जल शक्ति मंत्रालय
भारत सरकार
MINISTRY OF JAL SHAKTI
GOVERNMENT OF INDIA
सत्यमेव जयते

IWW

8th INDIA WATER WEEK- 2024

Partnerships and Cooperation for Inclusive Water Development and Management

17-20 SEPTEMBER, 2024

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महानिदेशक
Bhopal Singh
Director General

सत्यमेव जयते

राष्ट्रीय जल विकास अभिकरण
जल शक्ति मंत्रालय, भारत सरकार
(जल संसाधन, नदी विकास और गंगा संरक्षण विभाग)
National Water Development Agency
Ministry of Jal Shakti, Government of India
(Department of Water Resources, River Development and Ganga Rejuvenation)

FOREWORD

Greetings and welcome to the eighth edition of **India Water Week -2024**. The event is being organized by Ministry of Jal Shakti, Government of India during 17th to 20 November, 2024 at Bharat Mandapam, Pragati Maidan, New Delhi. The theme of present edition is **"Partnerships and Cooperation for inclusive Water Development and Management"** focusing on need of Cooperation at every level to get success in sustainable development and management of water resources. The India Water Week is an excellent multi disciplinary "give and take" forum for all stakeholders to deliberate on all water related issues. It provides splendid opportunities for sharing experiences, showcasing technological advancements / achievements, learning from best practices and identifying the best course of action for future.

The India Water Week 2024 will encompass various events in form of sessions under Country Forum, Water Leaders' Forum, Practitioners' Forum, Youth Forum, Start-up Forum and Water convention. These sessions involve participation of various national and international organisations, partner countries, NGOs, water experts, water leaders, academia and students. The event would be a complete package of knowledge transfer for all the stakeholders of water sector.

This volume of technical proceedings compiles the synopsis of papers received for different sessions from professionals, academia and technocrats from India and abroad for explicating ideas.

As an organizing Secretary, it gives me and my team an immense pleasure and satisfaction that 340 synopsis were received. There will be more presentations by various experts and professionals during the event, which we plan to compile session wise in electronic form along with full length papers and presentations and make them available to the participants on last day of the event and later in post-session proceedings.

I express my sincere gratitude to the Organising Committee, headed by Smt. Debashree Mukherjee, Secretary, DoWR, RD & GR, Ministry of Jal Shakti and all of its members. My special thanks to Sh. Rakesh Kumar Verma, Additional Secretary, Ministry of Jal Shakti for his valuable guidance. I express my gratitude to Sh. Kushvinder Vohra, Chairman, CWC for his valuable inputs and guidance as Chairman of Technical Committee. Thanks to all members of Technical Committee, Sh. Bhupinder Singh, Chief Engineer, CWC, Sh. Sanjay Gangwar, Director (TC), CWC and their team, my special thanks to Sh. A.B. Pandya for his contributions.

My sincere thanks to reviewing and session management groups. I express my thanks to Sh. Baleshwar Thakur, Chief Engineer (HQ), NWDA and Sh. R. K. Jain, Head, IWW Secretariat and his team for their untiring efforts and hard work.

We, the organizing group, hope that this volume would be a treasure of knowledge and information for all.

(Bhopal Singh)
Director General, NWDA
& Organising Secretary

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MESSAGE

Greetings at the Eighth edition of India Water Week. The India Water Week event provides an incredible opportunity for water sector with an encyclopedic coverage of all aspects of water resources. This event acts as an excellent platform that brings together all stakeholders for sharing of knowledge and ideas.

The present edition is 8th edition of the event. Theme of India Water Week-2024 is "Partnerships and Cooperation for inclusive Water Development and Management". It is a 3 days' conference along with an exhibition organized for all stakeholders of water sector. The India Water Week was conceptualized and organized for first time in year, 2012 by the Ministry of Jal Shakti, Government of India.

The theme for this year signifies the need of collective, cooperative and collaborated thinking, efforts, decisions and action for management of our most precious resource.

India Water Week - 2024 is an International Forum hosting a multi-disciplinary dialogue, insightful, diverse and in-depth perspectives, discussions and knowledge exchange on wide range of topics from experts and practitioners from Government and private sector and interaction and networking with Government leaders, Industry leaders, Scholars, Planners, Innovators and Decision-makers in the field of water resources across the globe.

The event is comprised of Ministerial Plenary, Global Water Leaders' Plenary, Country Forum on the sidelines of IWW, Water Leaders' Forum for National /International experts from Public and Private sector, Policy makers, Research and Academia, Multilateral development institutions and NGOs, Practitioners' Forum for experts to share their experiences in implementing water sector programmes, initiatives, policies and best practices, Start-up Forum for innovators, Youth Forum for students and Water Convention for presentations by authors of short listed papers on various sub-themes and topics of IWW in various sessions.

The present volume provides a glimpse of the contents of full length papers in form of abstracts. The papers have been published separately in electronic form and other presentations not covered in this volume will be available in form of post – session proceedings. These will be made available for reference of the community through our web portal www.indiawaterweek.in

We have had participation of more than 3000 delegates and professionals over a period of three days and their contribution and cooperation is very significant for making this event a grand success! I express our gratitude to all of them.

(Rakesh Kumar Verma)
Additional Secretary DoWR, RD & GR
Ministry of Jal Shakti

CONTENT

COLLABORATION AND COOPERATION FOR WATER SECURITY

WC-1

Delineation of Aquifer System and Estimation of Ground Water Resources of Chandigarh City for Sustainable Management of Ground Water

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KEYWORDS
Aquifer system, Ground water, In-storage resources, Water logging, Water level decline

ABSTRACT

Chandigarh city, with an area of 114 km2, is an UT and the capital of two states i.e. Punjab & Haryana. It is located at the foothills of the Siwaliks about 250 kms north of Delhi. Geomorphologically, Chandigarh has four physiographic units i.e. The Siwalik range; The Kandi formation; The Sirowal formation & the Alluvial deposits; making the aquifer system complex for the occurrence of ground water. Data generated from CGWB exploratory wells, wells from MCC and Private drillings in the area are compiled to delineate disposition of sub-surface aquifers. Major lithological formations are sand and clay although lithological sequence encountered during drilling does not display continuity in aquifer geometry in the area. As per the National Aquifer Mapping study carried out in the year 2019, four aquifer groups have been identified up to the depth of 400m. The major aquifer system of Chandigarh is alluvial fan deposit having older and younger alluvium which mainly comprise of boulder, sand, silt and clay. Ground water in the area occurs under water table, confined as well as semi- confined conditions. The pumping test data of the aquifers tested in the city clearly indicates the presence of good confined aquifers and leaky aquifers. Intercalation of sand and clay is more frequent in the northern and north-eastern parts as compared to southern portion. Thickness of potential aquifer zones is also high in the northern and north-eastern part. The first aquifer is water table aquifer and extends all over the area. Static/In-storage ground water resources are estimated up to 400m depth. Major data elements considered in this estimation are thickness of granular zones, specific yield/ storativity, and area of study. The calculation of in-storage resources has been done in two parts due to high variability in geological formation/aquifer system, broadly separating the city into two segments- northern and southern segments depending upon the ratio of granular zones. In the northern part, the thickness of clay formation is less as compared to southern part, and is divided in to two parts with an area covering ratio of 50:50. The total in-storage quantum thus calculated comes to 191.45, 220.67, 172.24 & 80.68 MCM for Aquifer I, II, III and IV respectively up to the depth of 400m. There are two major ground water issues occur in the area, i.e. declining ground water levels of the deeper aquifers due to sustained pumping, and marginal decline in water levels of the shallow aquifer causing problem of water logging in some parts. Thus, based on the findings, sustainable Aquifer Management Plan for Chandigarh city is formulated i.e. for Zone A where extracting shallow ground water is proposed for secondary uses in the water-logged areas and for Zone B where water level is declining, there recharges of deeper aquifer with depth slot of between 70-90 mbgl is proposed.

