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Association of Hydrologists of India
Proceedings of
National Seminar on Hydrology
with special reference to
Hydrological Solutions for Sustainable Development

1st & 2nd December 2023

Editors
Dr. P. Rama Rao
Dr. R. Selvakumar

Organized by
Association of Hydrologists of India
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41st Annual Convention and National Seminar on Hydrology with special reference to 'Hydrological Solutions for Sustainable Development'

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ASSOCIATION OF HYDROLOGISTS OF INDIA (AHI)

The Association of Hydrologists of India (AHI) was started in 1981 at Andhra University with the prime objective of bringing together academics, professionals and institutions engaged in various hydrological aspects of water sciences on to a single platform to evaluate and asses the status, requirements, identify the challenges and to propose a way forward. As a part of the activities AHI has been organising annual seminars on Hydrology with special thematic areas in different parts of the country and abroad. To provide a common vehicle for and effective sharing of knowledge the Journal of Applied Hydrology was started in 1988 and is being published regularly. The association also organises a number of practical training programmes on contemporary areas of relevance in Hydrology for the benefit of young scientists, professionals and the scientific community of the Indian subcontinent. In addition, a few international seminars were held in Kathmandu, Nepal and Visakhapatnam, India in addition to a few International training programmes on specific topics. The AHI also closely works with international Associations like International Association of Hydrological Sciences (IAHS), British Hydrological Society (BHS), UNCED, and national organisations like Federation of Indian Geosciences Associations (FIGA). The AHI in association with NGRI organised the 8th Scientific Assembly of IAHS and 37th Congress of the International Association for Hydrogeologists (IAH) in 2009 in Hyderabad. The Association has local chapters at Sholapur and Vadodara.

PSG INSTITUTE OF ADVANCED STUDIES

PSG Institute of Advanced Studies (PSGIAS), an institution under PSG & Sons' Charities is an approved Research Centre under Anna University, Chennai and Bharathiar University, Coimbatore to do research in Nanoscience and Technology, Material Science, Mechanical engineering, Biotechnology, Nanobiotechnology, Physics and Chemistry. Having world-class infrastructures & facilities, PSGIAS has collaborations with various Universities in the USA, UK, Germany and Australia for joint research and international exchange programs. The institute currently undertakes several sponsored projects from funding agencies like DST, SERB, DBT, DRDO, BRNS, DAE etc., The institute also supports industrial consultancies, testing and startups for product development and validation.

ABOUT THE CONFERENCE

The deficit of water for domestic and agricultural usage is becoming a global reality due to rapid urbanization, growing population and energy production. Climate change adds to the existing list of issue that alters the water dynamics of a region leading to rise in temperature, frequent floods and water scarcity. In an intrinsically connected environment, the change in water yield leads to uncertainties and threats to water, food and energy security. It ultimately affects achieving the SDGs like Clean water and Sanitation, Climate action and Life on land by 2030. The main objective of the National Seminar is to bring together hydrologists, hydrometerologists, water resource engineers and managers, policy makers and N.G.O.s to report results, problems and exchange ideas under this umbrella. In this context, Association of Hydrologists of India and PSG Institute of Advanced studies together are organizing this National seminar to discuss various aspect of hydrology with a focal theme of 'Hydrological Solutions for Sustainable Development' along with a preconference workshop on 'Advances in Contaminant Hydrology and Remediation'. The major themes of the seminar are as follows:

Seminar Themes

- Impact of natural and anthropogenic activities on water resources- Mining and geohydrology
- Advances in water resources mapping and assessment
- Emerging contaminants in water resources systems
- Sustainable water resources in changing climate
- Recent trends in treatment of natural and contaminated waters- recycle and reuse
- Geospatial techniques and data analytics
- Governance to address future water challenges
- Natural hazards and risk assessment in hydrology
- **Special Session on "Unsolved problems in Hydrology"**
  (Jointly organized by Federation of Indian Geosciences Association (FIGA) and AHI)

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Message from The Managing Trustee, PSG Institutions

It is with immense pleasure and pride that I extend my warm greetings to all the distinguished participants, scholars, faculties, and industrialists who have come together for the 41st Association of Hydrologists of India (AHI) Annual Convention and National Seminar on Hydrology organized by the AHI and PSG Institute of Advanced Studies (PSGIAS).

Water, the elixir of life, is a critical resource that demands our unwavering attention and collective efforts to ensure sustainable management. The collaboration between PSG IAS and the Association of Hydrologists of India is a testament to our commitment to advancing knowledge and fostering dialogue on crucial hydrology issues.

This seminar is a platform for experts, researchers, and enthusiasts to share insights, exchange ideas, and explore innovative solutions to the challenges posed by water scarcity, quality deterioration, and the ever-changing dynamics of hydrological systems. As we navigate the complex landscape of water resources, it is imperative that we join hands, pool our knowledge, and work towards a sustainable future.

I commend the organizers, speakers, and participants for their dedication to advancing the field of hydrology and contributing to the greater cause of environmental stewardship. Let us embark on this intellectual journey with enthusiasm and a shared commitment to creating a water-secure future for generations to come.Wishing you all a fruitful and enlightening seminar.

L. Gopalakrishnan
Managing Trustee
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Director

MESSAGE

It is heartening to know that the Association of Hydrologists of India, for the past four decades ever since its establishment, has been actively engaged in propagating hydrological sciences and their impact on society, national economy and food security through a number of annual seminars conducted in different parts of the country. It is equally happy to note that a large number of academicians, professionals and institutions engaged in various hydrological aspects of water sciences come together to evaluate and asses the status, requirements, identify the challenges and to propose a way forward.

In this context, I am happy to know that the Association of Hydrologists of India (AHI) will be organizing its 41st Annual Convention and Seminar on Hydrology with special reference to 'Hydrological Solutions for Sustainable Development' during 1st & 2nd December 2023 at Coimbatore in association with PSG Institute of Advance Studies. I am equally happy to note that the present seminar is focussing on important aspects like impact of natural and anthropogenic activities on water resources, sources and fate of emerging contaminants, sustainability of water resources in changing climate, natural hazards and risk assessment in hydrology along with a special session on the identification and defining the unsolved problems in hydrology.

The association is also putting its continued efforts in not only debating the latest and current trends and future challenges but also organise a pre-conference workshop on "Advances in contaminant hydrology and remediation" on 30th November 2023, for the benefit of young scientists, professionals and the scientific community of the Indian subcontinent.

I Congratulate AHI for their efforts in bringing awareness on the important aspects of Hydrology and water resources and wish the deliberations of the seminar and workshop will go a long way in promoting hydrological sciences in the country.

27/11/2023

Prakash Kumar

Date: 27.11.2023

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डॉटी.श्रीनिवासकुमार   **/Dr.T.SrinivasaKumar**
निदेशक **/Director**

No. INCOIS:DIR:03:2023

November 27, 2023

I am happy to note that the Association of Hydrologists of India is organizing its 41st Annual Convention and the seminar on 'Hydrological solutions for sustainable development' during December 1-2, 2023 preceded by a training workshop on' Advances in contaminant hydrology and remediation' on 30th November 2023 at PSG institute of Advanced Sciences.

When India is facing an acute shortage of water resources even to cater to the drinking water needs of humanity and the impact of waste waters and the non-point sources of contaminants on the entire environment including the water systems and the coastal oceans are getting polluted, this seminar and the contemplated topics slated for deliberations are of immense relevance and importance both at national and international levels.

The increasing gap between demand and supply of various facets of water for multiple purposes forced the scientific community to look at the coastal oceans to address and cope up with their water needs. At the same time, in recent times, the natural and anthropogenic forces have become ubiquitous all along coastal tracks, constraining the scope for augmentation of fresh water from oceans. Further, submarine discharges and their role in hydrological process across the coastal and near shore regions deserve a closer monitoring and solutions to realize the associated challenges. Further, the interaction between land and ocean across the coastlines has a significant impact on not only national economy but also water and food securities. I am sure the seminar will deliberate all these aspects and come up with viable adoptable solutions.

I take this opportunity to congratulate the Association of Hydrologists of India for organizing the seminar on such an important topic and wish the seminar a grand success. I also wish a wonderful time for all the delegates coming from across India.

(T. Srinivasa Kumar)

Dr. T Srinivasa Kumar
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ASSOCIATION OF
HYDROLOGISTS
OF INDIA

Dept. of Geophysics
Andhra University
Visakhapatnam-530 003, India

30-11-2023

Message

The Association of Hydrologists of India (AHI) came into being in 1981 with the objective of providing a common platform to the scientists and engineers and professionals of various disciplines including social scientists interested in fostering, developing and adapting new techniques in the development, conservation, mangment and distributions of water resources both in terms of quantity and quality. The AHI, in pursuance of this objective, has organized 40 annual conventions and national seminars on various focal themes of local, regional and national relevance. Five international seminars were organized, including the one at one at Kathmandu and three at Visakhapatnam, and the latest being the Joint International Conference of 8th IAHS Scientific Assembly and 37th IAH Congress held at HICC, Hyderabad. The association also having realized the need to promote the dissemination of knowledge and results of contemporary significance have been publishing a quarterly journal since 1987.

It is gratifying to note that the Association of Hydrologists of India has decided to organize its 41st Annual Convention and Seminar on Hydrology with special reference to 'Hydrological Solutions for Sustainable Development' during 1st & 2nd December 2023 at Coimbatore in association with PSG Institute of Advance Studies. I thank and congratulate the PSG Institute of Advanced Science to steer the seminar.

It is heartening to note that contemporary challenges like sustainability of water resources in changing climate, natural hazards and risk assessment, emerging contaminants, etc. are slated for deliberations. Further, it is highly rewarding to note that the AHI, since 2004 has been in the process of identifying and defining the Unsolved Problems in Hydrology and addressing the same in the Indian perception which is again scheduled for in-depth discussion at a special session being organized jointly by AHI and Federation of Indian Geosciences Associations (FIGA). Organisation of a special training program on Contaminant Hydrology and possible remedies is yet another act of preparing the young talent to face the current and future challenges in water sector.

It is gratifying to note that more than 90 research papers presented by scientists, academicians, engineers and professionals representing more than 34 institutions in the country are being discussed at the seminar. I am sure the hydrological fraternity will come up with viable solutions to address the challenges in the water sector and will come up with innovative proposals to protect the interests of our posterity.

I wish the delegates to have a rewarding professional experience and a wonderful time in PSG Institute of Advanced Sciences campus and the beautiful city of Coimbatore.

P. Rajendra Prasad
President, AHI

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Message from the Director Emeritus, PSG Institute of Advanced Studies

Understanding hydrology and climate change is currently needed to achieve sustainable development and manage water crisis in India and throughout the world. In this context, I take this opportunity to appreciate the efforts put forth by Association of Hydrologists of India and PSGIAS for organising the 41st Association of Hydrologists of India (AHI) Annual Convention and National Seminar on Hydrology along with a Pre-Conference Workshop on "'Advances in contaminant hydrology and remediation" from 30th Nov to 2nd December, 2023. I am also happy to know that SERB, MOES, NGRI, INCOIS and ELICO Pvt ltd is supporting the conference and preconference workshop to discuss this pressing issue. I am sure this conference and workshop will facilitate the exchange of ideas, experiences, and knowledge that will be useful for mankind.

I wish the conference a grand success.

P. Radhakrishnan
Director Emeritus,
PSG Institute of Advanced Studies, INDIA

Message from the Principal, PSG College of Technology

PSG College of Technology expresses the happiness and pride over the several achievements that PSG Institute of Advanced Studies have accomplished over past several years. This 41 st AHI Annual Convention and National Seminar on Hydrology organized jointly by PSG IAS and Association of Hydrologists of India (AHI) is another significant event that addresses SDGs of United Nations.

Water being an essential element for life, demands our keen attention and concerted efforts towards its sustainable management. This convention serves as a central platform for academia, researchers and practitioners to delve into the complexities of hydrology, exchange ideas and chart the course of action for future advancements in the field.

During discussions, participants can actively explore the possible collaborations through networking opportunities. It is through such collective endeavors that we can address the challenges posed by scarcity of water of good quality that can ensure good health for mankind and environment.

I congratulate the organising committee for their sincere efforts and thank the sponsors and everyone involved in making this convention a reality. May this event be a catalyst for positive change, inspiring new ideas and fostering lasting partnerships towards the attainment of sustainable development goals.

I wish the convention a grand success.

K. Prakasan
Principal,
PSG College of Technology, INDIA.

Message from the Director, PSG Center for Academic Research and Excellence

It's a pleasure to know that the PSG Institute of Advanced studies is organizing the 41st Association of Hydrologists of India (AHI) Annual Convention and National Seminar on Hydrology jointly with the AHI during 1st and 2nd December 2023.

Considering depleting groundwater quality and quantity, understanding hydrological issue for attaining sustainable development is critical and crucial. It also remains a challenge to maintain the water reserves and related infrastructure for agricultural and domestic use.

I strongly believe that the eminent scientist participating in this national seminar will discuss and deliberate the salient aspects of hydrology and bring out useful suggestions for the improvement of water use and management. I appreciate the efforts put forth by the organizing committee to discuss such an important area through this conference. I wish them all success.

R. Rudramoorthy,
Director,
PSG Center for Academic Research and Excellence, INDIA

Message from Deputy Director, PSG Institute of Advanced Studies

With immense pleasure, I am happy to inform you that we are hosting this 41st AHI Annual Convention and National Seminar on Hydrology along with a Pre-Conference Workshop on "'Advances in contaminant hydrology and remediation" from 30th Nov to 2nd December 2023 jointly with the Association of Hydrologists of India. This conference envisages the impact of natural and anthropogenic activities on water resources and their effects on climatic change which yields uncertainties regarding water, food, and energy security. I appreciate the efforts put forth by Association of Hydrologists of India and our team at PSG Institute of Advance Studies led by Dr. R. Selvakumar, in bringing together leading researchers at the national level to discuss the significance of Hydrological solutions through this conference. I am sure that the young researchers and students will gain valuable information and acquire knowledge through the lead lecture delivered at this conference.

I wish this conference a grand success

J.Kanchana
Deputy Director,
PSG Institute of Advanced Studies, INDIA

Program

Pre-Conference Workshop on

Advances in Contaminant Hydrology and Remediation

30-11-2023

Association of Hydrologists of India
41ˢᵗ Annual Convention and National Seminar on Hydrology
with special reference to
Hydrological Solutions for Sustainable Development

01-12-2023

Session 1: Impact of natural and anthropogenic activities on water resources - Mining and geohydrology

Session 2: Natural hazards and risk assessment in hydrology

Session 3: Emerging contaminants in water resources systems

Session 4: Recent trends in treatment of natural contaminated waters- recycle and reuse

02-12-2023

Session 5: Advances in water resources mapping and assessment

Session 6: Sustainable water resources in changing climate

Session 7: Geospatial techniques and data analytics

Session 8: Governance to address future water challenges

Special Session- Unsolved Problems in Hydrology
(jointly organised by FIGA & AHI)

Invited Talks

Abstracts

Pre-Conference Workshop

Advances in Contaminant Hydrology and Remediation

Monitoring and modelling of contaminants including emerging contaminates in Hydrological systems

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Abstract

This talk delves into the critical aspects of monitoring and modeling contaminants within hydrological systems, with a particular emphasis on emerging contaminants. As water resources face increasing threats from anthropogenic activities, understanding the dynamic interplay between contaminants and hydrological processes becomes imperative for effective water management and environmental conservation. The presentation begins by exploring contemporary monitoring techniques, including advancements in sensor technologies and remote sensing, that enable comprehensive surveillance of water quality. The integration of real-time data and sensor networks facilitates a nuanced understanding of contaminant transport, transformation, and fate within hydrological systems.

Furthermore, the talk delves into the challenges posed by emerging contaminants, such as pharmaceuticals, personal care products, and industrial chemicals, whose impact on water ecosystems is still being comprehensively understood. The presentation highlights innovative approaches in modeling the behaviour of these emerging contaminants, incorporating factors such as environmental persistence, bioaccumulation, and ecotoxicity. The discussion extends to the incorporation of hydrological models to simulate contaminant dispersion in surface water and groundwater systems. Emphasis is placed on the synergy between monitoring data and modeling techniques to develop predictive tools that aid in risk assessment and decision-making for water resource management.The audience will gain insights into the current state of monitoring technologies, modeling methodologies, and the challenges and opportunities associated with addressing contaminants, including emerging pollutants, in hydrological systems. The talk aims to foster a multidisciplinary dialogue among researchers, policymakers, and practitioners to enhance our collective ability to safeguard water quality and ensure the sustainability of hydrological systems in the face of evolving environmental challenges.

Importance of reactive transport modeling in porous reservoir for sustainable consumption of subsurface resources and mitigation of pollution

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Abstract

Subsurface hydrologic system is (i) the largest source of fresh water, (ii) an enormous source of energy (geothermal and fossil fuels), iii) minerals (metals and radioactive minerals), and (iv) a repository for biodegradable contaminants, nuclear wastes and greenhouse gases. For both extractions of resources from subsurface reservoirs and geological storage of wastes,flow and transportin porous medium are directly or indirectly involved. In some cases we have to deal with multiphaseflow and multi-components reactive transport. Hence, for understanding the behaviour of subsurface in response to human interferencesmodelling of flow and transport is very crucial. However, the subsurface system exhibitmulti-scale physico-chemical heterogeneityand detailed exploration of reservoir properties is impossible. The lack of knowledge about the reservoir is often modeled as theuncertainty in the stochastic framework. Conditional i.e. data driven stochastic modelling is the most appropriatetechnique to predict the performances of the extractions of resources, waste management and long term consequences of all forms of human interferences with subsurface hydrologic mm system.

In this talk the important theoretical concepts of flow and transport in porous media and numerical modelling will be first discussed. Thereafter, the effect of heterogeneity on contaminant transportand some complex behaviours arising from the nonlinear interaction between flow and transportin hydrothermal and oil&gas reservoirs will be showed. At last, a case study ofcontaminant transport and bio-remediation will be presented.

Biological and bio-electrochemical waste water treatment technologies and their efficacies for imparting sustainability to wastewater treatment

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Abstract

Growing scarcity of fresh water reserves and ever-increasing demand for water have led to a condition where the option of reuse of treated wastewater need to be encouraged. Innovative wastewater treatment plants aiming not only at treating the wastewater, but also providing benefits, such as facilitating reuse of treated water, resources or nutrient

recovery, are the need of the day. Conventional sewage treatment either require huge land or high capital, maintenance and operational costs, and/or huge energy requirements; which make them unsuitable for use in developing countries. Energy efficient low-cost wastewater treatment systems are the best choice for such countries. Anaerobic treatment systems excel in such respect.A pilot-scale (400 m^3/day) up-flow anaerobic sludge blanket-moving bed biofilm (UASB-MBB) reactor followed by a high-rate algal pond (HRAP) was designed, constructed and operated to remove organic matter, nutrients and pathogens from low strength sewage (chemical oxygen demand, COD,of about 230 mg/L) generated on campus.This UASB reactor demonstrated annual average total COD removal efficiency of 63 ± 8% and total suspended solids (TSS) removal of 86 ± 7%. The HRAP following UASB reactor demonstrated nitrogen removal of 85 ± 3%, phosphate removal of 91 ± 1% and up to 3 log coliform reduction, thus producing treated effluent suitable for horticulture reuse. Biomass granulation has been achieved in the UASB reactor, which has not been reported earlier anywhere while treating such low strength sewage, which was possible due to proper hydrodynamic design.

