sediment concentration at Ghala and Nehru bridge is considered as the upstream and downstream boundary condition respectively. The study revealed that construction of the Singanpore weir leads to increase in bed level upstream of the weir for the period of nine months (January to September) in the year 2004.

Keywords: Bed level change, MIKE 21C, Hydrodynamic model, upstream of the structure.

Performance of CHIRPS rainfall data for hydrological applications in Kaddam Catchment Area, Telangana, India

Vamshi Raj Mala[1,2*], Surya Kiran Guniganti[1] & Satish Kumar Regonda[1,3]
[1]Department of Civil Engineering, Indian Institute of Technology, Hyderabad, India
[2] Irrigation & CAD Department, Hyderabad, Telangana State, India
[3]Department of Climate Change, Indian Institute of Technology, Hyderabad, India
[*] ce22resch14001@iith.ac.in

Abstract

Precipitation is one of the most random hydrological processes and it varies significantly spatially and temporally. Recent advancements in remote sensing and GIS provided precipitation datasets of finer resolution at both space and time scales enabling hydrologic modeling for data sparse regions. However, it is important to evaluate precipitation in terms of bias and skill, and then calculate performance of estimated stream flows in the context of different hydrological applications such as flood estimation and water availability studies. As part of the study, rain gauge data, rainfall estimates from Climate Hazards Group InfraRed Precipitation with Station data (CHIRPS) and measured stream flows at the catchment outlet in the Kaddam catchment are considered for 10-year monsoon period (June-Oct) from 2013 to 2022. The objective of the study is twofold i.e., i) evaluate CHIRPS data using rain gauge data based as reference, and ii) analyze skill transferability of CHIRPS data via estimating stream flows at the catchment outlet using conceptual hydrologic models. Two hydrologic models, i.e., Modele du Genie Rural a 4 parametres Journalier (GR4J) and Sacramento Soil Moisture Accounting Model (SAC-SMA) are used, and hydrologic modeling is done on a daily time scale. Analysis of the streamflows provided insights on precipitation- and model- relevant uncertainties.

Keywords: CHIRPS, Hydrologic Modelling, GR4J, Remote Sensing and GIS

Seasonal distribution of flash drought events and their impact on terrestrial ecosystem over Indian river basins

Vikas Poonia[1] and Lixin Wang[2]
[1]Postdoctoral Fellow, Indiana University-Purdue University Indianapolis (IUPUI), Indianapolis, USA, 46202
[2]Professor, Indiana University-Purdue University Indianapolis (IUPUI), Indianapolis, USA, 46202
*vgpcivilengineer@gmail.com

Abstract

Flash droughts have received widespread attention due to their abrupt onset or swift intensification, which makes it challenging to forecast and prepare for them, hence posing serious impacts on ecosystems, socioeconomic development, and agriculture. Most of the studies deal with conventional drought and lack the knowledge of flash drought. To date, how the terrestrial ecosystem responds to flash over India has not been examined. As we know that India is an agricultural-based economy, where a large fraction of the population relies on agriculture. In the present study, we have investigated flash drought identification and its impact on the terrestrial ecosystem. Gross primary productivity (GPP) is used as an indicator of the terrestrial ecosystem acquired from MODIS. Investigation suggests that flash drought is a new extreme event and distributed all over 24 major river basins of India. Further, it was observed that the terrestrial ecosystem is highly sensitive to flash drought events with the highest response over Southern India and Ganga basin. Moreover, it was observed that vegetation adaptation to the flash drought decreases with increasing drought duration. Further, a serious decrease in water use efficiency and uWUE is also observed over some parts of Southern India and Ganga river basin, which indicates the non-resilient nature of the ecosystem towards flash drought conditions. This study facilitates a comprehensive approach to better understand the dynamic characteristics of flash drought events and their drivers over India, and thus provides useful insights for policymakers to develop effective strategies for drought mitigation and sustainable ecosystem management in the country.