Public-Private Partnerships (PPP) for a Sustainable and Reliable Water Supply in India

Dr Ajay Pradhan

Abstract: This paper aims to explore the role of Public-Private Partnerships (PPP) in ensuring a sustainable and reliable water supply for urban areas with a population of over one million. Public-Private Partnerships (PPPs) represent a cooperative arrangement between public sector entities, typically government agencies, and private sector companies or consortia. These partnerships are formed to jointly plan, finance, design, construct, operate, and maintain public infrastructure or deliver public services. In the context of water supply, PPPs bring together the expertise, resources, and incentives of both sectors to address pressing challenges.

Guyana Water Inc.

Partnerships and Cooperation for inclusive Water Development and Management

ABSTRACT

This paper looks at the approach implemented by the Guyana Water Inc. the sole water utility to advance partnerships and co-operation for inclusive water development and management in the hinterland communities of Guyana, to increase population access to clean water supply, reduce poverty and improve standard of living by achieving SDGs Goal 6[1]. Guyana's indigenous peoples and communities are critical to sustainable development across many sectors, including environmental conservation, economic growth, and social justice. Yet historical and structural barriers have posed a challenge for meaningful engagement of Indigenous peoples, that leverages their knowledge, expertise, and solutions.

Guyana's Low Carbon Development Strategy 2023 plays a critical role in enabling and building partnerships and co-operation for inclusive water development and management, including the Integrated Water Resources Management policy. To address the challenges and promote meaningful partnerships with Indigenous peoples, implementing partners must use structural flexibility (*in terms of contractual and financial mechanisms*) and intersectional approaches in the design, implementation, and learning stages of a project or programme. By understanding the interconnected nature of various social categories such as gender, culture, language, physical ability, and socioeconomic status, the utility can leverage these dynamics to better align our work with the objectives of Indigenous peoples. In addition, the National Toshao Council (NTC) plays an important role in the development of our indigenous people and communities. The NTC is mandated to represent Guyana's Indigenous Peoples, and to plan and develop policies, programs and projects aimed at sustainable development, general welfare improvement and the promotion of the rights of the Indigenous peoples, which include their human rights, land rights, preservation and promotion of their languages and culture, strategic planning, mitigation of Climate Change, protection, conservation and management of forest and natural resources, villages governance and other social and economic projects. Also, the National Water Council, when implemented will provide another opportunity for building partnerships and co-operation for enhanced Integrated Water Resources Management.

Its therefore essential to build partnerships and enhanced co-operation to achieve inclusiveness in the development and management of clean water and sanitation for all, to ensure improved socioeconomic standards of the indigenous peoples of Guyana.

Moradabad Amrit Sarovar Project – A Case Study

ABSTRACT

Moradabad city is often referred as the 'Brass capital' of India. Every home is involved in brass-based handicraft and both side of the city there are brass manufacturing industrial corridors. so much of metal work had its impact on the natural resources too. All Waterbodies were contaminated with effluent, Air Quality Index was bad (beyond permissible limits, above 300 since year 2017), ground Water was report depleting since year 2009, major biodiversity loss was observed and every monsoon there was an outbreak of vector-borne diseases. Urban flood & Water logging was also a common phenomenon post monsoon.

We got a project in April 2022, for 'in-situ' rejuvenation of six Waterbodies spread across the city on the periphery, through our Nature-based Solution (NbS) that we call as 'Cownomics Technology', wherein we focus on 'resurrection of the native ecology' of the Waterbodies & wetlands with a clear objective of 'restoration of the 'ecosystem services'.

As a result, the ground Water recharge was reported by August, 2022. There was steep decline in post monsoon vector-borne diseases (as observed and reported by the residents in the vicinity). They won the National Award for Best work in Air pollution mitigation (for last 360 days their AQI is recorded below 80). Return of birds, bee, butterflies and aquatic life has been observed in all ponds. And the Water quality is maintained as per IS 2296, class B category for outdoor bathing Water, as per the guidelines of National Green Tribunal (NGT).

Projected Precipitation Extremes over a transboundary River Basin under 1.5˚C, 2˚C and 3˚C Global Warming Levels

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ABSTRACT

Studying projected precipitation extremes over a transboundary river basin is crucial for understanding climate change impacts on water availability and distribution, which can affect international water management and cooperation. In the present study, we have computed the precipitation extremes over a transboundary river of Nepal and India (Rapti river) under 1.5˚C, 2˚C and 3˚C Global Warming Levels using multi-model ensemble CMIP6 dataset. Four extreme precipitation indices like CDD (Consecutive Dry Days), CWD (Consecutive Wet Days), PRCPTOT (Annual contribution from wet days i.e, annual total precipitation from days ≥ 1mm), and R95 (Annual contribution from very wet days i.e, annual sum of daily precipitation > 95th percentile) were used in this study.

Our results indicate that the maximum and minimum values for CDD are 291 days and 22 days, respectively. For CWD, the maximum and minimum values are 87 days and 4 days, respectively. The maximum PRCPTOT value is 3661.34 mm, while the minimum is 337.6 mm. The maximum R95 value is 1979.06 mm. The analysis shows a decrease in the annual precipitation trend at the 1.5˚C warming level, whereas there is an increasing trend at the 2˚C and 3˚C warming levels.

This research helps in preparing for extreme events like floods and droughts, ensuring the development of adaptive strategies to enhance resilience and sustain water resources for affected populations of both countries.

Keywords (*Precipitation, Global Warming Levels, Extreme precipitation indices, Trend analysis)*

Climate change adaptation via cross cutting methods for complete Water Security: A case study

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KEYWORDS
Ecosystem restoration, ecosystem based adaptation, climate resilience, cross cutting methods, carbon sequestration

ABSTRACT

The world is already experiencing changes in average temperature, shifts in the seasons, an increasing frequency of extreme weather events and other climate change impacts. Though we often think about human-induced climate change as something that will happen in the future, it is an ongoing process. Ecosystems and communities around the world are being impacted today. The faster the climate changes and the longer adaptation efforts are put off, the more difficult and expensive it could be. In this paper the author attempts to present the cross-cutting role that climate change plays in varied sectors especially the water sector and how concepts like ecosystem-based adaptation is a strategy that if adopted timely will address and fulfill achievement of all 17 Sustainable Development Goals by 2030. These ambitious goals are ideals for any civilized society in an attempt to achieve water security, eradicate poverty, ensure food security, health, education, gender parity, livelihood generation etc. The author underscores the significance of adaptation and to ultimately arrive at the successful completion of all targets set in 2015, over a period of 15 years, of which only 6 years remain.

The author presents the Case Study of North-East India as an example of integrated synergies amongst water, food, livelihood, education, gender equality and ecosystem restoration to achieve peace, partnership and prosperity and combat climate change. India Water Foundation in collaboration with Meghalaya Basin Development Authority ideated upon raising resilience and adopting adaptation through IBDLP Programme that transformed a subsistence-based community into entrepreneurs, empowered with entrepreneurial capacity as they took ownership of their lands for optimum, sustainable utilization. This Model serves as an example for regional South- South cooperation and implementation in States of Meghalaya, Sikkim, Mizoram and Nagaland through localization and ecosystem based adaptation. Political will remains integral to achieve success. The author will discuss in detail how cross cutting transversal systemic approach cannot only address water insecurity, climate change but also contribute to improving socioeconomic parameters of stakeholders. How adaptation techniques adopted across sectors like water, energy, agriculture, waste handling etc. can increase the resilience of communities to the potential impacts of climate and aid in achieving complete water security.