On Campus of IIT Kharagpur two sewage treatment plants with capacity of 300 m^3/day and 1350 m^3/day, comprising of moving bed biofilm reactors and tertiary treatment combinations are installed. Performance of these plants along with life cycle costing will be presented. For the higher capacity plant the life cycle cost of producing nearly potable quality treated water is less than 11.0 Rs. Per kL.

Bio-electrochemical systems (BES) have a potential to offer sustainable wastewater treatment and simultaneously recover valuables. This technology is likely to evolve as a way of treating sewage, industrial or agricultural wastewaters and at the same time produce electricity, hydrogen or other chemicals of high value. Thus, by adopting BES, the wastewater can be regarded as a resource, rather than a problem that demanding costly treatment.

Microbial fuel cell (MFC) is one of the popularly adopted configuration of BES, and scientist have widely explored it for treatment of various wastewaters, using them as fuel, and recovering direct electricity for onsite use. However, practical applications of MFCsare limited because of higher fabrication cost of it due to involvement of costly membrane and electrode catalyst. The research efforts undertaken at IIT Kharagpur on development of low-cost ceramic membrane separator and non-platinum-based electrode catalysts for application in MFC considerably reduced the fabrication cost. Utilizing outcome of these investigations a largest (1500 L)pilot-scale MFC based onsite sewage treatment system is designed and constructed at IIT Kharagpur campus. Performance of this 'Bioelectric Toilet (BET)' system for more than two years wassatisfactory. This BET is able to treat waste generated from the toilet onsite to produce electricity for illumination of toilet cabin and premises at night and produce reusable quality treated water for flushing the toilet, thus considerably reducing water consumption per use of toilet. In addition, this BET eliminates the problem of smell nearby the toilet due to effective treatment of the waste.

Challenges in identification, quantification and fate analysis of Emerging contaminants in water and associated samples

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Abstract

Recent reports on increase in the presence of emerging contaminants (EC) due to point and diffuse pollution in various environmental samples like air, water and soil warrants advanced and effective identification and quantification methods, protocols and instrumentation. Unlike conventionally reported metal, metalloid and ionic contaminants, EC are diverse, new and undergo transformation in environment that impose challenge in identification, quantification and fate analysis. In this lecture, I will be discussing on the behavior, fate and interaction of EC in environment, sampling techniques, risk assessment, analytical methods, instrumentation used, challenges faced and possible ways to overcome the challenges. The need for multi compartment monitoring, policy decision on the permissible limits for EC in various environmental samples, relevance to UNESCO- sustainable development goal (SDG) and way forward will also be discussed.

In Vitro and *In Vivo* Molecular Toxicology Approaches on Contaminants of Emerging Concerns

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Abstract

Contaminants of Emerging Concerns (CECs)are of global issue as there is a constant discovery and production of novel materials, devices, chemicals and pharmaceuticals to meet the demands of the rising population, which eventually end up in the environmental compartments affecting the ecosystem and health. Analytical methods and tools are being developed worldwide to detect, measure and understand the transformation and fate of CECs in the environment.Simultaneously, advancements in toxicological approaches continue to evolve globally to comprehend the adverse impacts and mechanistic responsesof CECs on the biota for efficient risk assessments, risk

communication, remedial strategies and regulatory guidelines on par. Toxicological approaches employ variousmolecular techniques onin vitro and in vivo models to understand the chemical nature, lethal concentrations, mechanisms of action and resulting hazardous effects for the competent safety guidelines. Field assessment of real-time toxic impacts of CECs on living organisms is challenging and the results are often elusive. Thus, suitable model organisms are chosen based on the sampling matrices and exposed to measured environmental concentration to analyze the same. *In vitro* models such as primary cells, cultured cell lines or 3D organo-spheroids are generally used in any toxicological assessment to determine the lethal dose (LD_{50}) and dose-response relationship. The findings are implemented in suitable higher-order in vivo models (aquatic-freshwater/marine, terrestrial-murine/rodents, nematodes) to further understand the toxicity impacts and mechanism. Measure of reactive oxygen species and oxidative stress in tissue samples using analytical instruments is the prelude of toxicity assessmentfollowed by studies on antioxidant defense mechanisms. Molecular techniques such as western blotting, immune blotting, RT-qPCR and fluorescent staining/imaging areused to understand alterations in molecules as biomarkersincluding proteins, RNA, miRNA and DNA in treated tissues, which reveal the toxicological endpoints. Ultrastructural changes in histology examined by HE staining and transmission electron microscopy are useful for understanding the hazardous nature of chemicals. In silico toxicological approachessuch as quantitative structure–activity relationships (QSARs) tools could complement existing wet laboratory toxicity tests to simulate, predict the toxicity and minimize animal usage.

Mobility and Pore Scale Interactions of heavy metals in the subsurface

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Abstract

Biosolids, also the sewage sludge, have the potential to be reused for plethora of applications such as soil quality enhancers, slow-release fertilizers and soil enriching compounds. However, biosolids are contaminated with heavy metals with mercury being one of the notable contaminants with highest impact on the environment and public health. Pore scale studies on its mobility and availability are important in order to apply suitable remediation technology. Studies on mobility, availability and emissions of mercury from biosolids are carried out to assess the biosolids contamination and to evaluate applicable techniques for future remediation. It is reported that C - Hg bond in methyl mercury would get converted to CH_4 and Hg(II) following which Hg(II) would be reduced to Hg(0) through the activity of mercuric reductase enzymes in soil. Quantifying pore scale parameters such as residual Hg(0)will help to promote the understanding of

Hg(0) transformation and ecological risks associated when biosolids are used for land application. The manifestation of these results can be seen in theoretical and modeling analyses in future.

- *Entrapment*
- *Dissolution*

- *Sorption*
- *Reduction*

Hg^0

Hg^0

SOM

Sorptionn

Soil Matrix

Free Drainage
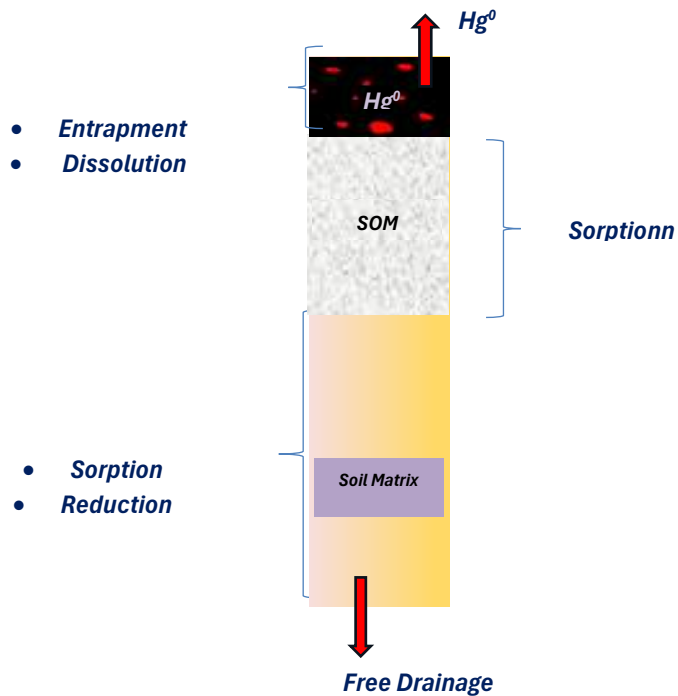
Conceptual model of Hg^0 fate and transport in soil systems

Abstracts

National Seminar on Hydrology

with special reference to

Hydrological Solutions for Sustainable Development

Session 1

Impact of Natural and Anthropogenic Activities on Water Resources-Mining and Geohydrology

<u>Invited Talk</u>
Sustainable Groundwater Management in Lignite Mining- Special Reference to NLCIL Mines

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Abstract

The Neyveli Hydrogeological basin is famous for its lignite deposits. Discovery and development of large lignite deposits around Neyveli stands Asia's biggest lignite mining centre giving it the pride of place on energy map of India. NLC India Limited (NLCIL) is one of the major Public-Sector Undertakings (PSU) and Navratna Company, functioning under the Ministry of Coal (MoC). NLCIL has been a pioneer company in lignite mining for more than six decades and operates the open-cast mechanized Lignite mines. NLCIL operating three lignite mines Viz., Mine-I, Mine-IA & Mine-II having a combined lignite production capacity of 30.0 million tons per annum (MTPA) and pit-head Thermal Power Stations with an aggregate capacity of 3390 Mega Watt (MW) at Neyveli, Cuddalore District, Tamilnadu which is the main source of Industrial development in Tamilnadu.

The lignite mines of NLC in Neyveli are located in the Neyveli hydro-geological basin which covers an area of 3500sq km. Detailed Hydro-geological study undertaken by different Govt. organizations including NLCIL has indicated the presence of three prominent multi-layered aquifers system in the area viz: Un-confined aquifer (water table aquifer), ii. Semi-confined aquifer and iii. Confined aquifer. The Sallow Water Table Aquifer and Semi-confined Aquifer are present above the lignite seam while the Upper Confined & Lower Confined aquifers occur below the lignite seam with high upward hydro-static pressure.

Mining of lignite from NLCIL's mines in Neyveli is faced with a unique hydrological problem due to the presence of powerful aquifers below lignite seam exerting an upward pressure, if not controlled, it could jeopardize the entire mining operations. Therefore, the depressurization of this aquifer is essential during mining to maintain the pressure head constantly at the lignite bottom at the depth of 80m to 120m and to bring down the pressure surface locally very closer to mine cut region through pumping operations by strategically located pumping wells in the lignite mines/ close to excavation zone.

The groundwater control operation in mines helps in lowering the water pressure and prevents flooding during the mines operation. The pressure surface of powerful artesian aquifers located below lignite seam is being controlled through pumping from large diameter wells strategically located and taken down up to depths determined from hydrological tests.

In addition to the groundwater from confined aquifer, the storm water (rain water) and seepage water from semi-confined and unconfined aquifer zones collected at the lignite mined out area - mine pit sumps also causing problem while mining. To avoid mine flooding, for safe mining operation and to maintain safe water level to protect bunds of sumps, the storm water control (pumping) operation is very essential. The entire rainfall and also mine benches seepage water are drained into compartmental sumps area located at the lowest level in the mine floor where the lignite seam is already mined out. All these storm water is managed by judicial pumping to achieve safe mining operation.

Due to progressing of mines across the potential ground water bearing zone i.e. Paravanar river basin, the present mine position causes heavy seepages in overburden benches inside the mine. Besides, large number of surface tanks & drainage networks are located in advancing side of present mining adding further seepage problem in Mines.

To control seepage water in the overburden benches, specific dewatering methodology is being followed by NLCIL. After ascertaining the potentiality of aquifer zones occurring in overburden strata, seepage wells are established at surface level in the advancing side of mine in series and as cluster wells in two rows at vulnerable zones in mines benches. All the discharge of seepage water taken farther & let into natural canal for irrigation.

The major drinking water requirement of Neyveli Township is met out from treated storm water (37.27 LCM/Yr) from Mine-I. About 47.78 LCM/Yr of storm water from Mine-IA is being supply to Chennai Metro water supply. In addition to above, Chennai Metropolitan Water Supply & Sewage Board (CMWSSB), Govt. of Tamilnadu is drawing about 95.57 LCM/Yr of NLCIL storm water let in to Paravanar River for drinking water supply to Chennai. Totally about 180.62 LCM/Yr of NLCIL mine water is being consumed for drinking water supply purpose after treatment.

After meeting out internal requirement of NLCIL storm water for thermal station, drinking water supply and afforestation usages, the balance storm water from mines is discharged in to natural canals for irrigation in the downstream area. In total about 341.67 LCM/Yr of Mine water is being discharged in to canals feeding to walaja tank and Perumal eri by which 25000 acres of land is cultivated by local farmers. About 25000 acres irrigated land covering 40 villages are benefited by NLCIL Mine water.

Zinc Oxide-Mediated Sono Photo and sonophotocatalytic Approaches for Eliminating Antibiotic-Resistant Bacteria

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Abstract

Antibiotic resistance poses a significant threat to public health, necessitating innovative and effective strategies for microbial eradication from water. The present study aims to find out the Advanced Oxidation Process (AOP) as a potential remediation method for the removal of antibiotic Resistance Bacteria (ARB) using ultrasound (US), sunlight (SL), and their combination in the presence of a semiconductor oxide catalyst. ARB was isolated from river water using chromogenic agar. Investigations of the effect of various operational parameters were done. Zinc oxide (ZnO) was found to be the most effective semiconductor oxide catalyst among the different catalysts screened. The study was carried out under natural pH. Oxidants such as hydrogen peroxide and potassium persulfate enhanced the deactivation of ARB in the SL, US, and US-SL. The re-emergence of ARB was also investigated and it was not observed in the presence of ZnO. The results clearly proved that US-SL/ARB/ZnO is an alternative and environment-friendly treatment method for the removal of bacterial pollutants from water thereby enabling the reuse of scarce water resources.

Keywords: Antibiotic Resistance Bacteria (ARB); Catalyst; Re-emergence

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Microbial Reclamation of Titanium and REEs from Redmud Leachate.

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Abstract

Red mud is the primary waste produced after alumina extraction from bauxite ore it is very alkaline in nature. Tons of red mud is generated annually and is often dumped in oceans and open field. These methods pose several potential threats to the ground water and environment due to Leakage of leaching solution from containment barriers and alkaline seepage in groundwater. However, this highly alkaline residue is a rich source of various metals like titanium and rare earth elements (REE) including, scandium and yttrium. The REE present in the bauxite residue can't be extracted through Bayer's process as the elements remain unchanged during the process of extraction. In an

attempt to extract the REE from red mud, environmentally harmful chemicals are employed in leaching. In addition to having unfavorable impact on the environment, the chemical leaching process is not economically favorable. Hence the work aims to extract the REE from Red mud leachate through a bioleaching approach aided by microbes. Microorganisms possess the ability to produce organic acid to leach out the REE from the residue. Augmenting this mechanism of microorganism, the study focuses on isolation of metal-resistant acid producers and bioleaching of titanium and REE, the concentration of which is detected through ICP OES.

Keywords – Red mud Leachate, Bioleaching, Rare Earth Elements Recovery

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Surveillance and molecular detection of Multi drug resistant Bacteria from Hospital Effluent Treatment Plant

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Abstract

Antibiotic resistance has put the whole world on line as the existing arsenal of antibiotic strains are becoming less-efficient in treating the multi-drug resistant bacterial strains. In hospital setting, the multi-drug resistant bacteria released into effluent and the sterilization processes including UV and chlorine treatment are less effective in treating the resistant strains. When let into the environment, these MDR bacteria are prone to cause infections and makes patients more viable to hospital borne infections. This study utilises microbial and molecular methods in the detection of MDR strains in hospital effluent treatment plant in Coimbatore.

Keywords – Multi-drug Resistance, Hospital waste water, ARG

Development of Bacteriophage impregnated Nanocarriers for Treatment of Antibiotic resistance Bacteria in Hospital Wastewater

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Abstract

Vancomycin resistance in bacteria has been classified under high priority by WHO and its presence in hospital effluent is reported to be increasing owing to excess antibiotics use and discharge from patients. Bacteriophage has been considered as a promising biological agent for mitigation of such antimicrobial-resistant bacteria through their host-specific lysis. Despite of its interaction very less information is available on the role of effluent's properties influencing the phage bacterial interaction in actual hospital effluent environment. The present works intends to study this influence of hospital effluent and its parameters on the interaction between vancomycin resistant bacteria and its host specific phage. The vancomycin resistant bacteria identified as *E. coli* using 16S rRNA sequencing, MALDI – TOF and whole genome sequencing. The infectivity of phage onto host was investigated using SEM, DLS, TEM and spectrofluorophotometer and confirmed using double agar overlay method. The polyvalency and monovalency of phage was determined. The phage morphology was identical to T7 phage belonging to *Podoviridae*. The impact of pH, temperature and vancomycin concentration on phage bacteria interaction was investigated. The infectivity was maximum at pH 7, 37 °C and vancomycin concentration of 100 μg/mL in both synthetic media and effluent. ICP-OES analysis of effluent before and after phage infection revealed reduction of metal concentration availability with increasing vancomycin concentration. The Whole Genome Sequencing was performed and bioinformatics analysis showed the presence of mdfA gene encoding the efflux pump that may be responsible for vancomycin resistance in *E. coli* and the organism possess multiple metal resistance genes responsible for tolerance to mercury, cobalt, zinc and cadmium. These results clearly indicates that bacteriophage mediated mitigation of vancomycin resistance is possible in actual hospital effluent.

Keywords: Hospital effluent; vancomycin resistant *E. coli*; bacteriophage; AMR mitigation; cation impact

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Analysis of salinity intrusion in Kole wetland and the surroundings using GALDIT index

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Abstract

A movement of saline water into fresh water aquifers that lowers the quality of groundwater resources is called salinity intrusion, also referred to as saltwater intrusion. The region's food security is under threat when saline water is utilized for agriculture because it negatively affects crop yield. Monitoring the intrusion of salinity in a region is therefore essential, especially if the region is close to the coast. The rice-growing region of Kerala's kole wetlands is a distinctive collection of wetland ecosystems, situated one meter below mean sea level. Due to their close proximity to Thrissur's coast, these wetlands are naturally susceptible to saline intrusion, which could have an adverse effect on agriculture by lowering crop yields. To find out the salinity intrusion in the study area using GALDIT index, six factors were considered as follows: Ground water occurrence (G), Hydraulic conductivity (A), Ground Water Table above sea level (L), Distance from the shoreline (D), Impact of existing seawater intrusion (I), and Aquifer thickness (T). Using the GALDIT index, this study aims to analyze the salinity intrusion in the Kole wetlands and their surroundings and to determine the salinity-vulnerable zones.