Keywords: Flash drought, Gross primary productivity, Soil moisture, Terrestrial ecosystem, Water use efficiency

Impact Assessment of Climate Change on lakes and rivers: a case study of Dal Lake and Jhelum River

Fatima Amin[1], Anil K Gupta[2], Dr Deeksha Katyal[3]
[1]Young Professional, NIDM, MHA New Delhi,
[2]Head ECDRM NIDM,
[3]Associate Professor at Guru Gobind Singh Indraprastha University,
*aminfatima011@gmail.com

Abstract

Climate change has significant impacts on the hydrological cycle, leading to changes in the water availability, quality, and flow in lakes and rivers. The increased temperatures and altered precipitation patterns can affect the physical, chemical, and biological processes in these water bodies, with potential consequences for the ecosystem functioning, biodiversity, and human societies that depend on them. The impacts of climate change on lakes and rivers are diverse and can include changes in water levels, changes in water quality, changes in the timing and magnitude of floods and droughts, changes in aquatic species composition and distribution, and changes in ecosystem services. The effects are often interrelated and can have cascading effects on the functioning of the entire watershed. Water bodies around the globe are in danger due to human activities that are not sustainable. The quality and ecology of water bodies are two important features, and if they are not protected, it can have negative effects on human well-being. Therefore, it is crucial to comprehend the reasons and outcomes of the declining state of water bodies. In the Himalayan water body ecosystems, the situation is particularly concerning, as unregulated urban development has put them at risk of disappearing completely. Various factors such as population growth, industrialization, deforestation, water pollution, developmental activities, sand and boulder mining, land-use changes, and encroachments have negatively affected the water flow patterns of the Jhelum River. Additionally, the construction of multiple hydroelectric projects has had a detrimental effect on the river's ecology, especially downstream areas, the flow of water and the organisms that live in it. The concern for river systems has increased due to the rise in pollution and broader worries regarding the sustainability of ecosystems. These concerns have been raised due to issues related to socio-economic development and climate change Effective impact assessments of climate change on lakes and rivers require an interdisciplinary approach that considers both the biophysical and socio-economic dimensions of the problem. This includes monitoring and modeling the hydrological and biogeochemical processes in lakes and rivers, as well as the social and economic drivers of change, such as land use and management practices, water demand and allocation, and institutional and governance structures. Without a consideration of climate change impacts, proper utilization and management of water resources in the basin will be more difficult. Adaptation and mitigation measures can help reduce the impacts of climate change on lakes and rivers. These can include improving water use efficiency, enhancing water storage and conservation measures, protecting and restoring riparian zones and wetlands, promoting sustainable land use practices, and strengthening governance and institutional frameworks. Effective adaptation and mitigation require collaboration and engagement among different stakeholders, including scientists, policymakers, resource managers, and local communities.

Keywords: Water Quality, Impact Assessment, Multi Approach, Mitigation Strategies and Adaptation

Estimation of Water Borne Soil Loss using Rusle and Gis in Hussainsagar Catchment

Pragna Kasarla[1], Rajesh Katta [1], Ramanarayan Sankriti[1], K Jagannadha Rao[1], Saravanan Subbarayan[2*]
[1] Chaitanya Bharathi Institute of Technology(A), Hyderabad, India
[2] Associate Professor, NIT Tiruchirappalli, India
* ssaravanan@nitt.edu

Abstract

Assessing soil erosion is important for the watershed's sustainable development, which is a global challenge for land-use planners. The environment is still in danger from manmade activities leading to land degradation. Planning and conservation efforts in a watershed benefit from evaluation of soil erosion. Modelling can offer a systematic and quantitative method to calculate soil erosion. In this study, the Revised Universal Soil Loss Equation (RUSLE) soil loss model and Geographic Information Systems (GIS) were used to predict soil loss in the Hussainsagar watershed in south-central India. Remote-sensing (RS) data were used to estimate “RUSLE” model parameters, and “GIS” was incorporated to pin-point erosion hotspots. The results indicate that the northwestern part of the watershed saw the greatest estimated total yearly potential soil loss. To prevent soil erosion in the Hussainsagar watershed, the results can undoubtedly help with the application of soil management and conservation practices. This model considers a number of variables, including the slope-length and gradient index (LS), rainfall and runoff erosivity index (R), soil erodibility index (K), crop cover management component (C), and supporting practice index (P). On a GIS platform, each of these layers was created utilizing various data sources and data preparation techniques. The average yearly soil loss in the watershed is close to 0.5 tons/ha/year, according to the study's findings.