Analysis of historic Extreme Climatic Events of Gomti River Basin

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This study aimed to analyze historical extreme climate events in the Gomti River basin, India, during the period from 1951 to 2013. Four temperature indices were selected: minimum of minimum temperature (TNn), maximum of minimum temperature (TNx), minimum of maximum temperature (TXn), and maximum of maximum temperature (TXx). Additionally, three precipitation indices were chosen: maximum 1-day precipitation (RX1day), maximum 5-day precipitation (RX5day), and total annual precipitation (PRCPTOT). To investigate these extreme temperature events, the Mann-Kendall test (MK test) was employed. The results indicate a significant decreasing trend for TXn and TNx during 1951-2013. No significant trends were observed for TNn, TXx, RX1day, RX5day, and PRCPTOT indices across many stations during the same period. This study contributes to understanding the shifting patterns of extreme climate events in the Gomti River basin.

Keywords: Extreme climate, trend analysis, Gomti river basin

Smart Laboratory for Clean Rivers- An Indo-Danish Collaboration Approach to Clean Rivers

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Climate change and anthropogenic stress have severely affected ecosystems and water bodies and exploited natural resources all over the globe. India being the home of 18% world's population, has highly polluted rivers. To counter all these issues a holistic river rejuvenation plan is needed that tests, innovates and implements sustainable solutions in the river space for sustainable river management. Smart Laboratory for Clean Rivers (SLCR) an Indo-Danish collaboration project, provides a living lab setup that brings all the stakeholders together to engage, learn, co-create and experiment for a clean and sustainable river that lasts for ages. SLCR has opted for a small catchment of the Varuna River for piloting, located in the Middle Ganga Basin in India. It's a major river flow in the city of Varanasi after the mighty Ganges. The Varuna River is a groundwater-feed river that currently facing several challenges to its existence. Considering the integrated approach of river rejuvenation, SLCR embraces various techniques and upgrades for rejuvenation. Likely, maintaining flow in the channel in the lean period, Managed Aquifer Recharge (MAR) is a proven technology. In SLCR, Floa TEM high resolution lithological data is used in MAR models to have better decision making for MAR structures in close proximity to the river to enhance the river aquifer exchanges. Furthermore, the concerns of quality in the river are a big issue. The river water is polluted with industrial waste (mainly textile), agriculture and pharmaceuticals. Moreover, the catchment is heavily populated. A city like Varanasi which is located in the last stretch of the river, generating almost 260 MLD of domestic waste in the catchment. The existing STP system is working at full efficiency. Instead of installed a new STP for the future, SLCR is upgrading those STP with IoT based system. SLCR also advocate nature-based solutions like reed beds. In search of micropollutants, SLCR is using fingerprint analysis to create unique chemical profiles of pollutants. However, rejuvenation attempts can not be possible without involving the entire catchment. A holistic water management plan that includes storm management, water harvesting structure to efficiently manage flow of water in the catchment and installation of several buffers zones to restrict pollutants entering into the river. Similarly, carbon (emission and sequestration) is also an important parameter for the catchment. SLCR has adopted 4 villages to make them carbon-neutral and water-positive. Moreover, for the 24×7 monitoring of the river and the catchment, robust IoT devices are going to be installed to observe, river and groundwater quality, groundwater level, river discharge and carbon emission in the catchment and ultimately provide fuel for the data analytics. In its completion, SLCR with provide a river restoration manual, which will strategize the detailed plan and way of implementation for stakeholders and local administrations to keep our rivers clean and sustainable.

Water Conservation Initiatives to Address Bangalore Water Crisis

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KEYWORDS
Bangalore Water Crisis, Groundwater Level, Eco restoration, Recharge structures, Water conservation initiatives

ABSTRACT

WATER CONSERVATION INITIATIVES TO ADDRESS BANGALORE WATER CRISIS

The water crisis in Bangalore, India, has been an ongoing issue exacerbated by rapid urbanization, population growth, and climate change. As one of the fastest-growing cities in Asia, Bangalore faces severe challenges in managing its water resources due to a combination of factors, including inefficient water management practices, inadequate infrastructure, pollution, and unequal distribution of water. Groundwater depletion has reached alarming levels due to excessive extraction for domestic, industrial, and agricultural purposes. Unregulated borewell drilling has further exacerbated this problem, causing the water table to drop rapidly. Of the nearly 13,900 borewells in Bengaluru, nearly 7,000 have dried up. Around 30-40% of the state's water needs are met through borewells. It is well known that the city has seen a 1055% bump in built-up areas, i.e., concrete structure and paved surfaces, in the last few decades. In addition, it has seen a staggering drop in the water spread area which has now been termed as the root cause of the depleting groundwater table across the city. Climate change has also played a significant role in the water crisis, with changing precipitation patterns leading to irregular rainfall and droughts. The monsoon season, which traditionally replenishes water reservoirs, has become increasingly unpredictable, causing water scarcity to become a recurring problem. According to the Central government's groundwater assessment 2023, all groundwater units in Bangalore (Urban) and Bangalore (Rural) are over-exploited. In Bangalore (Urban), the aquifers in Anekal, Yelahanka, Bangalore East, Bangalore North, and Bangalore South have been dug up much more than they are recharged. The situation is no good in Nelamangala, Doddaballapura, Devanahalli, and Hoskote units of Bangalore (Rural). To address the Water Crisis of Bangalore, The Art of Living-Vyakti Vikas Kendra India is putting tremendous efforts to construct around 10,000 groundwater recharge structures such as boulder checks, Recharge wells, Injection wells, Water pools, JalTara structures in alliance with Government, Corporates, Public and NGO partnership in Anekal, Bangalore East, Bangalore North, Bangalore North additional, Bangalore South along with Nelamangala, Doddaballapura, Devanahalli, and Hoskote units of Bangalore (Rural). The Art of Living has been working for the Water Conservation Projects since 2013 and so far, has rejuvenated Kumudvathi River in Bangalore Rural, Vedavathi River and Palar River through its unique model of Public, Government, Corporates and NGO partnership. The Art of Living has constructed more than 40,000 groundwater recharge structures like Boulder check, Recharge wells, Injection wells, Water pool, JalTara structures, planted more than 1.5 lakh trees, desilted 1.0 lakh CBM benefitting more than 13,000 Villages in Karnataka.

The Important Role of Forest-Water Nexus in Climate Change Adaptation and Mitigation

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KEYWORDS
Climate Change Adaptation, Forest-Water Nexus, Hydrological Resilience, Sustainable Forest Management, Water Quality and Availability

ABSTRACT

The forest-water nexus is crucial for formulating effective climate change adaptation and mitigation strategies, particularly concerning long-term water security. Forests and water systems are deeply interconnected. Forests significantly influence hydrological cycles through evapotranspiration, interception, and soil infiltration, while water availability and quality are vital for forest health and resilience. This paper examines how rising temperatures, changing precipitation patterns, and increased frequency of extreme weather events affect forest ecosystems. These impacts include altered species composition, increased susceptibility to pests and diseases, and heightened risk of forest fires. Climate change also alters hydrological cycles, leading to modified stream-flows and water quality, and more frequent droughts and floods. The paper focuses on adaptation strategies to enhance the resilience of forests and water systems. Sustainable forest management practices, such as selective logging, mixed-species plantations, and agroforestry, are emphasized for their ability to promote biodiversity, improve soil health, and sequester carbon. Water management practices like reforesting riparian zones, constructing check dams, and utilizing wetlands for water purification are also highlighted. Integrated landscape approaches are advocated for collaborative planning and management across sectors and stakeholders, considering the interdependencies between forests and water resources. Mitigation strategies include afforestation, reforestation, government initiatives, and enhancing forest carbon stocks through improved management practices. These strategies leverage forests as significant carbon sinks and reduce emissions from deforestation and forest degradation. Further, the importance of supportive policy frameworks, cross-sectoral coordination, and community involvement. Developing policies that promote sustainable forest and water management, encouraging stakeholder participation, and providing financial and technical support are critical for effective adaptation and mitigation. Engaging local communities in decision-making processes and recognizing their traditional knowledge are essential for the success of these initiatives. In conclusion, the paper advocates for an integrated approach to managing forests and water resources, emphasizing the need for holistic and sustainable solutions. By addressing the interdependencies within natural systems, such approaches can enhance resilience, reduce vulnerabilities, and contribute to global climate change mitigation efforts. The authors call for continued research, policy innovation, and collaborative action to fully harness the potential of the forest-water nexus in climate change adaptation and mitigation.