Key words: Salinity intrusion, GALDIT index, Kole wetlands

Session 2

Natural Hazards and Risk Assessment in Hydrology

Invited Talk
Mathematical Modeling for Floods in Complex River Networks

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Abstract

Floods are the most widespread and frequent of all the natural disasters, claiming several thousand lives and displacing millions of people across the globe annually. A well-equipped flood forecasting and warning system predicting the arrival and intensity of floods much ahead in time is required to alert the public to act in advance. Numerical models utilizing flood routing calculations are employed for forecasting floods. The non-linearity involved in the physical process introduces complexities in the numerical simulation of floods. Further complexities arise while capturing the flow dynamics in a river basin where multiple rivers in a network overflow and inundate the floodplains simultaneously. The extensive data requirement and computational expense in the developing and running of flood simulation models based on full dynamic equations for the entire domain make it necessary to develop reduced complexity modelling approaches which are computationally affordable and reliable. Investigations on models with reduced complexity are often limited to a single channel with floodplains. The present talk discusses a recently developed computationally efficient model for simulating floods in a network of channels with floodplains. The mathematical model is based on iterative coupling of main channel flow with flow over flood plains. Main channel flow module is based on full Saint Venant equations while the flood plain flow module is based on diffusion wave approximation. The developed model is two to four times faster than HEC-RAS models.

Invited Talk
Integrated framework for 2-D finite element based numerical simulation of groundwater flow and nitrate transport in the coastal aquifer

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Abstract

Groundwater basin simulation models based on the physics of groundwater flow can be important tools for groundwater assessment, integrated planning and management of water resources particularly in coastal regions. Further, threat to groundwater resources from non-point source pollution can be expected to increase in the future as irrigated agriculture and use of fertilizers will only intensify to meet the demands for

more food and fibre by the increasing population. To better understand the physical drivers of groundwater recharge and discharge mechanisms along with contaminant transport in coastal aquifers, an integrated approach that is based on understanding the dynamics of the crop - soil - water - fertilizer - groundwater flow - contaminant (nitrate) transport at regional scale is developed and applied to coastal aquifer overlying the Central Godavari irrigation project area, AP. The integrated framework consists of databases, simulation models (canal flow model, soil water balance model, nitrogen balance model, groundwater flow model and groundwater transport model) and interfaces between the models and GIS. Assembling data of the model inputs and assigning parameters for each model require significant prior processing of related information. The modelling framework was built such that the output of one model serves as input to other model. The groundwater flow in the unconfined aquifer of the study area was simulated using a 2-D groundwater model considering recharge, pumping, boundary conditions, and aquifer parameters that constitute the main input data for this model. GIS based soil water balance model helped to estimate the spatial distribution of recharge, one of the vital input for groundwater model. Since, over a large area, all of these vary spatially, this model used a triangular network finite element scheme to represent the variations and solve the flow equation using numerical techniques. The groundwater model for the study area is evaluated for its sensitivity to the aquifer parameters. Overall, it was confirmed that the identification of aquifer parameters and derived distribution for recharge and pumping are sufficiently accurate for applying the model in groundwater assessment and conjunctive use studies. Further, to model the movement of nitrate in the aquifer, a sequential solution of the groundwater flow and transport problem is necessary. Hence, the space-time domain problem within which the groundwater flow problem was solved, is adopted for groundwater transport problem also as both the models share the same numerical grid structure and solution methods. Additional parameters aquifer porosity and dispersitivity over the flow domain were obtained by model calibration. GIS based nitrogen balance model helped to estimate the nitrate loadings into groundwater that serve as an input for groundwater transport model. Thus, the finite element groundwater transport model developed in this study was able to simulate the hydrologic behaviour of the nitrate pollutant derived from the N-balance model in terms of space-time domain. The integrated framework helped to develop a scenario based approach for strategic planning based on the assessment of future non-point source pollution levels resulting from alternate management strategies for the coastal aquifer situated in Central Godavari irrigation project.

Key words: Soil water balance model, Nitrogen balance model, Groundwater flow model, groundwater simulation model, GIS

Urban flood simulation using hydrodynamic model-SWMM and HEC RAS

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Abstract

Storm water flooding has become major issue in most of the cities in the country. Due to climate change and changes in land use/land cover (LU/LC), the flood magnitudes are increasing and the existing storm water drainage network is not able to receive the flood water. Flood modeling plays an important role in understanding the characteristics and various socio-economic aspects of the urban floods. In this paper, SWMM (Storm Water Management Model) software was used to simulate the urban storm runoff in Zone-IV of GHMC (Greater Hyderabad Municipal Corporation) Hyderabad. Zone IV is divided into sub watershed in GIS tool using 50cm Digital Terrain Model (DTM) data. The major land use/cover details of the study area were obtained from Landsat 5 (1990 and 2000) and Resource Sat 1 & 2 (2005, 2010,2015 and 2020). The major land use classification found to be barren land, built-up area, plantation, road, vegetation and water body. These LU/LC maps were used to estimate the pervious and impervious areas in the basin. Further, the percentage of slope, soil types and curves number for each sub-catchments using various thematic layers were obtained and these parameters are provided as inputs to the SWMM. The observed rainfall event on 13th October 2020 is used to simulate runoff hydrograph from SWMM model. Further, various LU/LC details for the years 1973, 1990, 2000, 2005, 2010, 2015 are incorporated in the model and estimated the runoff coefficients and flood peaks accordingly. SWMM simulated runoff depth is used as input to 2D-hydrodynamic model (HEC RAS) and 2D flood map have been prepared for the event on 13th October 2020. These computed depths have been compared with field flood marks and found that the simulated results are in good agreement with field data.

Keywords: Flooding, SWMM, Modeling, Runoff Coefficient, Urban Catchment.

Spatial distribution of radon concentration and its health risk assessment in the groundwater: A study from a tropical river basin, Southern Kerala, India.

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Abstract

Radon is a naturally occurring radioactive inert gas found in the earth's crust and it is transported to groundwater through soil. Although, the increased amount of radon (^{222}Rn) on groundwater has serious environmental and health concerns. The present study investigates the distribution of radon (^{222}Rn) concentration and its annual effective dose exposure in the groundwater samples in a tropical river basin (Achankovil river basin). For this, ^{222}Rn concentration of the study area is measured from 36 groundwater samples during pre and post monsoon seasons using RAD7 radon detector. Thereafter the Spatio-temporal concentration of annual effective dose exposure was estimated for adults, children, and infants using the UNSCEAR guidelines. The result shows that the ^{222}Rn in the study area ranges from 0.2 Bq/L to 68.7 Bq/L during the pre-monsoon season and 0.6 Bq/L to 37.7 Bq/L during the post-monsoon season respectively. The total annual effective doses due to ingestion and inhalation of radon in drinking water varied from 3 to 904 mSv y-1 for infants, 1.6 to 483 mSv y-1 for children and 1.42 to 436 mSv y -1 for adults during pre-monsoon while 9.8 to 457.2 for infants 4.2 to 244.5 for children 3.8 to 220.4 for adults during post-monsoon season. The annual effective dose exposure of adults, children, and infants in the study area are higher than the recommended limit by (ie.,100 µSv/y for adults and 200 µSv/y for children) WHO. As a result, the inhalation and ingestion of ^{222}Rn in the study area may cause serious health issues in the study area.

Keywords: Groundwater, ^{222}Rn, Health risk, Achankovil river basin, Kerala

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Temporal Transitions: Change Point Analysis of Aerosol Optical Depth and Rainfall in the Amaravathi River Basin.

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Abstract

This study employs Change Point Analysis to investigate the temporal patterns in rainfall and Aerosol Optical Depth (AOD) from 2000 to 2022, focusing on monthly averages in the districts of Coimbatore, Tirupur, Erode, Dindigul, and Karur. Utilizing

three distinct change point detection methods—Buishand's, Pettitt's, and SNHT—we identify shifts in the time series data for each specific study area. The analysis aims to unveil significant alterations in both rainfall and AOD over the specified period, providing a localized and detailed understanding of environmental dynamics in Coimbatore, Tirupur, Erode, Dindigul, and Karur of Amaravati river basin. By examining multiple districts, we seek to capture regional variations of these changes within each area. The significance of this study lies in its potential to offer nuanced insights into the evolving climate patterns and atmospheric conditions in the specified regions, thereby assisting local authorities in informed decision-making for environmental sustainability and disaster preparedness tailored to Coimbatore, Tirupur, Erode, Dindigul, and Karur.

Keywords: Aerosol optical depth, Detection, Rainfall, Environmental dynamics, Sustainability

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Flood Inundation Mapping and Damage Assessment on the Greater Pamba River Basin, Kerala, India

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Abstract

Mapping flood inundation is crucial as it provides essential information for decision-makers to assess the extent of flooding. This study employs modern processing methods for Sentinel-Synthetic Aperture Radar (SAR) data to map flood inundation in the Manimala, Pamba, and Achenkovil catchments within the greater Pamba Basin. The study focuses on two key stages: pre-flood (May 1-15) and post-flood (August 20-31) in 2018. Techniques such as speckle filtering, temporal compositing, and thresholding are integrated to derive precise flood extent maps. The Copernicus Sentinel-1 Ground Range Detected (GRD) image collection was filtered for VH-polarized SAR data with the Interferometric Wide (IW) instrument mode, and orbit properties were chosen as either descending or ascending. Preprocessing steps, including calibration and the use of refined speckle filters on SAR images, were implemented to reduce noise for more accurate flood detection. Temporal compositing was employed to obtain images at specific time intervals, providing an overview of dynamic flooding processes. Differentiating waterlogged regions from dry ones was achieved through successive subtraction of backscattering coefficient values. Flood mapping represents flood-prone areas in red, while wetlands and waterbodies are depicted in blue using a visualized color-coded legend. The study involves calculating the total district area by measuring the flooded area from specified Regions of Interest (ROIs). The outcome indicates that the overall basin area is 4,505 square kilometres, of which 158.88 square kilometres

are subjected to inundation. The results are validated with NRSC data with efficient accuracy and these findings strongly support the use of SAR data from the Sentinel satellite and associated processing technologies for precise mapping of flooded areas. The impacts of floods on the agricultural lands and build-ups are also assessed.

Keywords: Flood Mapping, Sentinel SAR, Google Earth Engine, Greater Pamba Basin

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A Comprehensive Study on Groundwater Nitrate Hotspots in Odisha: Mapping and Health Risk Analysis

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Abstract

Nitrate contamination of groundwater is a major environmental and public health hazard. Understanding the extent, distribution, and health implications of groundwater nitrate contamination is critical in the Indian state of Odisha. This study takes a multidisciplinary approach to investigating the occurrence of nitrate hotspots in Odisha, combining geospatial mapping techniques with a complete health risk assessment. The spatial distribution of nitrate hotspots across the state was revealed using geospatial mapping, offering light on the vulnerable areas to groundwater contamination. Concurrently, health risk assessment method was used to measure the potential health risks connected with nitrate exposure. The findings emphasize that northwest districts of Odisha state have high nitrate concentrations and associated health hazards, enabling policymakers, environmental agencies, and local populations in developing effective mitigation methods and encouraging safe drinking water practices. This study adds to our understanding of groundwater nitrate contamination in Odisha, making it an important resource for protecting public health and assuring the long-term management of groundwater resources.

Keywords: Hotspots, Groundwater, Nitrate, and Health hazards

Trend Analytics of Rainfall Data in the North-Eastern Part of Visakhapatnam District, India

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Abstract

Cyclones and irregular monsoon patterns are two major contributors to unexpectedrainfall, both of which have an impact on natural drainage systems and urban population.Predictive trend analytics plays a crucial role in estimating the rainfall pattern those impacts on climate change, especially in water resource management. The present study area is highly prone to cyclones and rainfall irregularities that show a greater impact on the Watermanagement of Visakhapatnam. Present work focuses on the predictive trend analysis of the rainfall data for 38 years from 1982 to 2020 in the study area. Anon-parametric analysis using Mann-Kendall and Sen's slope is applied on monthly, seasonal, and annual rainfall data.Based on the results, it is predicted that the rainfall pattern in the study area mostly irregular in nature with significant variability for the next few years. The positive value of Z and Q Statistics revealed an upward trend with a rising slope of annual rainfall. The observed upward trend in annual and seasonal rainfall patterns presents an opportunity for enhanced strategic planning of water resource development and management initiatives and soil moisture preservation within the chosen study area.

Key words: Climate Change, Mann Kendall & Sen's slope, Rainfall Trend Analysis.

Flood Inundation Mapping of Beki River Basin of Assam

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Abstract

Flood is one of the most destructive events. The Beki (Manas) river originates in Tibet, runs through Bhutan and has wide floodplains in Assam's Barpeta district in India. Due to improper development of banks, the river flows over both the channels during peak flow/flood season. Area of the total basin is 32,725.92 Km². Soil Erosion, landslides and flash floods are the major problems faced in this region.

One of the objectives of the study is to assess usefulness and limitations of RRI model for flood inundation modelling for an Indian basin. The other major objective is to prepare flood Inundation maps for Beki river basin. In this study, the RRI model is proposed to be used to model the flood inundation area by simulating rainfall runoff

process and river routing. Further, the rainfall runoff process shall also be simulated using HEC-HMS/NAM model and the flood routing shall be carried out using HEC-RAS/ Mike Flood to generate flood inundation maps. Both the generated flood inundation maps shall be compared. Flood inundation simulations from the RRI Model and HEC-RAS/ Mike Flood shall be compared. The simulated flood inundation maps for historical flood events shall also be compared with satellite images.

Extreme Gradient Boosting an efficient machine-learning technique in landslide modelling: A study from Idukki district of Kerala

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Abstract

Landslides are cataclysmic event affecting the hilly regions across the globe. Landslide susceptibility or the likelihood of landslide occurrence plays a crucial role in landslide hazard mitigation and land use planning. Researchers use various techniques, including traditional methods and machine learning techniques to assess landslide susceptibility. In this study landslide susceptibility modelling is carried out for Idukki district of Kerala, which experienced hundreds of landslides during 2018 Kerala extreme rainfall event. For this nine landslide conditioning factors such as slope angle, distance from stream, distance from roads, rainfall, topographic wetness index, land use/land cover, plan curvature, profile curvature, and distance from lineament were collected from different sources and a total of 1200 landslide locations were identified and used for modelling. Thereafter, the extreme gradient boosting (XGB) method is used for modelling the landslide susceptibility and the result is compared with random forest (RF) method. The predicted model is validated using ROC-AUC, Sensitivity, Specificity and Kappa index. The result shows that XGB outweigh the RF method with a ROC-AUC value of 0.959 in training section and 0.938 in validation section. The study shows that XGB is an efficient method for landslide susceptibility modelling. Moreover, the slope angle, distance from the stream and distance from the road are the major factors which influence the landslide susceptibility in the study area. The predicted model is useful for hazard mitigation in Idukki district of Kerala

Keywords: Landslide modelling, Machine-learning, Kerala, India

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Session 3

Emerging Contaminants in Water Resources Systems

Invited Talk

Nexus Between Water Quality, Sanitation and Hydrogeology: A Few Case Studies

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Abstract

This paper addresses the critical issue of pathogen contamination in global water bodies, particularly affecting developing countries where 2.5 billion people lack proper sanitation and 780 million lack safe drinking water. Widespread open defecation, notably in Central and Southern Asia and sub-Saharan Africa, exposes 1.8 billion individuals to waterborne diseases like diarrhoea and cholera. The escalating risk to groundwater quality, a crucial global domestic water source, is attributed to population growth and development.

The study delves into the interconnection of water quality, sanitation, and hydrogeology, focusing on the impact of India's "Swachh Bharat Abhiyan" mission. The mission, aimed at achieving open defecation-free status, involves constructing millions of toilets with on-site wastewater treatment units, such as septic tanks, across the country. Understanding how these installations affect groundwater quality is crucial. Indiscriminate septage disposal emerges as a significant concern for ground and surface water contamination. As toilet numbers increase, the absence of adequate septage treatment systems intensifies ground and surface water contamination compared to open defecation. The paper provides insights into the water quality of open/dug and bore wells in selected study areas. Emphasizing the need for more efficient onsite wastewater treatment systems, the study explores the performance of modified septic tanks through pilot scale studies and their impact on groundwater quality. In conclusion, this paper underscores the importance of comprehending the intricate relationship between water quality, sanitation practices, and hydrogeology, especially in the context of large-scale sanitation initiatives like "Swachh Bharat Abhiyan." It highlights the potential exacerbation of water contamination issues when onsite wastewater treatment systems are insufficient. The study advocates for the development of improved wastewater treatment systems to align with the increasing deployment of toilets, offering a comprehensive approach to address the nexus of water quality, sanitation, and hydrogeology.

Agriculture and Irrigation suitability of Groundwater in Vizianagaram District, Andhra Pradesh, India with respect to Water Quality Indices

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Abstract

The objective of this study is to compute Water Quality Index (WQI) adopted by ICAR for assessing groundwater quality for agriculture and irrigation purposes in Vizianagaram district of Andhra Pradesh, India for the season November 2022. Other water quality indices like Sodium Adsorption Ratio (SAR), Sodium Percentage (%Na), Residual Sodium Carbonate (RSC), Magnesium Adsorption Ratio (MAR), Kelly's Ratio (KR), Potential Salinity (PS), Permeability Index (PI), Magnesium Hazard (MH) etc. have also been computed. The WQI thus computed indicates that 92% of groundwater samples in Vizianagaram district fall in Class - I with WQI score of < 150 which denote that the groundwater quality is suitable for agriculture without any restriction. 8% of samples fall in Class – II with WQI score of 150-300 indicating Slight restriction. The Electrical conductivity ranges from 200 μS/cm to 4500 μS/cm with a mean of 1720 ppm with a SD of ±754.3 μS/cm. The SAR values range from 0.4 to 11.8 indicating that the Sodium Hazard is low to medium.

KEYWORDS: Water Quality Index, ICAR, Agriculture, Irrigation, Sodium hazard.

Disposition of trace elements in groundwater of coral island, Lakshadweep, India

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Abstract

A hydrochemical study of groundwater was carried out for the disposition of trace elements at coral island, Andrott, Lakshadweep. In total 23 groundwater samples were collected from shallow (dug) wells, and analyzed for the trace elements such as Li, Be, B, Al, V, Cr, Mn, Fe, Ni, Co, Cu, Zn, As, Se, Rb, Sr, Mo, Ag, Cd, Sb, Ba, and Pb. This study indicates that

- B, Al, Fe, Ni, As, Se, Sr, Sb, and Pb vary from 100.61 to 1399.07, 0053.11 to 361, 19.571 to 470.36, 13.72 to 68, 2.6 to 1614.22, 3.78 to 10.4, 146.926 to 5764.34, 0.016 to 35.72 and 91.98 to 2710.77 µg/l, respectively.
- Li, Be, V, Cr, Mn, Co, Cu, Zn, Rb, Mo, Ag, Cd, and Ba are within the permissible limits for drinking water as per the WHO standards.
- The elements B, Al, Fe, Ni, As, Se, Sr, Sb, and Pb are above the permissible limits.
- The toxic element, Pb is 2-4 times more than the maximum permissible limit of drinking water in the entire island. Arsenic (As) is found in the range of 32.15 to 1614.2 µg/l in and around the Jetty. Another toxic element, Se (~10.4 µg/l) is observed at the northern part of the island nearby the Jetty.
- The areal distributions of alkaline earths (Sr, Ba), transition metals (Ti, V, Cr, Co, Ni, Mo, Fe), metallic elements (Cu, Al, Ag, Cd, Hg, Pb) and non-metallic elements (As, Sb, Se) are found a considerable variation in the entire island.