Keywords: RUSLE, GIS, Hussainsagar, watershed, Erosion, Soil Loss

Spatiotemporal Analysis of Warm and Dry Compound Extreme Events Over India from 1951 to 2014

Venkata Sathya Vivek Nannaka[1], Rehana Shaik[2*]
Hydroclimatic Research Group, Lab for Spatial Informatics, International Institute of Information Technology Hyderabad, Gachibowli, Hyderabad, Telangana, India
*rehana.s@iiit.ac.in

Abstract

Warm and dry climate extremes have large impact on water resources, agriculture, ecosystems, and human health. The present study used high-resolution rainfall and temperature data at 0.25-degree resolution from 1951 to 2014 to investigate the occurrence of compound warm and dry extreme events across India. The simultaneous occurrence of temperature exceeding the 75th percentile and a Standardized Precipitation Evapotranspiration Index (SPEI) of less than –1 is considered to represent the compound extreme event of warm and dry. The study reveals a strong negative correlation between temperature and SPEI across most of the country except south-west of India. Analysis reveals that about 3.1% of increase in the spatial areal extent of Warm/Dry compound extreme events allover India. The insights derived from this research could significantly contribute to shaping climate change mitigation and adaptation strategies related to compound extreme events.

Keywords: climate change, compound extreme events, India, temperature, precipitation, risk assessment

Variable Response of Ecological and Agricultural Drought to Meteorological Drought over Meteorological Sub-divisions of India

Akshay Bajirao Pachore[1*], Anjali C V[2], Suyog Balasaheb Khose[3], Renji Remesan[1]
[1]School of Water Resources, Indian Institute of Technology Kharagpur, India
[2] Indian Institute of Technology Palakkad, India
[3] Agricultural and Food Engineering Department, Indian Institute of Technology Kharagpur, India
*abpachore@kgpian.iitkgp.ac.in

Abstract

Vegetation productivity has a direct connection with the food security of the region, which is highly influenced by the meteorological and agricultural drought conditions. In this analysis, the connection between Gross primary production anomaly ($GPP_{anomaly}$), agricultural drought, and meteorological drought is analyzed for all 34 meteorological sub-divisions of India. $GPP_{anomaly}$ which is representative of ecological drought is observed to have a declining trend from winter to pre-monsoon, and further, it shows an increasing trend till post-monsoon season for most of the regions. The connection of regions with different climatic conditions is explored with vegetation productivity ($GPP_{anomaly}$) and Standardized Soil Moisture Index (SSMI) in response to Standardized Precipitation Index (SPIn). It was observed that soil moisture is having more control on $GPP_{anomaly}$ than SPI, showing the significance of soil moisture for carbon sequestration for the region. The seasonal analysis has highlighted that $GPP_{anomaly}$ has a stronger correlation with SSMI during Winter (SK:0.7877, MMRH:0.5985, and WRJ:0.7474) as compared to other seasons. This analysis has highlighted the different behavior of arid and humid climatic regions for connection between three drought types and also reported the implications of the seasonal dynamics over the country. The findings from this study are helpful to the policymakers and stakeholders to have an idea about the varying ecosystem response to meteorological and agricultural drought.

Keywords: Vegetation Productivity, GPPanomaly, SPI, SSMI, Meteorological Drought, Agricultural Drought.