WC-2

Fostering Cooperation across shared Waters: A case study of Brahmaputra Basin

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KEYWORDS

Brahmaputra basin, water conflict, water governance, transversality, geo-politics to geo-economics

ABSTRACT

The Brahmaputra mega-basin shared between Nepal, China, Bhutan, India, and Bangladesh is one of the poorest, most densely populated, ecologically vulnerable, and socially and politically unstable areas in the world. As such, reducing the potential for transboundary water conflict by increasing cooperation, creating livelihood opportunities in the basin and eliminating tradeoffs between riparian states has been of increasing interest to transform geopolitical tensions into geo-economic opportunities. These factors make collective action more urgent if they are to increase joint basin management and strengthen water-sharing institutions, build trust and work toward outcomes based on principles of water justice.

This paper is based on a close examination of open-source information which reveals that China's resistance to addressing India's and Bangladesh's concerns about the flow of Brahmaputra water downstream and regular data-sharing has been a source of friction, particularly between China and India. The policy shift in China's 14th Five-Year Plan unveiled in November 2020 emphasizing further dam construction on the Chinese side of the Brahmaputra River has reportedly reinforced India's suspicions that Beijing's ultimate aim is to divert the river's water to gain leverage over India by controlling the flow of the River, just China has done by restricting water flow along the Mekong to downstream Southeast Asian countries. Bangladesh, the lowest riparian in the Brahmaputra, is the most affected by dam construction activities undertaken by China and India, in terms of sedimentation as a result of upstream activities. India and Bangladesh have a Farakka Barrage agreement in place on sharing the water of the Ganga River and the failure to negotiate a water-sharing agreement on the Teesta River, a tributary of the Brahmaputra River representing a sore spot for Bangladesh-India relations, signifies a lack of progress on water issues between India and Bangladesh. Construction of a dam in an area overlaid with claims and counterclaims coupled with the lack of political trust is the problem that entails the potential of exacerbating resource competition in this region.

What ails the Brahmaputra Basin management is the under-institutionalized management of Brahmaputra, the absence of any multilateral water-sharing accord between China, India, and Bangladesh, and bilateral cooperation limited to periodic meetings and hydrological data-sharing agreements, most of which have been subject to failure. The global focus on climate change has added urgency to 'fixing' transboundary water conflicts because water resources play a central role in disasters emanating due to climate change. The under-institutionalized management of Brahmaputra basin, absence of any multilateral water-sharing accord and limited bilateral cooperation are the issues to be addressed.

This paper examines research questions of exploring means of forging close cooperation between Bangladesh, China, and India in water sector that could lead to a tripartite treaty on water-sharing and averting confrontation along with the frequent flow of data-sharing on regular basis.

THEME:-COLLABORATION AND COOPERATION FOR WATER SECURITY
SUB-THEME:-FROM WATER CONFLICTS TO COOPERATION
PAPER TOPIC:-"EVERY DROP OF WATER IS CRYING FOR PEACE"

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Keywords
Inheritance, conflicts, diplomacy, Sustainable Development Goals, trans-boundary

ABSTRACT

"The earth, the air, the land, and the water are not an inheritance from our forefathers, but on loan from our children. So we have to handover to them, at least as it was handed over to us." -- Mahatma Gandhi ji.

If an individual goes over the history of mankind then it is very easy to trace the fact that water is an invaluable resource to mankind and almost all activities of human beings revolve around or are closely related to availability, quality and quantity of the water resource. Population growth, industrialisation, growing overuse and pollution as well as the consequences of global warming result in a constantly increasing pressure on the global water resources. Water scarcity often leads to competition and disputes among communities and nations, making it imperative to recognize water as a potential catalyst for peace building amongst nations.

Efforts to build water infrastructure, facilitate diplomacy around shared water sources, and implement sustainable water practices can lay the groundwork for peaceful coexistence. More than 3 billion people worldwide depend on water that crosses national borders. The world's 263 international river basins cover 45.3 percent of Earth's land surface, host about 40 percent of the world's population, and account for approximately 60 percent of global river flow. Strikingly, territory in 145 nations falls within international basins, and 33 countries are located almost entirely within these basins. As many as 17 countries share one river basin, the Danube. India also having trans-boundary water conflicts since many years. As the world became aware about water conflicts the United Nations and other Human Development Organizations took initiative for various peace building tools to resolve conflicts for the betterment of mankind and to achieve in every respect by the end of 2030.

Now one have to consider water as a tool for peace and not for conflicts with a motto of urgent need to work together to protect and conserve our most precious resource. Cooperation and mutual understanding amongst the nations and states must be made on water sharing in a peaceful manner. We do not need now violent conflict to prove water is a matter of life and death. Water -being international, indispensable, and emotional-can serve as a cornerstone for confidence building and a potential entry point for peace.

The international community can work together to ensure that water resources become a source of cooperation rather than contention. The outcome from **India Water Week-2024** may inspire individuals, communities and governments to prioritize water as a tool for peace and may focus on the critical role water plays in ensuring stability and prosperity of the world. The deliberation form IWW-2024 will certainly stop crying of water to achieve universal peace.

Let us commit to fostering a culture of responsible water management & cooperation, ensuring that water is a catalyst for peace for the betterment of people of the world.

Indus Water Treaty: preventing conflicts and promoting cooperation between India and Pakistan

Abstract

Water cooperation is critical for riparian countries to fairly divide and use their transboundary water resources. The Indus Waters Treaty is a significant bilateral treaty between India and Pakistan that governs shared rivers. Unlike treaties in other basins, which divide rivers based on flow or quantity, the Indus Treaty splits the Indus River system into three eastern and three western rivers. This treaty establishes a mechanism for cooperation with regard to the Indus River Basin. However, some obstacles disturb cooperation, such as the continuous construction of disputed dams, the Indian regional water hegemony strategy, the persistence of historic hostilities, and the debate of the Kashmir problem in bilateral talks for peace. Although the Indus Water Treaty establishes persistent and symbiotic cooperation between the countries. This research explores the key provisions of the Indus Water Treaty for preventing conflicts and promoting cooperation between the countries.