The elevated trace elements in this coral island are attributed from marine sediments or excessive use of vehicles or death and decay of plants or anthropogenic activities.

Keywords: Groundwater, Shallow aquifer, Trace elements, Coralisland, Lakshadweep.

Assessment of emerging contaminants in groundwater: A case study from of Vellore urban, Tamilnadu

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Abstract

Emerging contaminants (ECs) are a diverse group of chemicals and compounds that have recently been identified in the groundwater. Caffeine (CAF) and Diethyltoluamide (DEET) are notable ECs commonly found in sewage. CAF, originating from various sources like coffee, tea, caffeinated products, enters wastewater primarily through human fecal matter and urine. DEET, on the other hand, is a widely used household insect repellent, and body lotions. Knowing the presence of these contaminants in the groundwater is necessary because of their potential health risks. Hence the objective of the present study is assessing the presence of CAF and DEET in the groundwater of urban parts of Vellore, Tamilnadu. 33 groundwater bore well samples were collected across different seasons in the year 2022 and analyzed using Hichrom HPLC in an 844 UV/VIS compact ion chromatography system. The findings revealed that an average of 80% and 90% of samples contained the presence of CAF and DEET, with average concentrations of 82 µ/L and 57 µ/L, respectively. The presence of these compounds signals the contamination of groundwater by sewage from various sources, including

sewer leaks, open drains, surface runoff, septic tanks, and manhole overflows within the study area.

Keywords: Emerging contaminants, Caffeine, Diethyltoluamide, Groundwater, sewage

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NaCl hydrogeochemistry of endorheic astroblemes: An indirect dating approach

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Abstract

The Earth, preserves evidence of meteoritic impacts through ~210 confirmed impact craters, of which nearly 31 are astroblemes. One of the major constraints of craters is its lack of ages. In this study we propose a novel method of indirect dating using NaCl hydrogeochemistry of endorheic astroblemes. This idea was conceived through the indirect method of dating of Earth based on the sodium clock. For the study, three craters (Lonar, Bosumtwi, Karakul), with endorheic characteristics were selected. Endorheic lakes often exhibit saline or hypersaline nature. This study posits that water within these craters were initially devoid of salt; however, owing to lack of outlets, the salinity gradually increases. By determining rate of increase of total salinity with progressing time, the ages of crater can be estimated. It is achieved by quantifying total NaCl content in crater lake and plotting it against annual NaCl contribution (Fig. 1; Lonar). The NaCl content of astroblemes depend on climatic conditions. The observations from the study note that despite Bosumtwi (1.07 Ma) being older than Lonar (0.57 Ma), it contains less NaCl due to increased precipitation and rising water levels. In contrast, Karakul (50 Ma), experiences a reduction in salinity owing to limited evaporation and influx of glacial melt-water. Remarkably, this indirect and novel method aligns with radiometric ages, providing a way to date undated endorheic astroblemes.

Keywords: Endorheic, NaCl hydrogeochemistry, Salinity, Astrobleme, Lonar

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Entropy-Based Groundwater Quality Assessment of urban and peri urban water regimes of Ernakulam District, Kerala, India

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Abstract

Groundwater, a vital resource for sustainable development, plays a crucial role in maintaining human health and well-being. This study focuses on assessing the quality of groundwater in the context of urban and peri-urban water regimes in southwest India, where the responsible management of water resources is paramount for safeguarding public health and mitigating environmental impacts. In the present study 62 groundwater samples were collected, conducting comprehensive hydrochemical assessments during pre and post-monsoon season. The study reveals that the deterioration of groundwater quality is attributed to a combination of natural and anthropogenic factors. Entropy based water quality index (EWQI) model showed that 13% and 10 % of groundwater samples during pre and post-monsoon season were very poor quality. Higher concentration of TDS, alkalinity, hardness, chloride and iron were reported with high EWQI values. In the study area, the majority of groundwater is safe and suitable for drinking; however, certain urban areas exhibit exceptions to this general trend. This study highlights the need for water treatment in areas with compromised water quality and underscores the importance of protecting groundwater from geogenic and anthropogenic contamination. The integrated approach employed in this study offers valuable insights to inform policymakers in developing effective management strategies

Keywords: Groundwater, Hydrochemistry, Entropy water quality index, Urbanization

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Characterization of Hydrogeochemical Processes Influencing Groundwater Quality in coastal parts of East Godavari district, Andhra Pradesh India

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Abstract

Groundwater is often the main or only source of fresh water supply in semi-arid rural areas owing to decreasing rainfall patterns, reduced availability of surface water and socioeconomic activities. It is important to understand the hydro-geochemical processes influencing groundwater quality for improved management and sustainability of resources and to improve rural livelihoods. To understand the hydro-geochemical process influencing the hydro-geochemistry of the coastal region of East Godavari district, this study assessed groundwater quality data from 40 dug and boreholes collected seasonally between 2019 and 2022. Groundwater levels and salinities in monitoring wells were measured to inspect the general groundwater flow and chemical patterns and seasonal variations. Chemical components such as Na^+, K^+, Ca^{2+}, Mg^{2+}, Cl^-, SO_4^{2-}, HCO_3^- , NO_3^-, F^-, and TDS during the field period are analyzed to explore geochemical evolution, water-rock interactions and sources of salt concentrations. The decreased water levels without typical seasonal variation in the coastal tract of the study area confirm an over-exploitation of groundwater. The hydrogeochemical characteristics indicate fresh-saline pattern from inland to coast where evaporation is a vital factor to control the chemical evolution. The cation exchange processes are occurred at fresh-saline interfaces of mixtures along the hydraulic gradient. Groundwater suitability for drinking and agriculture purposes are further evaluated according to water quality standards. The saltwater intrusion is to be analyzed to be responsible for part of dissolution of minerals containing groundwater. Therefore, water treatment before drinking is needed in urgent to reduce the health expose risk.

Keywords: Hydro-geochemical processes; hydro-geochemistry; coastal aquifers; remediation

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Quantitative Modeling and Spatial Mapping of River Water Quality in the Bhadra River Stretch: Exploring Discharge and Pollution Scenarios

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Abstract

The primary objective of this study was to locate contamination hotspots in rivers and map contamination levels by integrating the Water Quality Index (WQI) with the QUAL2K stream water quality simulation model. Plausible scenarios of discharge and pollution load were considered in the analysis. The study focused on the industrialised Bhadravathi city region, representing the most polluted segment of the Bhadra River due to significant pollutant discharge from industries and urban areas. The Bhadra River stretch under investigation spanned 27 km, divided into three reaches, each comprising elements of 1 km (3, 4, and 20 for each reach). Discharge scenarios were generated by varying observed streamflow (±20%, ±40%, ±60%) at the headwaters, while hypothetical pollution scenarios involved varying Biological Oxygen Demand (BOD) in contributing drains. The QUAL2K model underwent calibration (91 months) and validation (41 months), simulating various water quality parameters in the study stretch. The model's performance, evaluated using R-Square (R^2) and Mean Bias Error (MBE), demonstrated highly satisfactory simulation during both calibration (R^2) ranging from 0.57 to 0.95 and validation (R^2 ranging from 0.52 to 0.98). Simulated parameters were then used to estimate the WQI employing the Weighted Arithmetic-Water Quality Index (WA-WQI) method. Observed WQI indicated a grade E water quality condition, with values ranging from 62 to 164. Scenario-based WQI analysis revealed diverse pollution characteristics, emphasising the significant impact of headwater flow rates and industrial pollutant loads on dissolved oxygen levels in the study stretch. The study's findings underscored the adverse effects of pollution load and upstream discharges, highlighting the methodology's potential for identifying pollution hotspots, assessing contamination levels, and classifying rivers for pollution control. The presented analysis provides valuable insights for policymakers and stakeholders, aiding in the formulation of pollution treatment policies, particularly for industrial effluents.

Keywords: QUAL2K model, Water quality, Bhadra River, Dissolved oxygen, Hypothetical scenarios.

Temporal Variability of Alkalinity, pH, DIC, and Nutrient Concentrations in the Coastal Waters off Visakhapatnam coast, Bay of Bengal

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Abstract

This study presents a comprehensive analysis of the temporal variability of key physicochemical parameters in the coastal waters of the Bay of Bengal, focusing on the Jodugullapalem area. Weekly and monthly observations were conducted to assess changes in Alkalinity, pH, Dissolved Inorganic Carbon (DIC), and Nutrient concentrations at two different depths, J1 (5m) and J2 (10m), J3 (20m) within the surface water samples. The study period covered a range of dates to capture seasonal and temporal trends. The results reveal significant fluctuations in Alkalinity, with concentrations ranging from 1925.847µmol/l to 2188.368 µmol/l. The pH levels exhibited variations between 8.7352 and 8.3326, with a notable dependence on temperature. Lower pH values were observed during the months of March to September, which correlated with higher salinity and lower temperatures. The study also documented changes in DIC concentrations, spanning from 23.14 to 25.65, and demonstrated their association with temperature and salinity. Furthermore, the investigation sheds light on the intricate relationships between Nutrient concentrations, temperature, and salinity. The findings highlight the dynamic nature of these coastal waters and emphasize the importance of considering multiple factors including river estuarine flows flooding into the ocean, when interpreting the observed variability in the studied parameters.

Keywords: Coastal Bay of Bengal, Temporal Observations, Physico-Chemical parameters.

Evaluation of reservoir operation to control water quality variations

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Abstract

Reserving reservoirs according to the inflow and initial storage volume satisfies the needs of stakeholders. Operation rule curves are developed to address stakeholder conflicts regarding the amount of water released. Under the current urbanization scenario, managed operations in the upstream scenarios can dilute the downstream water quality. Very few studies examined how a reservoir operates to provide the appropriate level of water quality in a certain area. Whether it is feasible to preserve the river's water quality in a real-world scenario where a reservoir downstream river passes through an urban environment may have many effluent release locations. To understand the behaviours of the river for controlled outflow from the reservoir, a modelling and optimization approach is described. In order to establish the framework

for this study, the following fundamental assumptions are taken into consideration. At presumed sites, a home load of organic pollutants is given to the downstream river together with pure reservoir water meeting the necessary drinking standard norms. The simulation-optimization framework predicts the downstream dissolved oxygen and the efficacy of the Genetic Algorithm (GA) with the least penalty to the water quantity needs.
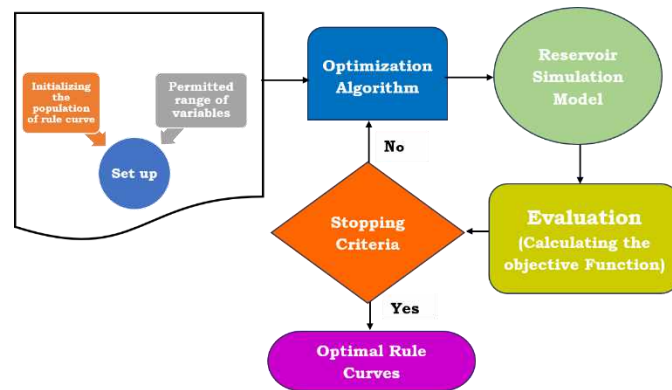
Reservoir optimization

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

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Session 4

Recent Trends in Treatment of Natural and Contaminated Waters- Recycle and Reuse

Invited Talk

Innovative Technologies in Water Quality Monitoring to meet the Current & Future challenges using IoT and Cloud

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Abstract

In a conventional approach water quality is monitored manually using laboratory instruments, which is a time-consuming process and the results are often prone to human errors. To mitigate the human intervention and reduce the time and cost significantly and provide reliable results, Elico has developed 1. Automated Multiparameter Water Quality Analysers 2. Portable Multiparameter Water Quality Analysers and 3. Mobile Water Testing Laboratories

The presentation talks about how Elico's Innovative solutions in water quality monitoring are addressing the challenges of water testing in rural areas.

Invited Talk
Wastewater Treatment and Recycling: Challenges and Opportunities

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Abstract

In India, over 600 million people face high to extreme water scarcity, with water contamination estimated to impact as much as 70 % of India's utilizable water resources. Currently, the disparity between water supply and demand is widening due to increasing water scarcity, population growth, contamination of available surface water sources, and depleting groundwater reserves. In response to this multifaceted challenge, the Plasma Lab group at CST has developed decentralized wastewater treatment and reuse technologies. In this talk, I will discuss, the challenges of wastewater treatment and reuse. Our experiences in developing a decentralized wastewater treatment/reuse system and monitoring large-scale (400 million liters per day) treated wastewater from Bangalore City for indirect groundwater recharge will be discussed. I will also discuss the findings and impacts of large-scale wastewater recycling. The understanding developed while studying the foaming of Bellandur Lake will also be discussed. The insights gained which shape the path ahead will be

presented. This talk is aimed at a general audience and does not need a specialist background.

Geochemical factors controlling groundwater suitability for agriculture and potability using GIS Techniques in the sedimentary part of Gadilam river basin, Cuddalore District, Tamil Nadu.

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Abstract

A hydrochemical investigation was carried out in the part of sedimentary part of the Gadilam river basin, Cuddalore district, to identify the groundwater quality suitability for drinking and agricultural uses; Geographical aerial extent of the study area is 663.65 Sq.km.

***Purpose*:** 50 groundwater samples were collected based on the equal grid method from various bore wells in different blocks of study area during the summer season of 2018. Qualitative and quantitative methods such as titranometric, flame photometry and Ultra-violet visible spectrometry were used to detect the major ions like Ca^{2+}, Mg^{2+}, Na^+, K^+, and Cl^-, HCO_3^-, SO_4^{2-}, NO_3^-, PO_4^{3-} and H_4SiO_4.

Results were interpolated in Geographic Information System (GIS) and subjected to statistical analysis and geochemical plots. The evaluation of factors controlling water chemistry was accomplished by interpreting the USSL plot, Permeability Index (PI), Piper diagram, Gibb's plot, and factor analysis. The groundwater of the study area falls under C3-S1 class (84%) by USSL classification. The majority of the sample is with high salinity and low sodium hazard category which is found to be suitable for irrigation. The Permeability Index of the ground water indicates water class I and II (66 and 34 percent), moderate to good quality for irrigation purposes in the study area. A Piper diagram classifies the study area's water types as Na-Cl water type, Ca-HCO_3 water type, mixed Ca-Mg-Cl water type and Na-HCO_3 water type indicating freshwater recharge, mineral dissolution and reverse ion exchange, respectively.

Conclusions: Gibbs plot suggests in most of the samples domination of rock water interaction and evaporation processes influencing the water chemistry. Interpretation of hydrogeochemical statistics conveys that the leaching of secondary salts, weathering and anthropogenic impacts through the industry are the controlling factors out of 65.62% of the cumulative total variance in the water quality of the study area. By considering the Salinity, Sodium Adsorption Ratio and sodium percentage it is found that most of the groundwater samples are suitable for irrigation and domestic consumption concerning drinking water standards.

FA - Pre monsoon season

Table 1 Factor analysis for the water samples in pre monsoon (Varimax rotated)

Variables	Factor 1	Factor 2
pH	-0.039708	-0.103288
EC	-0.989999	0.001221
TDS	-0.990000	-0.000402
Ca	-0.740117	-0.659806
Mg	-0.578395	**0.480706**
Na	-0.790203	**0.373626**
K	-0.405300	**0.054540**
Cl	-0.959258	-0.001707
HCO$_3$	-0.658417	**0.100195**
NO$_3$	**0.201161**	-0.294999
PO$_4$	**0.190087**	0.004871
SO$_4$	**0.191632**	-0.380987
H$_4$SiO$_4$	**0.081147**	**0.050084**
Eigen value	5.106373	1.064414
% Total variance	39.27979	8.187798
Cumulative Eigen value	5.106373	6.170787
Cumulative %	39.27979	47.46759

Keywords: Hydrochemical facies, Hydrogeochemistry; Groundwater quality and Factor analysis.

Removal of Carcinogenic metals from Electroplating industrial effluent using Nanobubble technology

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Abstracts

Technological advances have been rapid in using various phase-related processes for the treatment of wastewater and water treatment technologies, aquatic system restoration, food processing industries, aqua farming, and chemical and petrochemical industries, Among the various phase change operations, bubble technology has been in focus and has recently evolved to new heights. These bubbles' efficiency and performance are largely affected by design and operational parameters, types of contacting operations, and the properties of contacting fluids in gas–liquid operations. Nanobubbles (NBs) are exceptionally small ultrafine bubbles that range between sizes less than 1 μm. These bubbles are round circular gaseous particles lined with an outer shell and a core-shell filled with gas, making them significant in exhibiting palpable properties. These nanobubbles are deployed after their generation for the purpose of treating effluents from the chrome plating industry. The chrome plating effluent contains hexavalent chromium ion, which serves as a carcinogen when disposed of. While the chemical method of generation of nanobubble using hydrochloric acid and ferrous sulphate is carried out the release of hydrogen sulphide gas as nanobubble results in the conversion of hexavalent chromium ion to trivalent chromium ion in a pilot-scale fabricated reactor. In addition to this reduction, this had effects on various other parameters including pH and TDS. This study highlights the nanobubble's effectiveness in the effluent remediation process and its reusability in the industry as well.

Keywords: Nanobubble, Nanobubble technology, Electroplating industry, Reactor.

Adsorption of residual Chromium from Treated chromium Electroplating effluent using Zeolites of different porosity

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Abstract

Zeolites are microporous crystalline aluminosilicates that can be natural or artificial. They are employed in many different water treatment procedures, including heavy and radioactive metal removal. Zeolites have special ion exchange and sorption qualities. In addition, they have been thoroughly studied for a range of novel uses, like Adsorbents for the elimination of organic materials, microbes, and anions in the process of desalinating seawater materials for reactive permeable barriers, such as membranes and fillers. these zeolites based on their pore size are classified into different types. Each type has different applications and most of them are used as adsorbents for air and water. In this study, column studies were performed using zeolite powder, which did the adsorption of the residual chromium from the electroplating effluent efficiently but it had the drawback of clogging the column so zeolite beads were selected for the study. based on the porosity 13 X grade zeolite was selected which had different sizes. The adsorption ability was found to be proportionate to the Quantity and pore size of the zeolites.

Keywords: Adsorbents, metal removal, pore size, chromium removal, Zeolite

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Adsorption of rare earth elements like scandium and yttrium from aqueous solution using nanocomposite alginate beads

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Abstract

Rare earth elements (REEs) like scandium (Sc) and Yttrium (Y), plays a critical part in major global industries. Thus, they are strongly depending on the REEs. Due to the shortage supply of these REE's, the process development for the recovery of REEs from production wastes is generally seen as one strategy and more challenging. However, very

few reported process systems are both technologically feasible and economically viable. Herein, we studied, varying the composition of modified zirconium oxide and magnetic nanoparticles incorporated alginate beads and its sorption efficiency towards Sc and Y was examined in aqueous solution. The synthesized materials were characterized using suitable techniques like high-resolution transmission electron microscopy (HRTEM), X-ray diffraction (XRD) and Particle size analyzer. The adsorption efficiency onto the beads were confirmed using an inductively coupled plasma-optical emission spectrophotometer (ICP-OES). The sorption efficiency of Sc was high for the magnetic particle bead and for Y, modified zirconium oxide shows maximum removal than the other composition of synthesized beads. This adsorption study revealed that the reported beads were promising material that is cost-effective, non-toxic, biodegradable, eco-friendly and highly efficient towards the recovery of Sc and Y.