Experimental investigation of flow characteristics around L Head and I Head Groynes

Priyanka[1*] & C.S.P. Ojha[2]
[1]Research scholar, IIT Roorkee, India
[2]Professor, IIT Roorkee, India
*priyanka1@ce.iitr.ac.in

Abstract

Groynes are the commonly used river training structures. Understanding the intricate flow patterns around these structures is imperative for effective riverbank protection. This study presents experimental investigations conducted at the Hydraulics laboratory of the Civil Engineering Department, IIT Roorkee, focusing on flow around L and I head groynes. The main motivation of this work is the expectation that the additional longitudinal leg of the groyne may provide superior bank protection, as suggested by some researchers. However, limited work has been done to study flow around LHGs in gravel bed, necessitating a deeper exploration. The experimental conditions were characterized by a Froude number and Reynolds number of 0.6 and 9.6×10^4 respectively with a sediment size of 9.3 mm. The scour and flow field around the groyne was investigated and the variation of bed level and velocity across a grid within the flow field was determined. The maximum scour depth observed for LHG was 38 % more than that for IHG. Furthermore, velocity distribution demonstrated reduction in streamwise flow velocity near the groyne attached wall. This reduction indicates efficacy of the LHG and IHG configurations as river training structures. The comparative analysis made between LHGs and IHGs provide critical insights into their respective performances as river training structures in gravel bed. LHGs exhibited more substantial reduction in near wall velocity compared to IHGs, hence suggesting superior performance in terms of riverbank protection. These findings contribute valuable information to river engineering practices, aiding in the selection of the most suitable groyne type.

Keywords: Riverbank protection, Groyne, Gravel, Turbulence, Scour, Velocity distribution

Groundwater remediation using Meshless Local Petrov Galerkin (MLPG) simulation coupled with Differential Evolution (DE)

Sanjukta Das[1] and Eldho T.I.[2]
[1]Research Scholar, Department of Civil Engineering, IIT Bombay, Mumbai – 400076 INDIA
[2]Professor, Department of Civil Engineering, IIT Bombay, Mumbai – 400076 INDIA
*sanjukta.das1221@gmail.com

Abstract

The aquifers are often polluted with industrial effluents and chemicals. The Pump and Treat (PAT) is an effective remediation technique for the removal of such pollutants. This technique involves the extraction of groundwater from one or more pumping wells for the treatment above the ground surface. Remediation of contaminated aquifers is a tedious and resource consuming process. Thus, a proper planning and knowledge of physical processes is extremely essential, which can be achieved by using Simulation-Optimization (SO) models. For PAT, the SO models can be applied for the estimation of fate of contaminants, identification of optimal locations and rate of pumping and injection and analysis of the time and cost required to obtain the desired level of remediation. In this study, the Meshless Local Petrov Galerkin (MLPG) method is used as the simulation tool for solving the contaminant transport equation. The merits of this meshless method over the classic mesh based Finite Difference Method (FDM) and Finite Element Method (FEM), is the exploration of areas within the grids for optimal solutions along with the reduction of preprocessing efforts arising due to the mesh. MLPG being a local weak form meshless method, is robust due to the local integration of the governing partial differential equation. The MLPG model is developed using MATLAB R2020a and is coupled with Differential Evolution (DE), which is a simple yet efficient optimization technique. The MLPG-DE model is applied for the study of design of PAT remediation plans using a hypothetical aquifer. This study highlights the effectiveness of the MLPG-DE model and its capability for the analysis of field problems.

Keywords: Groundwater remediation, Simulation Optimization, Pump and Treat, Meshless Local Petrov Galerkin, Differential Evolution

Water policy advocacy towards IWRM for the Ganges R

Sujana Dhar[1*] and Dr. Avdhesh Pratap[2]
[1]Sujana Dhar is a freelancing hydrologist PhD CEng, PEng, FIE
[2]Dr. Avdhesh Pratap is an Environment, Water Law and Governance Expert, Former Member, Group of Legal Aspects for Inter -Linking of Rivers Under Task Force Ministry of Jal Shakti Government of India
*sujanadhar@gmail.com

Abstract

Water advocacy is an important part of enabling Integrated Water Resources Managemnt. The River Ganges in many parts of India still suffers from blockages and pollution due to encroachment and solid waste dumping. There is no provision in our constitution and water legislation to lend effective flood-plains/river space restoration and maintenance and reconstruction of destruction of catchment area. Hence, a draft policy or a legislation is absolutely required to protect the rivers in long run. A draft in the form of 'Flood-plains Restoration and Maintenance Act' and 'Catchment Reconstruction and Restoration Act' to protect our rivers and to ensure uninterrupted flow in adequate quantum in lean season also. This paper will include case studies of the Yamuna River of Delhi. Special reference will be given to the Sahibi River (previously Najafgarh Nala) and Tolly Nala (previously Adi Ganga). Existing constitutional provisions will be explained. A comprehensive approach to conserve and governs all kinds of water resources was developed by the author and includes the following:

Water Engineering/ Technology & Science.