Keywords: *Transboundary water resources, Indus Basin, Indus Water Treaty, Conflict management, Water cooperation, Bilateral water treaty,*

Conflict to Cooperation Potential of Deterministic Water Sharing Agreements: Challenges and Ways Forward

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KEYWORDS
WATER CONFLICTS, WATER SHARING AGREEMENTS, PAP, CWDT, DETERMINISTIC AGREEMENTS

ABSTRACT: (9 pt)

Intensified competition worldwide over water resources has increased conflicts. Population growth, economic development and changing regional values are some of the reasons for this intensified competition. Water conflicts have many dimensions, and they can be grouped into many categories. Conflicts are predominant in trans-boundary waters. They all originate from the increasing concern about access, equity and the response to growing needs. Water sharing agreements between the parties are one of the best pathways in 'Conflict to Cooperation'. Potential Conflict to Cooperation Potential (PC-CP) is an important paradigm being considered worldwide. Generally, these water sharing agreements are made deterministic because of its easiness in conceptualising and implementing. Compared to deterministic water sharing agreements, stochastic water sharing agreements are more climate resilient and sustainable. However, arriving at a stochastic water sharing agreement requires reliable long-term data sets and precise climate change impact predictions. Due to this limitation, most of the water sharing agreements are drawn in a deterministic fashion. Even in the case of these deterministic water sharing agreements, several conflicts are triggered over a period due to many unforeseen factors. This paper investigates the main challenges in realising the conflict to cooperation potential of the deterministic water sharing agreements. The investigation is based on two case studies of deterministic water sharing paradigm. The agreement between Kerala and Tamil Nadu on Parambikulam Aliyar Project (PAP) and the imposed agreement between Karnataka, Tamil Nadu, Kerala and UT of Pondicherry based on the final verdict of Cauvery Water Disputes Tribunal (CWDT) are analysed in the current context to explore their PC-CP status. The analysis shows that conflicts are predominant in both the cases and further considerations are required for their hydrological and environmental sustainability. A few thoughts on the ways forward are also suggested. This paper is organised in five sections. In the introductory section water conflicts and water sharing agreements are discussed. This is followed by a section on the general nature of deterministic and stochastic water sharing agreements. Third section discusses the PAP agreement and the CWDT settlement agreement. Analysis of water sharing agreements in the current context is presented in the fourth section and the suggestions on ways forward are discussed in the concluding section.

INTEGRATED WATER RESOURCES DEVELOPMENT & MANAGEMENT

WC-3

“Insights into The Emerging Trends in Groundwater-Surface Water Interactions”

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KEYWORDS
GW-SW interactions, Contaminant Transport, Numerical Modelling, Bibliometric analysis, Biblioshiny, R-studios, Integrated Water Resource Management

ABSTRACT
The interaction between groundwater (GW) and surface water (SW) is vital for water balance, ecological integrity, and water resource quality in diverse regions as contamination of one system affects the other. Comprehensive knowledge of numerical tools, field methods and their application trends for SW-GW interaction is still insufficient. This study aims to identify emerging trends in GW-SW interaction through bibliometric analysis. The Biblioshiny R-toolbox was utilized to assess bibliometric indicators using data from the Scopus database from 1980 to 2022. The findings indicate that between 1980 and 2010, there were relatively few publications on GW-SW interactions. There has been a significant increase in publications since 2010, focusing on water resource management, GW pollution, and environmental monitoring from 2015–2017, shifting to risk assessment concerning environmental impact and human health from 2021 onwards. Researchers predominantly hail from Western Europe, including the United States, the Netherlands, Canada, and Australia. However, contributions from Low to Middle Income Countries (LMICs), except China, remain limited. Various models are used to analyse flow dynamics and solute transport between SW and GW; MIKE SHE, SWAT-MODFLOW, GSFLOW, and FEFLOW are extensively used. Geophysical, hydrogeochemical, hydraulic, heat tracer, and remote sensing are the most frequently utilized field methods. Earlier research focused on quantifying SW-GW interaction, with recent emphasis on contaminant transport simulation. (Sub)-surface parameters like hydraulic conductivity, recharge, runoff effects, water table levels, and geographic data are explored. The findings of this study show a growing interest in SW-GW interaction studies in general and solute transport in particular, and these results would help researchers select an appropriate model for effective water resource management.

Geo-Morphometric Study of Watershed Using Remote Sensing (RS) and Principal Component Analysis (PCA) Technique

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KEYWORDS

Remote Sensing, morphometric parameters, Dendritic Drainage Basin, PCA Techniques, Long-term sustainability

ABSTRACT

This study focuses on utilizing geo-morphometric parameters, Remote Sensing (RS), and Geographic Information Systems (GIS) to manage hydrological processes, such as runoff, in the Beas River watershed, which extends up to the Pong Dam, covering an area of 12,606 km². By employing a geospatial model along with Principal Component Analysis (PCA), the research aims to prioritize sub-watersheds within this region. Initially, the watershed was divided into eight sub-basins along the main river based on various morphometric characteristics, which include linear, areal, and relief aspects. The Beas River, classified as a 4th-order river, displays dendritic drainage patterns across its sub-watersheds, which was a primary focus of the analysis. PCA was applied to identify redundant morphometric parameters, facilitating a more efficient approach to watershed prioritization. A total of 21 morphometric parameters categorized into three aspects were analyzed. The study also assessed the erosion potential of streams within the watershed, which collectively span 1,615.85 km. The results highlighted sub-watersheds 7, 5, and 2 as high-risk areas, emphasizing the urgent need for soil and water conservation measures in these regions. These findings provide a crucial foundation for developing policies and practices aimed at reducing peak flooding and promoting long-term sustainability in the watershed area.

Challenges in Rolling out Conjunctive Water Management Plans: Case of Chalakudy Subbasin in Kerala

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KEYWORDS

Chalakudy sub basin ,Conjunctive water management plan, CROPWAT, CRDS, Water Use policy.
Arial 10pt

ABSTRACT

Integrated Water Resources Management (IWRM) is reckoned as an effective tool for sustainable and climate resilient water management at basin level. Integrated planning and conjunctive use of surface and ground water are essentially required to make IWRM a reality. However, there are several challenges in executing conjunctive water management plans at basin level, particularly in Indian context. Some of these important challenges are intertwined with inappropriate institutional arrangements at local level, absence of regulatory mechanisms with overarching framework, lack of sufficient datasets, territorial jurisdiction issues and the stakeholder capacity building initiatives. This paper discusses an action plan to roll out a conjunctive water management plan at basin level. The case of Chalakudy sub basin in Southern Peninsular India for which a conjunctive management plan is already developed is presented in this paper. A brief introduction followed by four major sections build this paper. The salient features of Chalakudy sub basin including its interstate water sharing agreement ramifications are presented in the first section. The second section depicts key features of its conjunctive management plan. Issues to be addressed in rolling out this plan as identified by the informal stakeholder consultations are presented in the next section. The paper concludes with some way forward thoughts and suggestions on its implementation protocol. .

Water Conservation Initiatives Through Project JalTara

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KEYWORDS
JalTara Structures, Increased Groundwater Level, Water conservation, Groundwater recharge, Jalna Maharashtra

ABSTRACT:

WATER CONSERVATION INITIATIVE THROUGH PROJECT JALTARA

To address the water logging situation in the Jalna district of Maharashtra, we came up with the concept of JalTara Recharge Structure in the Farmer's land. We carried out two pilot JalTara project in the summers of 2021 and 2022 in 37 villages of Jalna district by making 20,000 recharge structures with the increase of groundwater recharge level, zero waterlogging in the farmer's fields, increased crop production, and economic benefits. Third party done Impact Assessment studies of JalTara structures in Jalna have shown that the water levels in the wells have gone up by 14 feet in the area, and the crop yield has increased by 42% enabling farmers to go for multiple cropping. This has not only more than doubled farmers income but also provided better employment opportunities to the local people in the villages itself which can lead to stop reverse migration of people from rural to urban side. The unique JALTARA approach is to create Recharge Structures of 4 feet x 4 feet x 6 feet deep at the lowest point within arable acre-plot of land. This structure is then filled with varying sizes of rocks. This arrangement enables rainwater to bypass the dense impervious topsoil. Structure will have two fruit bearing trees on the two sides of structure which enables rainwater to bypass the dense impervious topsoil to recharge the Groundwater. One JalTara Structure recharges nearly 3,00,000 (3.0 Lakh Liters) of groundwater per annum, so, 20,000 such structures may contribute 6,00,00,00,000 (600 Cr. Liters) of groundwater per annum. Our standardized methodology helped us to scale-up the construction of JalTara structures in 3 to 4 month's time. So, far we have constructed nearly 45,000 JalTara structures, 90,000 Saplings planted, in more than 115 villages of the Jalna district, Maharashtra by covering 1,70,000 acres of farmland. Theoretically 45,000 JalTara Structures might have contributed 13,50,00,00,000 (13.5 Billion Liters) of groundwater per annum. The outcomes of this project have been appreciated by the Government of Maharashtra (GOM) and recently, we have signed an MOU with GOM to address the water management under the project "JALTARA" in all districts of Maharashtra. To address the water crisis of Bangalore, we have been implementing JalTara structures in the rural Bangalore for Rain water harvesting and increase the groundwater levels. We have signed an MOU with the state government to prepare JalTara structures as Jal Sanjeevini in entire district. Our JalTara vision for solving India's groundwater crisis within five years is: 1 Lakh Villages, 5 Crore JalTara Recharge Structures will recharge 15 Trillion Liters of groundwater per year across India in five years.