Keywords Rare earth elements, Scandium, Yttrium, alginate beads, adsorption.

Application of Waste Water Quality Monitoring System to Enhance Operational Efficiency in Sewage Treatment Plants

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Abstract

Sewage treatment plants play a crucial role in safeguarding public health and the environment by treating wastewater before its discharge. To optimize the operational efficiency of these facilities, there is a growing need to implement advanced technologies that provide real-time insights into water quality parameters. This research explores the application of a Waste Water Quality Monitoring System (WWQMS) as a strategic tool to enhance the performance of sewage treatment plants. The study focuses on the integration of cutting-edge sensor technologies and data analytics within sewage treatment processes. By continuously monitoring key water quality indicators such as temperature, total dissolved solids, turbidity, and pH levels, the WWQMS enables operators to promptly identify deviations from optimal conditions. The study focuses on the practical application of this system within a 400 Kilo Liters per Day (KLD) capacity Sewage Treatment Plant situated at the International Institute of Information Technology, Hyderabad. This proactive approach facilitates early intervention and adjustments, preventing potential disruptions to treatment processes and ensuring compliance with environmental regulations. Furthermore, the research investigates the potential economic and environmental benefits associated with the implementation of

the WWQMS. By minimizing energy consumption, reducing chemical usage, and optimizing resource allocation based on real-time data, sewage treatment plants can achieve significant operational cost savings. Additionally, the improved efficiency in pollutant removal contributes to the overall reduction of environmental impact, supporting sustainable wastewater management practices. The findings of this research offer valuable insights for policymakers, environmental engineers, and plant operators seeking to enhance the performance of sewage treatment facilities. The integration of a Waste Water Quality Monitoring System not only provides a proactive approach to addressing water quality issues but also establishes a foundation for the development of smart and sustainable sewage treatment practices in the era of advancing technologies.

Keywords: Water quality sensors, Internet of Things (IoT), sewage treatment plants (STPs), Water Treatment Plants, STP Efficiency.

Session 5

Advances in Water Resources Mapping and Assessment

Invited Talk
Scanning River-Aquifer Interactions and Recharge Potential By Airborne Electromagnetics
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Abstract

The rivers and shallow aquifers are believed to be closely coupled and exchange water to maintain a healthy aquifer system, stream water flow, and ecological functions. The increasing stress on groundwater usage for the past few decades and the resultant decline in the groundwater level have affected baseflow adversely. Lowering of groundwater table not only restricts the baseflow to the river but also makes river-aquifer interaction unidirectional i.e. flow from river to aquifer. Thus, the number of non-glacial-fed rivers and their tributaries across India and the globe are being converted from perennial to seasonal rivers. Also, pollutants discharged into the river enter into the connected aquifer system, contaminating larger areas for a long time. Thus, there is a strong need to generate knowledge on aquifer system, river-aquifer interaction, and their recharge potential to plan for an effective managed aquifer recharge. The paper presents the application of airborne electromagnetic surveys with special reference to dual-moment transient electromagnetics applied in diverse hydrogeological settings in India.

Keywords: Aquifer, river-aquifer interaction, water, and Airborne electromagnetic

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Invited Talk
Decoding hydrodynamics of hydraulic heads for decisive Aquifer Unit Management Plan
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Abstract

Decoding the hydrodynamics of hydraulic heads of the aquifers shall form the base for aquifer management. This study on Aquifer Unit Management Plan is based on the above geoscience approach and is designed to provide decisive guidance for groundwater management of a multi-layered coastal aquifer. The aquifer unit management plan discussed in this study is based on the summative examination of the aquifer unit disposition, response of hydraulic heads to recharge and discharge and effect of increased pumping on aquifer hydraulics. The safe hydraulic heads and annual exploitable potential were considered as the guiding factors to manage fresh

groundwater resources of the coastal aquifer. One such potential and prolific coastal aquifer referred as Cuddalore coastal aquifer system (2100 sq.km) has been subjected to summative examination to evolve aquifer unit management plan. The results show that the process of sea water intrusion has already started and with the present rate of pumping (1034.86 mcmy $^{-1}$), the sea water intrusion risk has increased manifold all along the coast at various depths. The salient management strategies recommended are; restricting pumping to 695 mcmy $^{-1}$ in aquifer unit 1, stepping up recharge activities in recharge zone, catchment area treatment, adopting water use efficiency methods and regulation along the coastal zone. Aquifer Unit Management Plan is simple and can guide water managers to plan for sustainable groundwater withdrawal and safeguard the coastal aquifer from sea water intrusion and ensure sustainability of groundwater abstraction structures within the coastal aquifer.

Key words: aquifer hydraulics, fresh water, Aquifer Management plan & sea water intrusion.

Aeromagnetic studies for Mapping of aquifer thickness and basement depth in the western part of the Cuddapah basin, Andhra Pradesh, India.

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Abstract
Aquifer thickness has been estimated by making using of Aeromagnetic, remote sensing, and geology data in the western part of Cuddapah basin, Andhra Pradesh, India. The Aeromagnetic data has been processed and analyzed in Geosoft software. The technique, 3D Euler depth solution was adopted in this study. The results reveal that, the aquifer thickness is about 250 to 1200 meters; the depth to the basement was about 1900 meters in the study area.

Keywords: Aeromagnetic, Aquifer, 3D Euler, Geosoft.

Investigation of Groundwater Potential Zones Using an Integrated Approach of Electrical Resistivity, Remote Sensing, and GIS: A Case Study in the Alluri Seetharama Raju District, Andhra Pradesh, India.

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Abstract

The tribal people of agency areas in the Machkund River catchment of Alluri Seetharama Raju District, Andhra Pradesh, mostly depend on springs for their water requirements. As these sources are depleting at a faster rate, an immediate need for the exploration of potential groundwater zones was felt to meet the demand. In this study, remote sensing, Geographical Information System (GIS), and Geoelectrical resistivity-based groundwater potential zone (GWPZ) mapping have been carried out in the study area. The percentage of influencing factors for groundwater occurrence of the nine thematic layers has been calculated using an analytical hierarchal process. All these thematic layers were integrated by performing Weighted Index Overlay Analysis in Arc GIS Software to demarcate the groundwater potential zones. The entire study area has been classified into different categories of potential zones, ranging from good (with an area of 96.82 km^2 covering12.06%), moderate (412.09 km^2 covering 51.35%), and poor (covering 36.57% of the total area of 293.45 km^2). In the study area, 271 Vertical Electrical Soundings (VES) were performed to create spatial distribution maps illustrating aquifer thickness and basement depth. These VES data were employed to derive secondary geo-electrical parameters. Using the Dar-Zarrouk parameters, aquifer transmissivities were calculated and mapped spatially. The accuracy of the GWPZ model was verified through ROC analysis, yielding a 76.5% accuracy rate. Moreover, the model's performance was compared with maps depicting aquifer thickness and aquifer transmissivity, revealing a strong agreement between them.

Keywords: Groundwater potential zones, Aquifer transmissivity, Dar-Zarrouk parameters, AHP, and WIOA.

Groundwater influence on carbon dynamics in the lower basin of the Cauvery River

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Abstract

Groundwater, as a substantial continental carbon reservoir, intricately intertwines with key global carbon fluxes, including terrestrial carbon uptake, degassing from inland waters, and delivery to oceans. The present study was carried out to understand the influence of carbon dynamics in the lower basin of the Cauvery River. The samples were collected in river water and groundwater from May 2018 to August 2021 thrice a year and the sampling period was categorized as dry (May & March) and wet season (September, December & August) based on monsoon. The samples were analyzed for EC, pH, major and minor ions, DIC and DOC. In general, groundwater is found to have a higher DIC concentration than river water, whereas river water has a higher DOC. The temporal variation implies that in contrast to DOC, the concentration of DIC in river water is higher during dry seasons and lower during wet seasons. The rock-water interaction was the dominant geochemical process in this region. The δ D and δ^{18} O isotopes indicate that the few samples have been isotopically enriched during the dry season as a result of evaporation, suggesting that groundwater contributes to the river's water. Consequently, the groundwater is released into the river during the dry season and river water recharges the groundwater zone during the wet season. Hence, understanding the influence of groundwater on river water, especially during the dry season plays an important role in sustainable water resource management and provides insight into the intricate dynamics of subsurface water exchange and emphasises the significance of groundwater as a source of water for river systems, especially in seasonal variations and climate change.

Keywords: Lower Cauvery basin, carbon dynamics, δ D and δ^{18} O isotopes & groundwater contribution

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Assessing Water Balance and Future Scenarios in the Chennai Basin Using the WEAP Model

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Abstract

This study employs the Water Evaluation and Planning (WEAP) model to analyze the water equilibrium and projected scenarios in the Chennai hydrological basin. As the disparity between water supply and demand grows globally, it is imperative to understand and address these dynamics in large metropolitan regions. The research integrates key water supply sources—reservoirs, groundwater, inter-basin transfer, and desalination plants—into the WEAP model to simulate both current and future water demand and supply scenarios. Three distinct rainfall scenarios (excess, normal, and deficit) are applied to assess their impact on water supply. The study underscores the escalation of unmet demand, particularly in normal and deficit rainfall scenarios. In response to these challenges, various mitigation options are explored, encompassing increased groundwater recharge, reservoir capacity enhancement, expansion of water treatment plants, additional storage solutions, and the utilization of water stored in rock quarries. The outcomes of this research offer crucial insights for policymakers and stakeholders, guiding the development of sustainable water management strategies in the Chennai Basin.

Keywords: WEAP model, Water balance, Future scenarios, Chennai Basin, Water supply and demand

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Extreme Value Analysis of Rainfall of Latehar and Chandwa Using Normal, Gamma and Extreme Value Families of Distributions

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Abstract

Rainfall is one of the most important parameter in hydrological studies and its occurrence and distribution is erratic, temporal and spatial variations in nature. One of the important problem in hydrology deals with the interpreting past records of hydrological event in terms of future probabilities of occurrence. The estimated 1-day maximum rainfall will be helpful to the stakeholders to know about an effective utilization and management of water resources. This can be computed through Extreme

Value Analysis (EVA) by fitting probability distributions to the series of annual 1-day maximum rainfall (AMR). These values will also be considered as one of the important parameters for planning, design and management of hydraulic and civil structures.

A number of probability distributions belongs to the Normal, Gamma and Extreme Value family are widely applied in EVA of rainfall. In this paper, 2-parameter Normal and Log Normal from Normal family of distributions while Extreme Value Type-1 (EV1), Extreme Value Type-2, Generalized Extreme Value (GEV) and Pareto from Extreme Value family, and Gamma, Pearson Type-3 and Log Pearson Type-3 from Gamma family were adopted in EVA. The parameters of the distributions were determined by method of moments, maximum likelihood method and L-Moments (LMO) wherever applicable. The adequacy of fitting distributions to the AMR series was evaluated by quantitative assessment using Goodness-of-Fit (viz., Chi-square and Kolmogorov-Smirnov) and diagnostic (viz., D-index) tests, and qualitative assessment using fitted curves of the estimated rainfall.

This paper presented a study on EVA of rainfall for Chandwa and Latehar sites in Jharkhand   using Normal, Gamma and Extreme Value Families of distributions. The AMR series was derived from the observed rainfall data (1990 to 2020) of Chandwa and Latehar, and used in EVA. The study showed that the GoF tests results confirm the applicability of all nine distributions adopted in EVA for Chandwa and Latehar. The diagnostic test results indicated that GEV (LMO) is better suited distribution for rainfall estimation at Chandwa whereas EV1 (LMO) for Latehar. The study suggested that the 1-day maximum rainfall given by GEV (LMO) for Chandwa and EV1 (LMO) for Latehar could be used for planning, design and management of hydraulic structures in the respective sites.

Keywords: D-index, Extreme Value Type-1, Generalized Extreme Value, L-Moments, Kolmogorov-Smirnov, Rainfall

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Integrated catchment scale assessment of the groundwater flow dynamics in the hard rock aquifer systems of India

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Abstract

The paper describes a groundwater model study (using MODFLOW) for a hard rock aquifer in the Musiriver catchment in Andhra Pradesh, India. The geology of the aquifer is complex, including weathering, fracture, faults and dykes. Remote sensing and GIS are used to identify and map the features of the aquifer, and parameters used in the model (aquifer parameters and recharge and pumping) are adjusted with consideration

of these features until the model simulates observed groundwater levels satisfactorily. The well calibrated (1990 to 2013) model used to predict the groundwater levels until 2096 by forcing groundwater model with climate change scenarios. The aquifer in the Musi catchment is typical for a large part of India. Therefore, the result of the study is not only an aquifer model for the Musi catchment but also the development of an approach that can be widely applied in other areas.

Keywords: Groundwater flow process, geological lineaments, aquifer parameters, Musi catchment, numerical modeling

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Evaluation of Groundwater Potential in Various Hard Rock Terrains, Telangana using Electrical Resistivity Imaging Technique

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Abstract

Groundwater occurrence is highly variable within short distances due to secondary porosity in hard formations. Due to this, well failures are common and groundwater investigation is a challenging task in these formations. To identify the weathering and fracturing characteristics, the deep Electrical Resistivity Imaging technique is carried out at success and failed well pair (within a few tens of metres) in granites, basalts, and laterites located in the Ranga Reddy and Vikarabad districts of Telangana State, India. The weathered/fractured environment of the success wells is characterized by the resistivity values of 50–130 Ω.m., 25–60 Ω.m., and 70–120 Ω.m. in the granitic, basaltic, and lateritic terrains respectively. The aquifer is highly productive in the granitic terrain in shallow depths (8–30 m) while it is extended to the moderate depths in the basaltic (12–50 m) and deeper depths in the lateritic (40–120 m) terrains. The deep resistivity imaging surveys are recommended in laterites as the aquifers are extended to deeper depths and the resistivity imaging technique proved in evaluating the groundwater potentials in the hard rocks.

Monitoring of Pumping test by Spontaneous Potential Technique at Buddulavarigudem Hamlet of Buttayagudem Village and Mandal

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Abstract

This paper presents observation of variations in spontaneous potential in the Crystalline formations of Eluru district during recuperation of pumping test was conducted under National hydrology project on 13th May 2023.During recuperation the bore well was monitored by the Spontaneous Potential (SP) for 30 minutes until reaches back to its static water level with potential electrode half spreads MN/2 =5m, 10m, 15m, 20m, 25m, 30m, 35m, 40m. A major shift is evidenced in the spontaneous potential readings after 90% of recuperation over potential electrode half spreads MN/2 =5m, 10m, 15m, 20m and 40m. During the recuperation lot of disturbance is recorded at potential electrode half spreads MN/2 =30m and 35m and it reflects the aquifer contribution into the bore well and is coinciding with the major fracture zone evidenced in Vertical Electrical Sounding (VES) data, Drilling and Litholog data.

Keywords: Pumping Test, Recuperation, Drawdown, Spontaneous Potential (SP)

Session 6

Sustainable water resources in changing climate

Invited Talk
Surface and Ground Water Interactions in the context of Rejuvenation of Rivers

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Abstract

One-fourth of the world's ground water abstraction is done by India alone. India is abstracting more ground water than America and China abstractions put together. Higher abstraction of groundwater has brought down the water tables in peninsular India of hard rock regions so deep that, rivers are not receiving any contribution from the aquifers not only during the lean period but also during the monsoon period. The research indicates that the deeper the groundwater table, the more the recharge of the rainfall water to the ground producing little or no runoff from the watersheds leading to reduced inflows to the downstream rivers and reservoirs. With the increased interventions of the up streams coupled with drastic reduction in the base flows, rivers are drying up. To reverse the situation, the only way forward is to bring the ground water levels back by reducing ground water usage and increasing the water use efficiency in the irrigation by implementing the micro irrigation systems as we are using nearly 89% of our ground water for irrigation alone. Various groundwater modeling studies in the Deccan Plateau of India suggest that groundwater utilization for the irrigation purposes must be reduced at least to the half of the present usage. Quality issues are the natural fallout as we use deeper ground water which contains more dissolved substances or having geogenic contamination mostly with Fluoride and Arsenic. Recent investigations have also indicated that anthropogenic contamination of ground water with heavy metals, pesticides and pharmaceuticals even in deeper ground water is not uncommon particularly in the hard rocks.

Key words: Ground water, Abstraction, Rejuvenation, Rivers.

Invited Talk
Precipitation to the shallow groundwater reserve in a granitic area, southern India

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Abstract

Precipitation is one component of hydrological cycle and the primary source to reserve dynamic groundwater resources. Shannon entropy is adopted utilizing simply rainfall data and well hydrographs to assessing natural groundwater reserve in a granitic area of southern India, where two predominant monsoons act. The information contained in the rainfall measurement coupled with the information embedded in the well hydrographs is statistically estimated, proving natural groundwater reserve at shallow aquifer. Results indicate that the estimated groundwater reserve yields a good agreement with the site-specific recharge zones obtained using Remote Sensing (RS) and Geographical Information System (GIS) techniques. The groundwater reserve varies from 3.37 to 11.10% of the rainfall during NE monsoon, with an average of 6.44%. It has also observed that the groundwater reserve varies from 1.391 to 3.446 MCM during the SW-monsoon for the period of 2012-2018, whereas 2.958 to 6.554 MCM during the NE-monsoon in the study area. The maximum natural groundwater reserve is about 3.446 MCM in the SW-Monsoon of the year 2017 and it is about 6.554 MCM in the NE –Monsoon of the year 2015. But it is almost half in the years of 2012, 2013 and 2016 during the SW-monsoons. On average, the maximum natural groundwater reserve of 8.571 MCM has been assessed in both the monsoons of 2017. The calculated seasonal groundwater reserve could be utilized for sustainable groundwater management of groundwater resources.

Keywords: Shallow aquifer; Rainfall; Water table; Shannon entropy; Natural water reserve; granitic area, southern India.