Water Legislations

Water Education

Water Literacy

Appropriate Budget Allocation

Keywords: IWRM, Ganges River, Adi Ganga River, water advocacy, restoration of flood plains, Sahibi River

Impact of flexible emergent vegetation on open channel velocity distribution in a compound channel

L. Rathod[1], P.V. Timbadiya[1] & B. Barman[2]
[1] Sardar Vallabhbhai National Institute of Technology, Surat, India
[2] Indian Institute of Technology (Indian School of Mines), Dhanbad, India
*d20ce017@ced.svnit.ac.in

Abstract

Understanding the hydraulics of flow in a compound channel with vegetated floodplains is very important. In the present study, artificial vegetation (bladed type) is selected for the experimental work. The vegetation is arranged in a staggered pattern with equal longitudinal and lateral spacing. Two cases, flow through a compound channel in (a) No vegetation (b) Homogeneous vegetation has been considered. The velocity measurements are performed using Acoustic Doppler Vectrino profiler (ADVP). It was observed that due to presence of homogeneous vegetation over the floodplains, increase in velocity in the main channel in comparison to no vegetation. Due to momentum exchange between main channel and floodplains and resistance offered vegetation over the floodplains lower the velocity in the floodplains which encourage the deposition of sediments in the vegetated floodplains.

Keywords: Compound channel, Velocity measurement, Vegetation, Floodplains, Spatial and lateral distribution of velocity

Urbanization and its effect on storm water management

S. V. Ighare[1], V.S Pradhan[2]
[1]MGM University, Aurangabad, India
[2]MGM University, Aurangabad, India
*sighare@mgmu.ac.in

Abstract

Rapid growth and development of Urbanization leads to surface runoff, which ultimately become storm water. Sometimes draught and flood like situation may arise because of improper drainage system. It affects the rate of infiltration of soil through decades due to various reasons like soil erosion, concrete pavements, less vegetation etc. Urbanization increase through decades 1990, 2000, 2010, 2020 are evaluated from various modern tools as GIS (Geographical Information System). Rate of infiltration in urbanized area has changed drastically from previous decades. The changes are incorporated in SWMM (storm water management software) for analyzing proper drainage system. Application of LID (low impact development) on catchment area can reduce surface runoff and increase the infiltration rate of soil. Proper drainage system of storm water is a necessity in urban areas.

Keywords: SWMM, GIS, LID

Sediment yield estimation of Seonath river basin using RUSLE model

Md. Masood Zafar Ansari1, Z. Ahmad, PK Garg2
Civil Engineering Department, IIT Roorkee

Abstarct

The Seonath river in Chhattisgarh state is one of the major left joining tributaries to the Mahanadi. It has the catchment area of about 33,000 km^2. The estimation of sediment yiled from the catchment keeps in understanding the morphodynamics condition of the river Seonath. The present study deals with the application of soil erosion model in particular the RUSLE model and integrated with Sediment Delivery Ration (SDR) to estimate the average annual sediment yield from the year 2011 to 2020 at the different gauging stations of Seonath river basin. The average sediment yield at the gauging station of the Seonath river is Jondhara, Kotni, and Simga is about 3.43, 0.50, and 1.09 million tons (MT) respectively. Andhairkore and Ghatora gauging station on river Hamp and Arpa respectively, which is a tributaries of Seonath river shows sediment yield of about 0.71 and 0.22 MT respectively. The study concludes with depiction of % change in sediment yield obtained from RUSLE model from the year 2011-20 with respect to previous year. The change varies from -30% to +50% at all the gauging sites of Seonath river basin.

Keywords: Seonath basin, Soil erosion, Sediment yield, SDR, RUSLE model