Changing land use with a decline in the number of water bodies in India: A big concern for groundwater resources, particularly for the Urban Clusters

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Abstract

The groundwater and surface water resources are intrinsically related, where the health of one affects the health of the other. The present work tries to correlate the number of water bodies (ponds, tanks, reservoirs, water conservation schemes/percolation tanks/check dams, lakes and others) in any area with the depth to water levels, and the stage of groundwater extractions as estimated by Central Ground water Board (2022). The state-wise numbers of water bodies, as enumerated in India (6th Minor Irrigation Census 2023, reference year- 2017-18) reflect a clear positive relation with the average depth to water level (DTW) in the state. In major cases, the states with deeper water levels show a lesser number of surface water bodies and vice versa. Some of the states and Union Territories (UTs) (Delhi, Gujarat, Haryana, Madhya Pradesh, Punjab, Rajasthan, Chandigarh, Goa, and Pondicherry) with groundwater extractions exceeding 70% of the annual recharge at several parts show the average DTWs beyond 10 m bgl owing to low density of water bodies in them. In contrary, some other states (Andhra Pradesh, Maharashtra, Tamilnadu, Telengaga, and Uttar Pradesh), in spite of having several segments with groundwater extractions exceeding 70% of the recharge, show the average DTWs levels less than 10 m bgl owing to high density of water bodies in them. In last several decades, there has been shrinkage of surface water bodies in India in their number, area of spread, water storage capacity, and the gross annual water yield, besides their pollution. Expansion of agriculture unplanned urbanization, encroachments, and construction of roads/ rails/ houses/ industries are the leading reasons of vanishing water bodies, other than their siltation and drying up.

Post independence, India has witnessed rapid urbanization. During the period of 2010-18, around 34% of the Indian population lived in urban clusters, and it is estimated that by 2050, more than 50% of the country's population will live in urban areas. Around 50-80% of the urban drinking is supplied from surface water bodies including rivers. The number of water bodies has declined to the tune of 10-95% across the cities in India. In such conditions, owing to increase in pressure on the aquifers aggravated by low recharge owing to unsuitable land cover, the groundwater has gone to unsustainable levels of deeper than 50 m bgl in parts of several cities (e.g., Delhi, Bangalore, Jaipur, Hyderabad). Such scenarios make the aquifers in urban areas more vulnerable to groundwater pollution owing to the seepages from the waste dumping, septic tanks, and sewages, other than the risk of release of toxic trace elements (e.g., uranium, cadmium, nickel, lead, zinc, cobalt, selenium) through oxidation processes in the thick vadose zone.

Keywords: Water bodies, Groundwater, Water level, Groundwater extraction, Urban clusters

A Sustainable Solution Maharashtra Water Crises

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KEYWORDS
Water crises, Pipe line water, Water security, Sustainable solution, grid, Gravity flow

ABSTRACT

Water crises of unprecedented nature is being felt in Indian state of Maharashtra for last few years. There are peak floods during monsoon period but in the same region there is no water during summer months. Some regions chronically face droughts and the rivers currents get webbed. Some reservoirs overflow during monsoon whereas some do not even get filled up to the designed capacities. Thus, spatio-temporal natural distribution of water is highly uneven. On the other hand, water demands are increasing rapidly causing conflicting situations and socio-economic crises. In fact, water management is one of the biggest challenges the state is facing to overcome these issues, in this study an attempt is made to develop an "inter basin water transfer pipeline grid" for the river basins in the state of Maharashtra with the objective of transfer of water from surplus to deficit regions on both spatial and temporal scale. Major storages in all the river basins of Krishna, Godavari, Tapi and West Flowing rivers of Konkan region in the state are tagged at the geo-referenced locations on the Digital Elevation Model (DEM) of Maharashtra. Using the DEM to contour operation in Arc-GIS, morphology of the basins and FRL&DSL of each of the selected reservoirs, the pipe line water grid is delineated for intra basin as well as inter basin regions in the state. An attempt is made to ensure gravity flows in the grid. Though there can be several links possible, the pipeline grid proposed in this study consists of 31 intra-basin and 19 inter basin links with 1.8 m diameter concrete pipes to be running alongside of the existing road network, state and national highways. The proposed pipeline grid can operate as and when required but with emphasis is to operate during monsoon so that maximum volume of waters can be transferred from spilling reservoirs to deficit reservoirs. It can also operate during non- monsoon periods to serve the scarcity regions. Since the proposed water pipeline grid is designed for gravity flows, ensuring least transit losses and no major land acquisition issues involved, this inter basin pipeline water grid can fulfill substantial water demands of public water supply as well as irrigation and prove to be an effective and sustainable solution to mitigate the water crises the state is facing.

THEME: -INTEGRATED WATER RESOURCES DEVELOPMENT AND MANAGEMENT

SUB-THEME:-ROLE OF INTERBASIN WATER TRANSFER IN WATER RESOURCES DEVELOPMENT

PAPER:-INTERBASIN WATER TRANSFER- A MASTER KEY FOR PROSPEROUS INDIA

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KEY WORDS

Inter Linking, National Perspective Plan, Floods & Draughts, Water Resources Department,Himalayan-Peninsular

ABSTRACT

Even though the blessing of rain God to about 800 Crores children of this earth, yet world is witnessing floods and even draughts. In India we have about 5334 Major-Large-Dams and about 447 are under pipeline even though we are having good storage capacity, it seems not sufficient.

In this situation here comes a tremendous and fruitful concept of “Inter Basin water transfer” which in reality may make every country prosperous in every respect. An inter basin water transfer has been defined as “the transfer of water from one geographically distinct river catchment, or basin to another, or from one river reach to another” (Davies et al.1992). There are dozens of large inter-basin transfers around the world, most of them concentrated in Australia, Canada, China, India and the United States.

Dr.K.L.Rao, a dam designer and former irrigation minister proposed "National Water Grid”@1970. The then Ministry of Irrigation formulated a National Perspective Plan (NPP) for Water Resources Development in 1980 envisaging inter basin water transfer and planned the project in two parts- the Himalayan-14 rivers & Peninsular Components-14 rivers. Accordingly 185 billion cubic metres of water storage along with building inter-links. Nearly 170 million acre feet of more water will be available in India to irrigate 35 million hectares in addition, generation of 40,000MW capacity hydropower, flood control and other benefits in the field of water resource development. In addition to these, the Inter linking of rivers project claims to generate total power of 34 GW out of which, 4,000 MW from the peninsular component & 30,000 MW from the Himalayan component, more Ground Water Recharging. It will contribute to flood and drought hazard mitigation for India and aims at increasing food production from about 200 MTs a year to 500 MTs and much more benefits will be achieved after the completion of such projects.