Sustainable Solution for Semi-arid Areas: Indirect Groundwater Recharge Using the Treated Wastewater from Urban to Rural Areas

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Abstract

The need to conserve and reuse water is becoming important, and sustainable water solutions for India are absolutely necessary. Reusing treated wastewater is an emerging sustainable solution to address this freshwater scarcity. The presented study introduces an innovative project sponsored by "Minor Irrigation & Ground Water Department, Karnataka" aiming to reuse secondary treated wastewater (STW) from the STPs (440MLD) in Bengaluru, to fill surface irrigation tanks (137) in the semi-arid Kolar district where the groundwater (GW) table has drastically fallen and agricultural activities are under severe stress. The concept is that the STW is purified when it flows by gravity from one tank to another via canals and also percolates in the soil and recharges the GW through a natural soil purification mechanism. Water quality analysis of the STW meets the NGT standards which ensure safe discharge into _water_ bodies as well as for land disposal. The average GW table from 2018 (the commencement of the project) to 2022 has increased by 50-70% in the study area. The GW quality also improved as the STW was 'self-purified' during passage through the tank soil strata infiltration mechanism and with the addition of a dilution factor. The project has benefited 2 million people in the Kolar district. A comparative study before and after the recycling of water was carried out to find out the socioeconomic impact. Positive impacts were observed in the agricultural sector where agricultural productivity improved by 12-43%, milk productivity by 41%, and fish productivity by 347%. This has paved the way for a sustainable solution to the water crisis and socioeconomic growth. The project has become a "role model" for the rest of India and the best example of water in a circular economy and resilience system.

Keywords: Wastewater reuse, Groundwater Recharge, Groundwater Quality, Socio-Economic Impacts

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Hydrogeological Characterization of Groundwater Occurrence from Visakhapatnam Urban Area: Unravelling the Interplay of Geomorphology and Subsurface Geology towards Sustainable Groundwater Management

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Abstract

The Visakhapatnam city is one of the fastest developing cities in India and located in the east coast India. The population increase in this city is very alarming because people are migrating from rural areas for employment, business etc. This is causing severe pressure on natural resources like land, water etc. In this way the ground water resources are under severe threat of depletion due to increasing consumption at the same time the decreasing their recharge potential, due to urbanization and decreased areas for rain water infiltration. Under these circumstances, the groundwater occurrence in Visakhapatnam city and the data on controlling factors of groundwater occurrence including the geomorphology, subsurface geological conditions, areas of natural recharge are very important. In this study, the data on groundwater resource availability in 3 aquifer zones namely Kailasa aquifer, Coastal aquifer and Duvvada aquifer are presented. This investigation also provides information on groundwater availability in these aquifers as well as the recharge potential. The geomorphological, lithological conditions of the area are discussed. The condition of coastal aquifer with reference to the increased groundwater extraction due to massive residential multi-storied building constructions and possible future hazards like saltwater intrusion are also discussed. This paper gives an overall groundwater scenario of Visakhapatnam urban area, which is being projected as one of the important cities of newly formed Andhra Pradesh state after bifurcation from Telangana. The data will be highly useful to prepare groundwater information system for groundwater monitoring and management so that futuristic remedial measures for groundwater conservation and sustainable groundwater management can be achieved

Key Words: Hydrogeology, Geomorphology, Aquifer, Subsurface Geology, Groundwater Management.

Identifying the suitable sites for recharge structures in sub watershed of Coimbatore region using remote sensing and geographical information system

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Abstract

The study was carried out in the Sub watershed 4B2B3 of Thondamuthur taluk in Coimbatore district, for identifying the suitable sites for recharge structures. The basic data for carrying out the study like toposheet, soil map and DEM were collected. This was georeferenced and digitized and the thematic maps were prepared (Land use /Cover Map, Soil Map, Slope Percent Map and Stream order Map) for the study area in the ArcGIS environment. The ranking was assigned from 9 to 1 for the Land Use Classification Map with Fallow lands, Waste Lands or Land with scrubs with highest ranks and lowest rank for the Built up, Water bodies, Forest area etc. In case of topography, highest ranks were given to slopes of 2-10% and lesser ranks to slopes <1% and >10%. In the soil map, loamy soils with more infiltrating capacity were given highest rank and clay soils were given lowest ranks. In case of drainage map, II stream order was given highest rank, followed by III order and the remaining stream order were given lowest ranks. After assigning suitable ranking and weightages to the various parameters, weighted overlay analysis was carried out to identify the most suitable sites for water harvesting. This methodology of using Remote Sensing and GIS as a Rapid Assessment and Planning Tool (RAPT)proves effective in watershed planning and developmental activities at a faster rate than the traditional method and can be adopted in future. Planning that requires months if done manually can be done in a few days using Remote Sensing and Geographical Information System.

Keywords: Watershed, Water harvesting, Recharge structures, Remote Sensing, ArcGIS

Polavaram Project Reservoir: A Paradigm in Adaptive Water Resources Management Amidst Fluctuating Climatic Dynamics

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Abstract

India primarily an Agricultural country since ages. Rainfall varying year by year, thus causing years of scarcity of water followed by floods, so water security intimately tied with the food security,livelihood,environment and overall wellbeing of the society as a whole. As a largest populated country with 18% of world population and 4% of worlds renewable water India coupled with the impact of climate change causing uneven distribution of water availability owing to the impact of climate change. The wide temporal & spatial variation in availability of water further aggravated due to fluctuating climatic dynamics. To reap good harvest assured irrigation under the vagaries of the monsoon. This uncertainty perhaps been the driving force to harness the abundant quantum of water available and utilize the same for the betterment of mankind by the creation of large reservoirs by construction of Dams.Large reservoirs play a crucial role in water resources management, particularly in the face of varying climatic conditions. As climate change continues to affect precipitation patterns and water availability, the need for effective and sustainable water management strategies becomes even more critical. Large reservoirs act as vital storage and supply infrastructure, helping mitigate water scarcity and drought by regulating water flows, balancing supply, and supporting agricultural and irrigation systems. This article explores the significance of large reservoirs in water resources management, understanding the impact of climate change on water resources, successful case studies, challenges, and ways to enhance the resilience of large reservoirs in the face of climate variability. By examining these aspects, we gain insights into the role of large reservoirs in ensuring water security and sustainability under changing climaticconditions.
In this article I am going to thoroughly discuss by analyzing the flood data of 56 years, about the role of Polavaram Project reservoir on river Godavari with a storage capacity of 195 TMC in stabilizing the 1Million acres of ayacut contemplated to Age old Sir Arthur Cotton Barrage, Dowlaiswaram in East Godavari District of Andhra Pradesh which is in existence since 1852, amidst the intricacies of climate variability. Polavaram reservoir stand as a beacon of judicious water allocation, mitigating the impact of floods and climatic uncertainties on regional water resources.

Key words: Polavaram, floods, spillway, Godavari river

Assessing the Efficacy and Constraints of Deep Learning for Advancing Hydrological Predictions in Indian Context

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Abstract

Accurate hydrological predictions are essential to prepare for the impacts of climate change, especially in India, which is frequently affected by floods and droughts. Recently, deep learning-based models have shown the potential to revolutionize hydrology by enabling more accurate and efficient predictions of water resources. However, the complex hydrological processes, diverse anthropogenic influences, and limited data pose challenges for accurate projections in India. In this study, we assessed the first instance of the hydrologic model based on long short-term memory (LSTM) for 55 Indian watersheds, using a new dataset comprising meteorological forcings, watershed attributes, and streamflow data. The LSTM model achieved much-improved performance with a median NSE (Nash Sutcliffe Efficiency) of 0.56, outperforming conventional models in India. Further, the LSTM model trained on all the watersheds is more favorable to those trained on individual or homogeneous watersheds, showcasing representative spatial generalization. However, a stratified analysis unveiled the model's limitations in non-perennial, large, and semi-arid climate zone watersheds, attributed to the intricate hydrological processes specific to these environments. To address these limitations and enhance model performance in such watersheds, we integrated lagged observations into the LSTM model (referred to as DI-LSTM), which improved the median NSE to 0.76 by leveraging the inherent memory of hydrological processes and provided a viable solution in the absence of comprehensive additional data. Overall, the contrast of LSTM and DI-LSTM model performance suggests that major limitations could be associated with the quality of meteorological forcings, and the slow flow or groundwater processes are vital in the Indian context. Notably, the LSTM and DI-LSTM models trained on diverse watersheds performed well for predictions in ungauged basins with a median NSE of 0.67. We also explored the applicability of LSTM for temporal disaggregation of streamflow series, achieving satisfactory results with a median NSE of 0.47 for disaggregating monthly aggregates to a daily scale and 0.54 for downscaling monthly and weekly singular observation series to a daily scale. Overall, our findings suggest that data-sparse countries, including India, can benefit from big-data deep learning for improved water resources management. However, further optimization may be necessary for watersheds in challenging environments.

A Comprehensive Analysis of Hydroclimatic Variability over Godavari Delta: Trends, Extremes, and Seasonality with Implications for Sustainable Development Goals

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Abstract

The study focuses on analyzing the hydroclimatic variability over the Godavari Delta during 1951-2020 using statistical methods. To this end, the high-resolution gridded observation dataset prepared by the India Meteorological Department (IMD) is utilized. This analysis primarily addresses the trend, extreme characteristics, and seasonality of rainfall and temperature variables, providing a comprehensive understanding of climatic patterns and changes in the region. Monthly rainfall distribution is evaluated using the precipitation concentration index and seasonality index. The extreme rainfall indices, viz., maximum 1-day rainfall, maximum 5-day rainfall, number of rainy days, total precipitation in rainy days, number of heavy rainfall events, maximum consecutive wet days, and simple daily intensity index are computed for each year considering the thresholds suggested by IMD. The non-parametric modified Mann–Kendall and Sen's slope tests are employed to detect the trend in monthly, seasonal, and annual rainfall time series, extreme precipitation indices, and seasonality indices. The entire period is then divided into two epochs, i.e., 1951-1985 and 1986-2020, to decipher the alterations in recent times. Although the rainfall showed an increasing trend in recent epoch, the precipitation extreme and seasonality indices reveal a remarkable intensification in recent years. Further, the maximum and minimum temperatures showed an increasing trend, along with a higher frequency of heatwave days in recent years. The results indicate higher risks of extreme floods, heatwaves, and timely water unavailability, which may exacerbate the repercussions of climate change on the agricultural and socio-economic conditions over the deltaic region. This study's findings are vital for regional water management and sustainable development goals, especially clean water and sanitation (SDG 6), climate action (SDG 13), and life on land (SDG 15). It emphasizes integrating hydroclimatic analysis in the Godavari Delta region's planning and policy-making to strengthen resilience against climatic uncertainties and foster sustainable development.

Keywords: Climate change, Godavari Delta, Sustainable Development Goals, Trend analysis, Heatwaves.

Session 7

Geospatial Techniques and Data Analytics

Invited Talk
Geospatial technology in Water Resources Management

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Abstract

Geospatial technology plays a crucial role in water resources management, offering innovative tools and solutions to monitor, analyze, and manage water-related activities. The application of geospatial technology in water resources management encompasses a wide range of activities, including data collection, mapping, analysis, and decision-making. Major applications of geospatial technology in water resources management including remote sensing-based surface water bodies and its quality monitoring. Geospatial technology utilizes satellite imagery to monitor water bodies, track changes in land use, and assess the extent of water resources. This information helps in understanding the dynamics of water availability, identifying potential issues, and planning for sustainable water management. Besides the various spectral information also helps to derive the water quality parameters. Also, watershed management and conservation are another interesting application of Geospatial technology in water resources management. In the case of groundwater management, groundwater potential zone identification and management are significantly improved by Geospatial technology and statistical models. Similarly, groundwater recharge and flow dynamics can be computed efficiently using GIS. In addition, the groundwater quality modelling is also an important application of geospatial technology. Geospatial technology integrates data from diverse sources, providing decision-makers with a comprehensive view of water resources. Decision support systems built on GIS platforms assist in planning and implementing sustainable water management strategies. In summary, the application of geospatial technology in water resources management enhances our ability to monitor, analyze, and sustainably utilize this critical natural resource. By providing valuable insights and tools for decision-making, geospatial technology contributes to the development of effective water management strategies that address the challenges of water scarcity, pollution, and climate change.

Invited Talk

Community led adoption of precision irrigation system in Tank and Canal command areas through Conjunctive use of SW and GW and using SW & GW Supervisory Control and Data Acquisition (SCADA) System

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Abstract

In canal irrigated areas, where interactions between surface water and groundwater are high, the conjunctive management of surface water and groundwater can play a significant role in improving water availability in time and space, thereby promoting more equitable distribution of water while maintaining long-term availability of groundwater resources.

Achieving a harmonious balance between the use of surface water and groundwater requires careful consideration of the associated benefits, impacts, and trade-offs.

The main objectives of this initiative are, to develop an integrated framework and implement to characterize and quantify interactions between surface water and groundwater in a canal irrigated area; this framework will be used to evaluate the impacts of alternative levels of conjunctive use under varying climate, soil, water quality and cropping conditions.

Adoption of precision irrigation system in an area to enhance the crop production/ and productivity. Thereby, improve the WUE and improve / protect soil health.

Different scenarios need to be modeled for the area for continuous flows/ insufficient flows of surface water, crop water demands in space and time, combination of SM, SW and GW for a given crop type/stage and weather conditions. The SCADA System mainly to be developed for implementing precision irrigation system with an objective of more crop per drop, improve WUE, enhance the crop productivity and production, improving the water and soil quality.

Key words: Precision Irrigation, Conjunctive Use, SCADA, Surface Water, Ground Water

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Monitoring of Urban waterbodies using geospatial data

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Abstract

Water is precious and monitoring them is very important. Urbanization has been increasing at an enormous rate, it is expected that by 2030 half of the population will be in urban areas. This will result in a further increase in demand for water and at the same time disturb the natural drainages which in turn will impact the waterbodies, resulting in drying up or decrease in water volumes. Satellite data provides a synoptic view with a good temporal coverage of any area of interest which in turn will provide an excellent tool to monitor the waterbodies. Water Spread Area (WSA) of waterbodies can be extracted using satellite data and this can be used to monitor the waterbody for different time periods. Not only this, the land use and land cover around the waterbodies also can be monitored to understand the changes that have taken place around the waterbodies.

NRSC has developed a web based geospatial portal called the Urban Waterbody Information System (UWaIS) using time-series satellite data. This is an interactive portal where the user can query in 1) to get the inventory of all waterbodies in a town 2) apply a criteria to get the information of perennial waterbodies 3) Water Spread Dynamics (monthly) of all the waterbodies and 4) Water Quality parameters viz., Turbidity and Chlorophyll.

This information can be utilized by the authorities to take necessary action for monitoring and rejuvenation of the waterbodies.

Urban waterbody monitoring through satellite data

Keywords: satellite data, geospatial, urbanization, monitoring, quality, water spread

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Disentangling the Characteristics and Drivers of Compound Drought and Hot Extremes

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Abstract

Compound drought and hot extremes (CDHE) are periods of prolonged dry and hot weather exhibiting adverse impacts on nature and humankind than their counterparts. Understanding compound extremes is in its infancy due to complex dynamical climate systems involving interactions and feedback with the different processes at different scales. Our detailed investigation of the last seven decades of CDHE during the Indian Summer Monsoon has shown alarming observations. Our results confirmed a threefold increase in CDHE frequency for the recent period (1977–2019) relative to the base period (1951–1976), exhibiting a strong spatial pattern. Further investigation revealed CDHE likelihood, and spatial diversity in the CDHE occurrence is a function of the strong negative association between precipitation and temperature and soil moisture-temperature coupling, respectively. Investigation into the temporal evolution of CDHE confirms the strengthening of the negative association between precipitation and temperature, indicating a higher number of CDHE in future.

Soil and water conservation planning for a hill watershed using geospatial technologies

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Abstract

Natural resource conservation is the prime focus of watershed development programmes implemented irrespective of the country. The morphometric characteristics are essential for understanding any watershed's underlain structure, geomorphological formations and hydrological behaviour. The role of geospatial tools like remote sensing and GIS in morphometric analysis is remarkable. The different morphometric characteristics like linear parameters (stream order, stream number, bifurcation ratio, strength length, mean stream length), areal or basin parameters (circularity ratio, elongation ratio, drainage density, drainage frequency) and relief parameters (dissection index, ruggedness index, hypsometric characteristics) are important for watershed management. Any basin's hydrological and morphological behaviour can be best understood through the areal and relief morphometric parameters, respectively. The morphometric characteristics were derived for the Sillahalla watershed in Nilgiris, Tamil Nadu, using DEM and GIS. The study watershed was designated as 5th order watershed.

The linear aspects like stream order, stream length, and stream length ratio suggest that the watershed may experience flooding during the monsoon. Due to the high water flow in higher order streams, RR masonry and rubber check dam are recommended for 4th and 5th order streams, respectively, to avoid flooding agricultural lands. The mean bifurcation ratio of the watershed is 3.55, suggesting that the conservation structures can be rationalized to minimize their cost. The aerial aspects, such as drainage density and form factor, suggested the scope of microscale water harvesting structures like farm ponds, lined farm ponds, and percolation ponds in the watershed. The relief factors showed the potential risk of soil erosion in the watershed. As the study watershed is dominated by agricultural land use, and the maximum area (52 %) falls in the 16-33% slope category, the in situ soil conservation measures like Bench terraces, stone walls and trenches need to be intensified suitably based on the land use and slope. Researchers, policymakers and field-level engineers can use the results of the morphometric analysis for effective watershed planning.

Keywords: hill watershed, geospatial techniques, water harvesting structures, soil erosion

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Unlocking Subsurface Secrets: Synergizing GRACE Satellite Insights and Land Surface Models for Unprecedented Groundwater Anomaly Detection

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Abstract

A detailed scientific approach that considers regional trends like rainfall and land use is required to investigate India's complicated water issues. We have created a spatiotemporal variation to illustrate unusual groundwater storage patterns in India. Tackling India's complex hydrological problems, we have driven to the crucial problem of groundwater scarcity, which differs sharply between states. Investigating groundwater storage anomalies becomes more critical, especially when considering convincing statistics that depict various water stress levels. Groundwater, surface water, and snowpack distribution changes are being revealed by the ground-breaking Gravity Recovery and Climate Experiment (GRACE) satellite project. The Global Land Data Assimilation System (GLDAS) soil moisture dataset, backed up by careful statistics, adds to this investigation. GLDAS produces a detailed understanding of soil moisture content by combining ground-level measurements and advanced hydrological modelling. This assists in assessing vegetation health and potential groundwater replenishment, an urgent problem in states dealing with water scarcity. The GRACE and GLDAS datasets comprehensively understand India's hydrological dynamics, supplemented with relevant statistics. GRACE-detected decreasing total water storage

anomalies coincide with ongoing groundwater depletion, particularly noticeable in Punjab, Haryana, and Rajasthan states. Drought-prone areas within these states are identified using GLDAS-derived soil moisture data. Statistical research suggests that increases in total water storage anomalies indicate groundwater replenishment. Comprehensive assessments, including state-specific statistics on variable rainfall, changing land use, and distinctive water consumption patterns, are necessary to navigate India's complex water terrain. This combination resonates with specialists in the sector because it advances scientific knowledge and provides a foundation for wise policies.

Keywords: Groundwater, GRACE, Land surface model, Groundwater anomalies, LULC, Remote sensing.

Morphological changes through Beach profiles during Pre-Monsoon and Monsoon Season along Visakhapatnam, East coast of India

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Abstract

Costal erosion is one of the major problems for our country showing its adverse impact on both coastal structures and on the costal population. The seasonal morphological variations along the beach are mainly influenced by the waves, tides, ocean currents and also by anthropogenic activities (dredging, building of groins and jetties etc.) to some extent. The City of Visakhapatnam has a coastline of about 48 km from Bheemunipatnam to Yarada, which is highly dynamic and continuously subjected to both erosion and deposition throughout the year. To understand these morphological and seasonal variations along the beach, 10 stations were selected along the Visakhapatnam coast. Beach Profiles were carried out bimonthly (twice a month) at these locations along with the collection of Littoral data during Pre-Monsoon and Monsoon of 2023. Detailed Volumetric estimations were done to quantify the changes in all components of beach i.e. Foreshore, Berm, Backshore and Dune. Our current research article mainly focuses on the identification of major erosion and deposition prone zones along the Visakhapatnam coast and correlate the Net erosion and deposition patterns with the data obtained from Granulometric analysis of beach sands. Beach profiling data revealed that the southern coast of Visakhapatnam city from Yarada to South of Submarine was mainly effected by Net erosion (ranging from 10215 m³ to 1277 m³ based on base profile) during both Pre-Monsoon and Monsoon time with

the much intense erosion during the July to August months of Monsoon. In contrast to this the Northern coast of Visakhapatnam city from Rushikonda to INS Kalinga was characterized by Net deposition (11174 m³ to 1522 m³ based on base profile) from Pre-Monsoon to Monsoon time. Bheemili station at the Northern tip of Visakhapatnam coast was subjected continuous increasing erosion, this is due to local embayment of the Bheemili coastline which resulted in localized erosion.

Keywords: Coastal Changes, Erosion, Deposition, Visakhapatnam coast.

Enhancing Ocean Satellite Data Corrections and Geophysical Product Generation off the East Coast of India Using radiometer data

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Abstract

The study focused to analyse NRT parameters near three selected coastal regions off the Visakhapatnam coast situated along the East coast of India. It is aimed to enhance atmospheric correction procedures for ocean satellite data and generate long-term ocean color geophysical products in this region. The research involved extensive data collection and analysis, including parameters such as downward Irradiance, upward Radiance, pH, dissolved inorganic carbon (DIC), total alkalinity (TA), and nutrients (silicate, phosphate, nitrate), along with conducting temperature, conductivity, salinity, depth, chlorophyll, and dissolved oxygen profiles. Preliminary analysis of DIC and nutrient data, revealed across the sampling locations and depths. This study inputs to improve the understanding and monitoring of this region's oceanographic parameters with variable hydrological conditions as one of the factors.

Keywords: Atmospheric Correction, Radiance, Ocean Satellite Data, Geophysical Products.

Spectral Variation in Hyperspectral Chlorophyll Indices Across Phenological Stages of Forest Species

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Abstract

Hyperspectral remote sensing was utilized to gather detailed information about the physical condition and photosynthetic variables of the plant through seasonal or continuous observations. The primary objective of the study, to estimate chlorophyll content and monitor leaf status during various phenological stages of plant leaves, utilizing both biochemical analysis and remote sensing technology. The research concentrated on four commonly available plant varieties in Kerala: Alstonia scholaris (Ezilampala), Lagerstroemia speciosa (Manimaruth), Macaranga peltata (Vatta), and Tectona grandis (Teak). The investigation encompassed a broad spectrum of pigment content and its correlation, utilizing spectral reflectance in the range of 400 to 900nm. Nitrogen and chlorophyll levels were estimated using various vegetation indices such as VI (Vegetation Index), RVI (Ratio Vegetation Index), red chlorophyll index, and green chlorophyll index. The study also assessed plant health and leaf water content through NDVI (Normalized Difference Vegetation Index) and NDWI (Normalized Difference Water Index). The spectral information gathered within the 400 to 900 nm range provided extensive insights into the physiological status of the specimens. Notably, wavelengths at 870 nm and 1260 nm showed the highest potential for obtaining water content information in plants. This integrated approach demonstrated the effectiveness of combining biochemical analysis and remote sensing techniques to comprehensively understand the dynamics of plant pigments and physiological parameters throughout different stages of plant growth.

Keywords: Spectroradiometer, NDVI (Normalized Difference Vegetation Index), DVI (Direct Vegetation Index), IPV (Infrared Percentage Vegetation Index), VI (Vegetation Index), NDWI (Normalized Difference Water Index), RVI (Ratio Vegetation Index)

Past, Present and Future Variations of Surface runoff of Saroor Nagar Urban Watershed of Telangana Using Geospatial and Deep Learning Techniques

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Abstract

Hydrological modelling is an effective tool for predicting the hydrological response of a watershed to develop strategies for efficient water management. The overarching goal of this study was to simulate rainfall-runoff processes in the Saroor Nagar urban watershed, Telangana for the year 2008,2014, 2020, and 2026 using geospatial and deep learning techniques. The Land Use Land Cover (LULC) Maps of 2008, 2014, and 2020 are generated using Support Vector Machine (SVM) algorithm, and Cellular-Automata based Artificial Neural Network model is used to simulate the LULC for the year 2026. Daily rainfall of 2026 is forecasted using Long- Short Term Memory (LSTM) technique using univariate daily rainfall data of twenty-two years from 2000-2022. HEC-HMS model is used to simulate the rainfall-runoff process. The infiltration loss, the conversion of the excess rainfall into surface runoff, and the flow routing of the channel reach were all modelled using the SCS-Curve Number method, the SCS unit hydrograph method, and the Muskingum routing method. As the watershed is ungauged, the calibration and validation of the proposed model is performed by considering the discharge data of Hussain Sagar catchment by the method of regionalization. The performance of the model is evaluated using coefficient of determination (R^2) and Nash-Sutcliffe Efficiency (NSE). The study revealed that the built-up area increased by 55.18% at the cost of vegetation and barren land during 2008–2020, and the waterbodies have increased by 29%, the vegetation layer has increased by a marginal 6%, whereas barren land has decreased drastically by 75.8% during 2008-2020.The future LULC of 2026 simulated using the CA-ANN technique, revealed that the built-up area is expected to increase further by 17.4%. The waterbodies are expected to decrease by 8.3%, vegetation by 17.7%, and the barren land is expected to reduce to 1.25%. Daily rainfall of 2026 is expected to be 1484mm. The analysis of HEC-HMS model reveals that the simulated peak discharge increased from 44.4 m^3/s to 57.1 m^3/s during 2008-2020, and is expected to increase to 66.1 m3/s in the year 2026. During calibration, R^2 was 0.88 and NSE was 0.75, and during validation, the R^2 values was 0.83, and the NSE values was 0.89 respectively. The study's findings clearly demonstrate the proposed model's ability to adequately simulate stream flow in the basin, and can be taken as an input for judicious use of water resources in the watershed.

Keywords: Runoff, LSTM, HEC-HMS, LULC, SVM, CA-ANN

Application Of Sentinel-1 Data For Reservoir Capacity Estimation

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Abstract

Sediments carried by the rivers are deposited in the reservoirs and cause several detrimental effects, which include loss of storage capacity, upstream aggradations, effect on water quality and impairment of hydro-equipments. The deposition of sedimentation not only reduces the capacity but also the water-spread area at the entire water level of the reservoir. Optic satellite data has long been in use to estimate the water-spread area at different water levels of a reservoir, which in turn can be used to quantify the revised capacity of the reservoir. Presences of cloud in the optic satellite data (mostly during monsoon and cyclonic season) restrain mapping the water spread area of a reservoir. To overcome this problem, microwave Synthetic Aperture Radar (SAR) data has been used in this study which has the ability to penetrate the cloud, and hence the information beneath the cloud can be easily ascertained. Microwave satellite data (Sentinel 1-SAR) pertaining to Singur reservoir, Andhrapradesh contain twelve SAR images for the period 2018-20, has been used in this study. The pre-processing techniques were applied to all the SAR, dual-polarized (VV+VH) data. From the VV+VH processed data, a thresholding methodology was used to identify the water pixels. The processed microwave data contain water pixel values ranging from -34.28 dB to -18.62 dB, these pixels were extracted, and the water spread area occupied by all the twelve SAR images were estimated. The interpreted waters spread areas were used in a simple volume estimation Prismoidal formula and the volume between the twelve different water levels were calculated. This study shows that reservoir water spread and in turn the amount of sediment deposited in a reservoir can be effectively estimated using Sentinel1-SAR, which is a replacement to the cloud covered optical data.

Key Words: Reservoir Capacity, microwave satellite data, Sentinel-1, sediment estimation

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Spatial Variations of Land Use Land Cover Changes in Urban Catchment

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Abstract

Rapid urban development in industrial and commercial sector has led to drastic change in land use/land cover changes. This increase in urbanization has caused serious problem of water logging and rapid urban flooding in many parts of Hyderabad. This study was carried out to assess the land use/land cover change owning to the urban development in Zone-IV of GHMC (Greater Hyderabad Municipal Corporation), Hyderabad using remote sensing and GIS (Geographical Information System) application between year 1973 and 2021. The study area 49 sq km was considered for evaluation. The change in land use/land cover was analyzed using ArcGIS 10.7 image classification program. Landsat-5 images for year 1988, 1991, 1996, 2001, 2006, 2011, and two Sentinel images of 2016 and 2021, with an average interval of five years were downloaded from USGS Earth Explorer open portal. Maximum likelihood classification (MLC) was used and the study area was classified into four categories namely barren land, built-up area, vegetation and water body. The result indicates the drastic increase in built-up area to about 27 sq km (55%) of the total study area, while the shrinkage of area under vegetation, barren land and water body reduced to merely 7 sq km (14%), 14 sq km (29%) and 1 sq km (2%), respectively in year 2021. An accuracy assessment was conducted to quantify MLC assigned pixel classes. The overall accuracy and kappa coefficient were used for accuracy assessment of the processed images. Random points were generated in ArcGIS and verified with high resolution Google images. The overall accuracies were assessed as 77.5, 66.25, 80, 83.75, 90, 87.5 and 88.75 percent and Kappa coefficient as 0.69, 0.55, 0.73, 0.78, 0.86, 0.82 and 0.85 for the years 1991, 1996, 2001, 2006, 2011, 2016 and 2021, respectively. The results indicated that on comparing kappa coefficient values with kappa statistics, year 1991, 1996, 2001 and 2006 as substantial while 2011, 2016 and 2021 as perfect. The results of the present study will be helpful to urban planner and policy makers for further analysis in decision making for sustainable development of the city in the future.

Keywords: Urban, Land Use, Land Cover, Accuracy, Kappa Coefficient

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Session 8

Governance to Address Future Water Challenges

Invited Talk
Governance to Address Future Water Challenges

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Abstract

With a very fast growing economy, urbanisation and also change in land use patterns, there is a tremendous pressure on water resources. With the same type of water planning and management for future based previous experience may throw in several challenges since rainfall patterns itself is changing fast due to climate change leading to change in micro climate as well and the behaviour of whole basin going through rapid change.

With the inputs from rainfall pattern itself changing fast, the seasonal calculations of water storages as well as it's equitable distribution in both space and time at different scales is getting affected, bringing in flood, droughts etc. This also happens due to mismatch between hydrological studies as well as hydraulic water transfer capacities. To bring in balance in them, storages as well as transfer capacities in both natural and man-made systems may have to be revisited. Added to this, the connectivity or otherwise between surface waters and groundwaters pose a challenge. Quality of available water plays a dominant role in this.

There are National water policy as well as state water policies to address several issues with dominant among them being, water for Drinking, Irrigation, industrial and of course environment & ecology to name a few. Agro climatological and geological zones being very varied across the country brings in more challenges in the governance of water resources especially trying tom bring in equity. Though many of these aspects could be addressed in planning for future, imbalances between Surface water and ground water and their quality along with land use changes, brings in challenges in their management. Added to this, inter basin water transfers, change in source for drinking water from ground water to surface water with almost no change in irrigation water requirement as well as type of crops grown with less water consumption will bring in large inequity in different sectors. With several National missions like JJM, ARUT 2.0 etc., being taken up, what sort of changes are occurring in water sector need to be understood. Also the governance of this complex system need to be addressed. This paper tries to delve upon several of these aspects.

Comprehensive Water Audit for Better Water Management
A Case Study in Musi River Sub Basin in Andhra Pradesh

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Abstract

Water is elixir of life. The water demand for all sectors is increasing day by day where as supplies are more or less same without any increase.To meet the emerging demands and to provide water security to all, the Government of Andhra Pradesh has aimed to provide right amount of water at right place and time. In this direction, the Ground Water and Water Audit Department has initiated Comprehensive Water Audit on Sub Basin Approach under National Hydrology Project (NHP). For optimal and judicious use of water resources, meticulous planning and management of quantity as well quality is highly essential. The major five river basins of Andhra Pradesh viz., Nagavali, Vamsadara, Godavari, Krishna and Pennar are subdivided into 74 river sub basins for the purpose of Water Audit.

The case study presented here is for Musi River Sub Basin which is one of the 74 river Sub basins. The Musi-River Sub Basin is having area of 2,35,327 Ha and Terrain elevation is in the range of 30-300 m with 60% of the area having slope less than 2 degrees and 30% of the area having slope between 2 to 10 degrees. Normal rainfall is about 944 mm and in the last year the sub basin received 892 mm. Geomorphlogically most of the basin area is occupied by pediplains and structural hills in the West and alluvial planes in the East. Hydrogeologically most of the area is underlined by Metamorphic rocks of Eastern Ghats and Cuddapah Super Group. Depending on rainfall conditions dug wells in the area are yielding in the range of 20,000-30,000 lpd and bore wells are yielding in the range of 6,000-10,000 lph.

The major water assets of the sub basin includes Ramatertha Sagaram Balancing Reservoir with capacity of 1.51 TMC and Nagarjuna Sagar Project Right Main Canal with Irrigation Potential Created about 46,222 Ha. In the sub basin minor water assets are 157 Minor Irrigation Tanks with Capacity of 3,708 mcft and 19,706 Water Conservation structures with capacity of 992 mcft. In the sub basin Ground water is being extracted from 17,389 bore wells.

The major water utilization in the sub basin is about 61,067 Ha-m by Agriculture sector and about 1,932 Ha-m for Domestic needs. Industry, Livestock, Aquaculture Sectors consumed about 2787 Ha-m. All components of Water Cycle and utilizations are measured/ estimated/ derived from the available sources to put in to the water balance equation. In the last water year, 2022-23 Musi-River Sub Basin has received water

resources about 2,09,935 Ha-m through rainfall and about 23,355 Ha-m by Canal releases. In the sub basin Evapotranspiration is about 1,22,370 Ha-m and the Crop Water Requirement is about 60,735 Ha-m.

The ground water extraction is about 4,595 Ha-m and apart from surface water and ground water, the rainfall utilized directly by crops is about 32,785 Ha-m. The net change in storage of reservoir is negligible and it is about 1,954 Ham only. Normally negative change in Soil Moisture and Water Conservation Structures can be attributed to ground water recharge and it is about 13,592 Ha-m. In the sub basin the measured discharge of about 22,135 Ha-m has outflow to the sea. In the sub basin about 5.92% rainfall is unaccounted.

In the study, it is suggested to use a discharge of about 10,000 Ha-m as ground water recharge in places where ground water is below 10 m from ground level by means of different water conservation structures.

Key words: River Sub Basin, Canal Releases, Water balance, Crop Water Requirement (CWR), Components of Water Cycle, Discharge, Ground Water Recharge

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Groundwater Management Under Legislative Frame Work In the State of Andhra Pradesh

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Abstract

Andhra Pradesh is a seventh largest state where ground water plays an important role in agriculture. In Andhra Pradesh, around 41% of gross irrigated area is from groundwater. As per Ground Water Resource Assessment 2023 (GEC-2023) out of the 748 micro basins 14were classified as over-exploited, 4 critical and 13 were classified as semi-critical. Because of recent climatological changes and inadequate canal water supplies there is phenomenal expansion of groundwater exploitation for the last two decades and has led to steep fall in water table in several parts of the state especially in the Rayalaseema region and upland regions in coastal Andhra. As a result, ground water is becoming unsustainable with several adverse effects. Andhra Pradesh Water Land and Trees Act (APWALTA), the legislation to regulate ground water in the state, was enacted in 2002. The inadequacy of the existing institutional frame work in regulating of ground water utilization coupled with free electricity policy of the government accelerated the indiscriminate groundwater utilization in Andhra Pradesh. Though the state comprises robust water level monitoring network system with adequate number of piezometers covering all aquifer systems in the state and well advanced Water Resource Information and Management System (APWRIMS), the present policies and legislation with strong focus on state control and regulation of groundwater, missed the elements of community management of common property such

as groundwater. Unregulated over-exploitation of groundwater resource counting at rapid pace highlights the growing gap between the policy and practice. Gross-root experiences, such as social regulation of groundwater are promising and offering innovative and alternative solutions. The paper discusses groundwater situation in Andhra Pradesh and suggests to scale-up social regulations and sharing of ground water experiences for ensuring equity and sustainability in ground water management. The paper also recommends strengthening of institutional frame work and empowering local gram panchayats and additional incentives to groups willing to share water by amending the APWALT Act.

Key words: APWALTA, Social regulation, Groundwater and piezometer

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Identification of possible causes and slope stability analysis of recent joshimath, uttarakhand subsidence

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Abstract

The devastating land subsidence in Joshimath, Uttarakhand, from October 2022 to February 2023 profoundly impacted the region, necessitating a comprehensive investigation. This study aims to uncover the causative factors behind this abrupt event, which inflicted severe damage on infrastructure and posed significant threats to human safety. Employing extensive field investigations, soil sample collection and analysis, the research delves into geological mapping, land-use patterns, and historical subsidence records. The soil samples collected were instrumental in conducting direct shear tests, facilitating the determination of both internal angle of friction and soil cohesion values. These values were helpful in creating the conceptual slope stability model. Utilizing a conceptual slope stability model, the study seeks to simulate various conditions, providing insights into slope behaviour. This pursuit for understanding and addressing such catastrophic subsidence events holds critical implications for environmental preservation, infrastructure resilience, and community well-being.
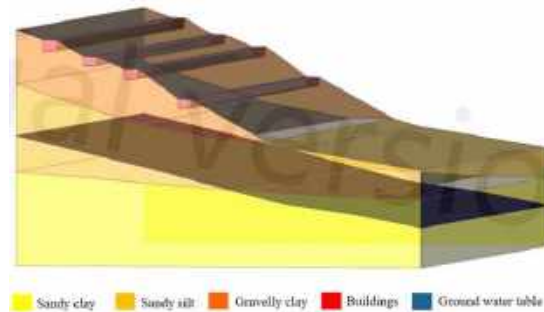
Keywords: Land subsidence, Slope stability, cohesion, angle of internal friction

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Determining the basic mapping unit for assessing susceptibility to shallow landslides: A case study in the Western Ghats, India.