Inter basin transfer of water have also Impact of the Climate change: Human cost: Huge financial cost: Impact on ecology and biodiversity: International Challenges: Political Challenges. The government is proposing a canal irrigation method for transmitting water from one area to the other & hence maintenance of canals is also a great challenge; Further, the government has to acquire large-scale lands for the smooth implementation of the project which is not easy.

We hope that Indian technocrats and management experts will solve such issues and India will become prosperous and will be known as Developed Nation in the coming years. In my full length paper, I shall be presenting detailed information about various Inter basin water transfer projects. I Hope that the committee will find my inputs valuable and provide me an opportunity to present the same. Jai-Hind.

JAL SAMRIDDHI
A Sustainable Approach Towards River Linking In India

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KEYWORDS
Jal Samriddhi Project, Cost-effective, Flexible execution, River interlinking, Pipeline method

ABSTRACT

The project of Jal Samriddhi aims to be cost – effective and flexible in its execution. It ensures no disturbances to both human habitat and the ecosystem. The project follows a natural approach where maintenance and management will be convenient. The fundamental methodology involves interlinking rivers through pipelines embedded in the ground. This enables easy connectivity and distribution of water to multiple rivers and tributaries. Flow valve management systems and turbines for power generation are incorporated. The project includes pumping stations at collection and distribution junction wells. The pipeline network covers various zones such as A, B, C, D, E, F, and G, connecting different rivers in regions across India. The project also includes a U-shaped loop between Karnataka and Tamil Nadu, covering the extended Nilgiris hills.

Diversion of west flowing rivers for the benefit of uplands in Maharashtra

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Keywords
Surplus waters, Rain shadow areas, Raising mains, Local use, Irrigation, Domestic

India gets the early rains in westernghats during monsoon and lot of streams which originated in westernghats are flowing towards narrow strip of west coast and draining into Arabian sea. At the same time the eastern patches of these ranges become rain-shadow and gets very less rainfall. Several attempts were made in the past for proper utilization of these waters, yet the fuller utilization of the waters could not take place due to non-availability of culturable land and topographical constraints.

National Water Development Agency (NWDA) on the request of Govt of Maharashtra carried out the detailed studies of Damanganga (Ekdare) - Godavari link project

The Damanganga (Ekdare) - Godavari (Waghad) link project envisages diversion of surplus flows of west flowing Damanganga basin by lift from the proposed Ekdare project to serve the water short Marathwada region in Maharashtra through Existing Jayakwadi Reservoir project. The water available for utilization is 100.569 MCM out of which 15% of utilization (15.09 MCM) is reserved for local use as per Govt. of Maharashtra resolution and remaining 85.48 MCM will be lifted in three stages to existing Waghad reservoir in Upper Godavari sub-basin. The diversion is proposed during the months July to October (123 days).

Ekdare dam is proposed on Damanganga river in Nashik district. With FRL of 374.0 m and corresponding live storage capacity of 29.56 CM. The length of the dam is 292.367 m. and the height is 77.50 m with submergence area of 231.30 ha. The land acquisition required for the proposed Ekdare dam is about 188.15 ha including forest area of 39.6 ha. The total land acquisition required for the whole project will be about 207.50 ha of which 42.95 ha is under forest.

The conveyance system comprises of 10.84 km long 2 MS raising mains The maximum discharge in the conveyance varies between 13.06 cumec at the head and attains 14.19 cumec at Nirgude.. The total lift is of 351.43m in three stages at Ekdare, Nirgude and Jharlipada with static head of 110.13m, 158.65 m, and 82.65m respectively and total power requirement will be about 106 MU.

Out of the total utilisation, 74.0 MCM will be used for irrigation, 14.63 MCM for domestic, 9.819 MCM for industrial uses and the remaining 2.12 MCM will be lost in transmission. The link project will provide irrigation to about 13966 ha annually (2987 ha in local Ekdare, Nirgude, Aad and Lingavane) and 10979 ha in Aurangabad district under Jayakwadi command. The project is proposed to be constructed in seven years. The B C Ratio of the link project is 1.46 and the IRR will be about 12.85

INTER BASIN WATER TRANSFER - OPPORTUNITIES AND CHALLENGES

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KEYWORDS : Inter basin, floods, droughts, transfer, linking.

ABSTRACT: This paper highlights the significance of Inter Basin Water Transfer or Interlinking of Rivers (ILR) to address inequitable distribution of water in country. There is spatial non uniformity in rainfall and large amount of unutilised water drains into sea. This paper discusses the benefits of Interlinking of Rivers and key challenges being faced by this huge engineering venture. For successful implementation of these projects, cooperation among concerned States is the basic requirement. Considering the likely changes in climatological, hydrological and socio-economical scenarios, water management has become inevitable and need of the hour is to ensure efficacy of a holistic approach for water development and management. The paper mentions few existing Interlinking of Rivers projects in India and their status to give a clear overview of the concept of Inter Basin Water Transfer.

Critical review of Manas-Sankosh-Teesta Link- A case for prosperity of India

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KEYWORDS
Mana,Sankosh,Tista,Socio-economic,rainfall,mother link

ABSTRACT: (9 pt)

Under River Linking program of Government of India, the Manas-Sankosh-Testa-Ganga (MSTG) link is mother link for transferring water up to south India. The present research work is done to critically review the bottleneck in implementation of MSTG link and how to have most sellable solution with win-win situation for all stakeholders The Manas,Sankosh and rivers in between these rivers have significant flow of water going waste to sea. It is observed that the project is envisioned with three alternative along with tapping water from Aie,Raidak ,Torsa and Jaldhaka Rivers .Depending on the negotiations for the Manas Dam three long term solutions are proposed. In Alternative 1, there is a provision to build a dam on the Manas and Sankosh river. Alternative 2 has no provision to build the dam on the Manas River but involves taking uncontrolled flow from the river. In Alternative 3, there is no provision to take water from the Manas and Aie Rivers. It is found that due to intense rainfall, high groundwater recharge, and substantial river discharge are vulnerable issues and the complexity of the region poses serious challenges for success of such a mega project

.It is concluded that in order to improve the socio-economic conditions of the region as well as benefitted parts in parts of India, alternate 1 will truly establishing's it as the mother link.

A Multicriteria Decision Making Framework for Flood Management by Incorporating Inclusive Planning Process in Inter Basin Water Transfer

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ABSTRACT

Floods and droughts are the hydrological extremes that India witness every year, floods occurring in some parts of the country and droughts are befalling in some other parts either at the same or staggered time. Floods are not only causing human and economic losses, but also affect the environment and society negatively to a greater extent. The past practices show use of several structural and non-structural measures to mitigate floods, but they have not been able to solve the flood problem effectively and society at large has disagreed on methods and their efficacy resulting in widespread diverging views and concerns because of losses and threat to life and livelihood. With these viewpoints, the present paper focuses on the development of a new multicriteria decision making framework that has a paradigm shift in flood management from conventional structural measures to an integrated comprehensive flood management approach in which structural measures are complemented with non-structural measures and involves inclusive planning process to incorporate human-flood interaction mechanisms and feedback and multi-basin hydrology to incorporate surface water-groundwater linkages to tackle adversaries of flood and water scarcity simultaneously. It combines the hydrological water balance model with the river hydraulic model, socio-hydrology model and multicriteria decision making to arrive at the best acceptable sustainable solution for inter-basin management of water resources. To demonstrate the applicability of the developed framework, a case study of the purposed Burhi Gandak-Baya link for inter-basin water transfer has been presented. Results were obtained for several plausible scenarios of inter basin water transfer that help in understanding of water surplus, water deficit, flood risk, and groundwater suitability for extraction under different climate and social acceptance configurations. The social processes were integrated through the structured questionnaire survey and the flood inundation and severity have been obtained using HEC-RAS model. This study shows that an innovative inter-basin water transfer approach that tackles groundwater scarcity and reduces flood risks efficiently manages the Burhi Gandak basin, which is the donor, and the Baya basin, which is the acceptor. The inclusive planning process enables us to incorporate interactions between hydrological and social processes prevailing in both basins connected through inter basin water transfer scheme. The findings of the study would be useful in managing floods as well as water scarcity and well-being in both basins.