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Abstract

Situated between the Tropic of Cancer and Capricorn, tropical regions experience substantial precipitation, often exceeding twice the amount of the driest year. The Western Ghats in India exemplifies this, but marked by frequent shallow debris flow landslides, particularly during the monsoon season. The region's high drainage density and seasonal landslides pose challenges for studies due to the absence of a fundamental mapping unit. This study addresses this gap by focusing on a specific area within the Western Ghats, situated administratively in the Idukki district of Kerala, pinpointing the Pettimudi landslide location (77.01˚E longitude, 10.17˚N latitude) that claimed 70 lives in August 2020. Extensive literature review and terrain analysis aided in selecting the drainage basin as the fundamental mapping unit. Through meticulous trial and error involving factors like geology, slope, and drainage, a 26.43 sq. km drainage basin, classified as a third-order basin, was delineated. Mapping 42 landslides from 2018 to 2020 using high-resolution Google Earth images and field investigations, the study area was further subdivided into lower-order basins. Subsequent analysis revealed a higher frequency of landslides in second-order basins. This identified unit is recommended to be prioritized as the fundamental mapping unit for characterizing shallow-seated debris flows and serves as a crucial element for developing a landslide susceptibility map, contributing to effective land use management and risk assessment for stakeholders. This unit will have the advantage of encompassing the entire landslide morphology starting from the crown to toe, which further makes room for run-out modelling.

Keywords: Landslides, Western Ghats, Pettimudi, Drainage basins

Invited Talks

Special Session: Unsolved Problems in Hydrology

Unsolved Problems in Hydrology (UPHs) in the Indian context

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Abstract

India faces many hydrological challenges in operational terms, in relation to its trajectory of development, and with a huge heterogeneity across its physical, hydroclimatic and human geography. Many challenges, mostly centred around, monsoon dynamics, increasing occurrence of extreme events, decreasing environmental flows, rainwater harvesting, submarine discharges, deteriorating health of river and aquifer systems, emerging contaminants, uneven distribution of resources in time and space, droughts and floods, inadequacy of hydrometeorological data sets, observation gaps between theory and field conditions in the development and adoption of suitable models, government policies and ineffective governance and management, lack of coordination between different institutions dealing with the different facets of hydrology are discussed along with their scientific rationale and possible solutions.

In this context, having ceased with the commitment to understand and facilitate finding solutions to the prevailing challenges in the Indian region, the Association of Hydrologits of India, has been deliberating on this aspect and has been consolidating the perceptions of the scientific and professional community ever since 2004 at its annual conventions with the support and involvement of Indian hydrological communities, the Department of science and technology and the Ministry of water resources, and the ministry of Earth Sciences.

Realising the concerted effort made the IAHS with the involvement of many roach international communities and the publications made in the area, an effort to arrive at a possible comparability with those 23 aspects identified by IAHS has been alleviated. The challenges identified are observed to have distinct associations with the prevailing geographic, climatic, hydrologic and socio-political conditions. Quite some of them are akin to the 23 UPHs identified by IAHS making the convolution explicit and allowing to identify critical gaps and priorities towards reinforcing science for solutions. The commonalities and the explicitly different challenges as compared to those identified by IAHS and the possible way forward to address these challenges is discussed in this paper.

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23 Unsolved Problems in Hydrology: Advances from India

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Abstract

Unsolved Problems in Hydrology (UPH) is a major global initiative taken up by the International Association for Hydrological Sciences (IAHS) in identifying and publishing the 23 Unsolved Problems in Hydrology (23 UPHs). The Global UPH initiative focuses on six major themes: Time Variability and Change, Space Variability and Scaling, Variability of Extremes, Interfaces in Hydrology, Measurements and Data, Modelling Methods, and Interfaces with Society. These pivotal areas drive collaborative efforts to address complex hydrological challenges worldwide. In this context, Unsolved Problems in Hydrology (UPH): Advances from India is an inspiration and initiative to identify and review the contributions of the Indian community to advancing key unsolved problems in hydrology, to enhance collaboration with surrounding countries with shared water issues, and to build a more coherent water community in India. It will also focus on enabling the Indian community to speak with one voice to increase public awareness and enhance funding opportunities for community projects. A total of 156 responses have been collected from researchers, academicians, policymakers, and water resources practitioners working in several areas which will help to identify the various water-related issues from geographical, geological, environmental, social, physical, and political aspects. These responses will help to unveil the hydrological processes and provide a way to deal with the several hydrological challenges at various levels.

Connecting Water and Carbon Cycle for India

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Abstract

We aim to delve into the intricate relationship between climate drivers and vegetation productivity, offering a comprehensive understanding of the complex interplay that governs ecosystems. In this discourse, we navigate through the multifaceted mechanisms by which climatic factors influence the growth and vitality of vegetation. Drawing on a synthesis of cutting-edge research, we explore the role of temperature, precipitation, solar radiation, and atmospheric carbon dioxide concentrations in shaping the productivity of diverse plant communities. India is the second highest contributor to global greening; however, its potential to capture atmospheric CO_2 and the role of climate drivers in shaping the same is not known. Increased CO_2 also has impacts on vegetation through carbon fertilization. Absence of sufficient in-situ

measurements is a major challenge to these quantifications. Here, using satellite and model output we identify the major climate drivers and role of carbon fertilization on vegetation on subsequently on the hydrology. Finally we identify the key science question, which needs immediate attention with a possible solution approach.

Urban Water Resources Systems – Issues and Challenges
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Abstract

23. What is the role of water in migration, urbanisation and the dynamics of human civilisations, and what are the implications for contemporary water management?

The above is one of the recommendation (last one) in USP in hydrology. Without water security, the whole dynamics may change. Urbanisation and role of water is interdependent as we require a large quantity of water as urbansation takes place. To sustain this, a large quantity of water being extracted from surface and/ or subsurface locally as well as bringing in water from long distances including inter basin transfer leading to many imbalances in the water cycle. Further to this, a very large amount waste water will be generated in the catchment of a city and it's management through recycling and reuse locally as well as it's transfer to water deficit neighbouring areas pose its own challenge. Any city is a part of a bigger catchment and thus there is a need to do Integrated Urban Water Resources Management (IUWRM), which is a subset of IWRM. This paper tries to address such issues as how a city performers Visa-vis local rain water harvesting, long distance water transfer(including inter basin), local ground water usage, recycled water usage and the city water balance keeping these components in perspective. To this the complexities when city receives very less rainfall leading to water shortages as well as drought situations some times, and also due to high intensity short duration rainfall, flooding could occur in many parts of the city. The same city may undergo flooding and drought situation during the same hydrological year. Thus there is a need to understand the recharge characteristics of the local catchment which gives the connectivity between the surface and subsurface reservoirs especially to use the flood waters as resource for recharging. Also use of treated recycled water for recharging will also enhance the water security, with moisture development, micro climate change is also anticipated. With this type of study, the recharge characteristics which is varied across the catchment as well as depth wise, runoff changes due to land use, evaporation and evapotranspiration across the catchment, rainwater harvesting to fill water bodies and at household level along with the recycled water movement poses

a real challenging hydrological problem at a city scale, which is one of the most important problem that need to be addressed.

Assessing the ground water system in hard rocks: Lessons learnt and perspectives

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Abstract

Two-thirds of India is covered by hard rock aquifers, which have relatively lower water storage & yield and yet these are being severely exploited for managing water needs. An improved understanding of the behavior of these fractured rocks is imperative for addressing the challenges posed on these aquifers and for formulating suitable sustainable management strategies. The presentation will discuss lessons drawn from studies on (i) recharge patterns especially from higher rainfall intensities, (ii) well yield behavior associated with changing groundwater storage/ stock, (iii) base flow dynamics related to stream-aquifer linkage, and (iv) groundwater in urban aquifers. Perspectives will be highlighted on ground water quality related to residence times and heterogeneity of the aquifers.

Unsolved problems in hydrology based on community consultation

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Abstract

The rise in the demand for food and energy, which increases water requirements added to the complexity of climate change, puts tremendous stress on hydrology. Urbanisation and rising individual and natural resource consumption also threaten the hydrological systems. Nearly the entire world population are experiencing flood and drought conditions in the changing world. The International Association of Hydrological Sciences (IAHS) initiated a community consultation process in 2017 under the leadership of its then President, Günter Blöschl. The outcome of this community initiative has resulted in identifying unsolved scientific problems in hydrology driven by a need for more vital coordination of research efforts. The procedure involved a public consultation through

online media and workshops through which many potential unanswered hydrological science questions were collated. These questions were subsequently prioritised and synthesised. The elaborate efforts have resulted in the synthesis of the 23 unsolved problems in hydrology. Towards this, a well-attended session regarding unanswered questions on water quality was held at the 2023 IAHS assembly in Berlin, Germany. The impacts of climate change on water quality were discussed with over 35 presentations by researchers worldwide.

Unsolved Hydrological Issues in the Coastal Regions of India

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Abstract

Many early hydrology deals with mainly about hydrometry data and subsequently groundwater. With the advent of remote sensing and digital data recording in the 1980s, there was a renewed interest in measurement methods and, more recently, there has been another boost of new technologies. In India after implementing National Hydrology Project (NHP) by Govt., of India all historical Hydrological data of various states has been digitized and processed using SWDES/GWDES software's. Not only data processing this NHP also helped in capacity building/infrastructure facilities, procuring state of art equipment for hydrological data monitoring and also to increase hydrological monitoring network in various states in India. The hydrological monitoring network was initial established by state/central departments for resources assessment therefore not enough importance given to the coastal regions (Saline zones). Due to Fragile environment of coastal ecosystem now monitoring of hydrological data and aquifer mapping was initiated to understand unsolved problems of Submarine Groundwater Discharge (SGD), Seawater intrusion (SI) fluxes, emerging contaminants, micro plastics etc. One of potential path forward is the use of proxies, replacing few accurate data by many less accurate data, e.g. by using qualitative observations from lay persons or from data mining; however, it is not yet clear exactly what proxies would be of most benefit in a particular situation of coastal regions. The impact of hydrological extremes on coastal systems also important due to sudden releases of water from reservoirs/tank beaches, sea water tides to be established to protect valuable resources in the coastal regions. The fusion of quantitative with non-quantitative data, as well as hydrological with other types of data (socio-economic, land-use), climate change etc. seems essential for making further progress. Addressing these issues requires a multifaceted approach involving sustainable water management practices, coastal zone planning, afforestation, stricter pollution control measures, and community participation in conservation efforts. Government policies, technological interventions, and community awareness programs are essential for mitigating these challenges in India's coastal regions.

Understanding the impacts of anthropogenic activities and climate change on hydrological cycle and extremes

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Abstract

In this paper, it is planned to discuss about the importance of understanding the how the hydrological cycle is impacted by the anthropogenic and climate changes, particularly trying the address the UPH 1 and 4. With significant changes happening in the catchment in terms of water resources development projects and land use changes there is a need to address these questions in the context of our country. Even though there has been sporadic attempts to answer these questions, but still there is a lot more to understand in terms of feedback mechanisms between land surface- atmosphere interactions, soil moisture temperature coupling changes, precipitation recycle ratio, residence time and travel time distribution.

3D Geophysical Imaging of Submarine Groundwater Discharge Pathways

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Abstract

The sea coast facilitates many ecosystem services to humankind and holds a dense population whose life is dependent directly or indirectly on the coastal aquifer system. There are two important hydrogeological processes i.e. seawater intrusion and submarine groundwater discharge (SGD) taking place either in isolation or together at places along the sea coast. To address the coastal hydrogeological issues and have a sustainable groundwater management plan, it is important to have a comprehensive and precise understanding of the major governing factors controlling these processes, their spatiotemporal variability, and quantitative estimates of hydrogeological fluxes. One can find a large number of studies on seawater intrusion in India and across the globe. However, a limited number of studies exist on SGD. The SGD appears to be one of the major unsolved problems in Hydrogeology. The paper presents a few relevant studies on SGD and their budgeting across the globe including a case study of CSIR-NGRI on aquifer mapping employing heliborne geophysics at sea coast near Cuddalore,

Tamil Nadu that provided high-resolution knowledge of multi-layered aquifer systems including connected pathways facilitating possible submarine groundwater discharge.

Understanding and Managing mini aquifers – An effort towards village level ground water source and sustainability planning

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Abstract

The main objective of the study is to develop and operationalize the methodology for villagevlevel groundwater prospects and sustainability planning. Pilot studies have been planned in 9 different hydro-geological provinces considering their homogeneity as well as heterogeneity.Pilot studies carried out in Peninsular Gneissic terrain (Jayachandrapura (JCPura) gram Panchayat, in Tumkur district, Karnataka); Basaltic province (Narkhed in Maharashtra) & Korba in Chhattisgarh (Gondwana rocks) has thrown few challenges and surprises. All these areas has shown variability in the groundwater availability, potential and its usage. The ground water problem in Tumkur & Narkhed are very challenging as they fall under overexploitation zones where less groundwater availability is due to variability in rainfall and excessive groundwater withdrawal for irrigation according to CGWB (2019) and the aquifer is draining due to the nearby coal mining in Korba. Using VHR (CARTOSAT-2E, KOMSAT-3) and High resolution (IRS-P6 LISS-4) satellite data, detailed hydrogeological mapping was carried out in these pilot study areas. Groundwater well observation was carried out systematically in a gridded manner. Data integration was carried out using heuristic knowledge guided methodology for sustainable groundwater development plan on 1:10K scale including ground water prospects and recharge zones identification at village level. In JC Pura, Tumkur, Karnataka, it was observed that more than 1000 bore wells have been constructed in 24 sq.km areas. Well inventory analysis clearly highlights the excessive withdrawal of groundwater. Wells in the shallow aquifers zones are mostly dried up and majority of the wells are exploiting groundwater from the deeper (200-300 m depth) confined aquifers. This has led to uneven distribution of ground water and erratic discharge of ground water bore wells. It was emphasized for the scientific planning of the aquifer management at village level with extensive construction of recharge structures for sustainable development of groundwater in this area. Similarly, in the Narkhed area, Maharashtra, ground water is being exploited for orange cultivation. Because of the poor water holding capacity of the basaltic region, the area has become ground water deficient. A Sustainable model has been suggested for aquifer restoration.

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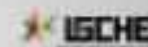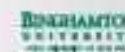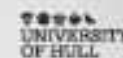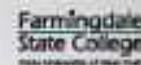
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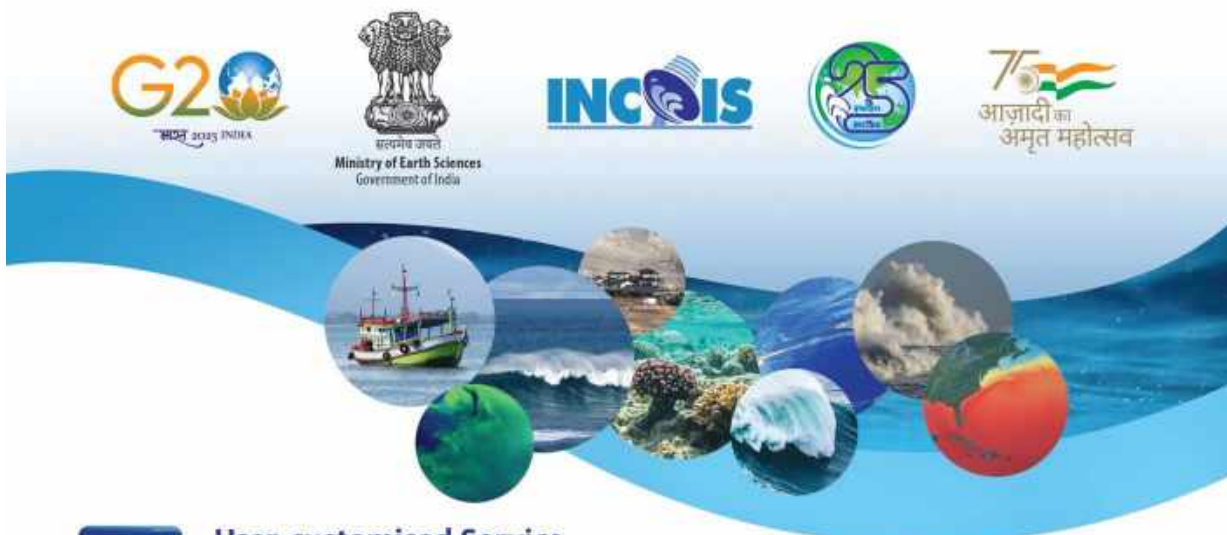
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Philip, J.R., 1967. Sorption and infiltration in heterogeneous media, Jour. of Soil Res., Vol.5 No.2, pp 1-10. Todd, D.K., 1959. Ground Water Hydrology, John Wiley and Sons Ltd., New York. Hibbert, A.R., 1967. Forest treatment on wateryield, Forest Hydrology, edited by Sopper, W.E. and Lull, H.W.Pergamon Press, New York.

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About the Editors

Prof. P. Rama Rao is presently the Honorary Director of Center for Studies on Bay of Bengal, Andhra University, Visakhapatnam, Andhra Pradesh. He started his career as faculty in Department of Geophysics, Andhra University and served as its Head and Chairperson. He made his untiring efforts for the growth of academics and research in the Department of Geophysics. He is associated with the Centre for Studies on Bay of Bengal and involved in coastal processes, coastal resources, ocean state forecast and potential fishing zone advisories. Besides he is the Secretary, Association of Hydrologists of India and is involved in its growth and development by involving people in Hydrological studies to promote research and conducting its annual seminars and training programs. He is also the editor for AHI's Journal of Applied Hydrology. He published more than 40 research papers both in Geophysical and Marine Geophysical fields. Thirty students were awarded PhD's under his guidance. He handled more than ten research projects of DST, INCOIS and presently working with three projects. He worked as DST BOYSCAST fellow at University of Bonn, Germany during 1992-1993 and visited Moscow, Russia under DST's ILTP Program in 2007.

Dr. R. Selvakumar, Professor and Head, Department of Nanobiotechnology, PSG Institute of Advanced Studies, Coimbatore, has 13 years of experience and expertise in microbiology, nanobiotechnology, Nanomaterials application in groundwater and wastewater treatment. He did his Ph.D. at Bharathiar University, Coimbatore and Postdoctoral Fellowships at the University of Newcastle, Australia and University of Nebraska, USA. He is the recipient of prestigious awards like Advanced Research and Innovation (WARI) fellowship from IUSSTF, Endeavour Research Fellow from Government of Australia, Blaustein postdoctoral fellowship awarded at Zuckerburg Institute for Water Research, Israel, CSIR-SRF from Govt. of India, etc. He has completed several funded research projects sanctioned by DST-Water Technology Initiative (WTI), DRDO, ICMR, ONGC, IGCAR etc. As on date, he has 92 publications with H index of 28 and 2407 citations, 7 book chapters, 2 patents and 2 technology transfer to industry.

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