Keywords: Flood, Inclusive Planning, Inter Basin Water Transfer, Multi-criteria Decision Making

Why Ken-Betwa Link is balance between Environment and need of water starved Bundelkhand region

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KEYWORDS
Adverse,mitigation,inter-state,Bundelkhand,water starved

ABSTRACT: (9 pt)
Interlinking of Rivers Programme of the country will be a real push towards countries water security as well as to mitigate adverse impact, climate change. The successful completion of individual project under interlinking of rivers shall resolve the dual phenomena of flood & drought syndromeThe present study has attempted to evaluate the adverse impact vis-a vis mitigation steps taken by Ken-Betwa Link Project Authority (KBLPA)which has moved a lot towards concerns. It has been assessed that the project has kept a healthy balance between environmental concerns, afforestation issues, and mitigation measures of wildlife with compared to huge benefits of 11 lakh ha. Irrigation. To critically visualize public view and analysis for acceptability of KBLP Review of existing status of micro irrigation and interlinking of rivers and Public views and analysis has been done for replacement of traditional irrigation with micro irrigation for various ILR projects.

Innovative Groundwater Management: The Impact of the Shirpur Pattern in Dhule District, Maharashtra

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KEYWORDS
Groundwater management, Shirpur Pattern, Water scarcity, Water harvesting, Climate change

ABSTRACT:
Groundwater management is crucial for addressing water scarcity, particularly in regions susceptible to irregular rainfall and drought. This study focuses on the implementation of the Shirpur Pattern, an innovative watershed management approach, in Shirpur Taluka of Dhule District, Maharashtra. The Shirpur Pattern employs strategic water harvesting and conservation techniques tailored to the unique geological composition of the Deccan Plateau, which includes layers of black soil, sand, silt, and gravel. The research examines the principles behind the Shirpur Pattern and its application in groundwater management. Results indicate significant improvements in water availability and agricultural sustainability in the region. The Shirpur Pattern has proven effective in mitigating the adverse effects of climate change, such as alternating droughts and floods, by enhancing the resilience of local water resources. This paper highlights the transformative impact of the Shirpur Pattern on groundwater management, demonstrating its potential to serve as a model for other water-scarce regions facing similar challenges.

SUSTAINABLE WATER RESOURCES MANAGEMENT IN THE STATE OF BIHAR

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KEYWORDS

Sustainable, Integrated, River Basin, Climate Change, Water Governance

ABSTRACT

The paper emphasizes the critical importance of sustainable water resources management in Bihar, highlighting the increasing demand for water due to various factors like climate change, population growth, industry, and agriculture. It stresses the need for efficient planning and management to prevent water scarcity in the future. Bihar's unique geographical position and climatic conditions are discussed, along with the challenges of over-appropriated river basins leading to conflicts over water use. The complexity of water control structures and hydrologic systems in Bihar is outlined, underscoring the necessity of an integrated approach for effective river basin management. The paper advocates for an integrated Ganga River Basin Management strategy to achieve sustainable water management in Bihar, recognizing the need for tailored recommendations based on individual state water governance structures.

WC-4

A Comparative Analysis of HydroRAM and SWAT Hydrological Models for Runoff Simulation: A Case Study for the Teesta River in Sikkim

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Abstract

The Teesta River is a significant river in the Indian state of Sikkim. The River is an essential water resource for Sikkim and the surrounding regions, playing a critical role in their ecological, economic, and cultural landscapes. The current study assessed the effectiveness of two hydrological models, HydroRAM (developed by RTI) and the widely used SWAT, in simulating runoff in the Teesta River. The models' performances were compared based on monthly simulation results, with the river's outlet considered at Domohani. The models utilized rainfall and temperature data from the India Meteorological Department, along with global soil maps from the Food and Agriculture Organization and global land use/land cover data from the USGS. The observed discharge data at Domohani was obtained from the Central Water Commission. The evaluation metrics included the Nash Sutcliffe Efficiency (NSE) and the Coefficient of Determination (R^2). During calibration, SWAT achieved an R^2 value of 0.87, while HydroRAM attained 0.85. For validation, SWAT and HydroRAM scored 0.87 and 0.88, respectively, in R^2. The NSE values for SWAT were 0.78 during calibration and 0.68 during validation. In contrast, HydroRAM scored 0.84 for calibration and 0.89 for validation in NSE. These results indicated that, for monthly analysis in the Teesta basin of Sikkim, HydroRAM demonstrated superior performance over SWAT. This accuracy of HydroRAM is vital for predicting water availability, and flood risks, planning irrigation, and hydropower projects, mitigating the impacts of climate change on water resources, and managing water resources more effectively in the Teesta River basin.

Keywords: *Teesta, Sikkim, SWAT, HydroRAM, Discharge*

Assessment of Seasonal and Annual Dependable Flows for River Baspa at Kuppa Barrage using Flow Duration Curves

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KEYWORDS
Correlation coefficient, Flow duration curve, Mean squared error, Weibull, Stream Flow

ABSTRACT

Assessment of flows at various dependable levels is considered as one of the important parameters for planning, design and management of various water related projects. For this purpose, the Flow Duration Curve (FDC) is considered by analyzing the available stream flow data at the site when adequate length of observed data is not available. This paper presented a study on assessment of seasonal (viz., monsoon, post-monsoon, winter and summer) and annual dependable flows for river Baspa at Kuppa barrage using FDCs wherein the probability of exceedance for each sample is determined by Weibull plotting position formula (PPF). The series of seasonal total and annual total discharges (STD and ATD) was generated from the observed stream flow data (1991 to 2016) of river Baspa at Kuppa barrage and used for construction of FDCs, which is evaluated through model performance indicators such as correlation coefficient and root mean squared error (*RMSE*). From the results of data analysis, it was found that (i) the computed STD and ATD from the constructed FDCs with Weibull PPF are closer to the observed flow data; (ii) there is a good correlation between the observed and computed flows using the STD and ATD series applied in constructing the FDCs, and these values vary between 0.928 and 0.937; and (iii) the *RMSE* in the computed seasonal and annual dependable flows through the constructed FDCs are 1810.5 cumecs for monsoon, 142 cumecs for post-monsoon, 89.7 cumecs for winter, 661.4 cumecs for summer and 2158 cumecs for annual. The 75%, 90% and 100% annual dependable flows were computed as 24468 cumecs, 28427 cumecs and 31417 cumecs whereas the monsoon dependable flows at 75%, 90% and 100% levels are 19528 cumecs, 22689 cumecs and 25075 cumecs. The study suggested that the irrigation, hydro power and drinking water projects at Baspa site can be designed based on the 75%, 90% and 100% dependable flows computed from the annual FDC. The study also suggested that the seasonal and annual dependable flows at various levels computed from the constructed FDCs with Weibull PPF can be used for design purposes and also for various hydrologic analyses at a site.

Assessing Environmental Flow Requirements for Sustainable River Ecosystem Management Through a Case Study of the Meenachil River in Kerala

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KEYWORDS

Environmental flow assessment, River ecosystem management, Hydrological parameters, Ecological integrity, Sustainable development

ABSTRACT

With rising populations and increasing water demands, intensified human intervention in river management has led to greater water extraction and diversion, resulting in reduced flow during dry seasons and damaging river ecosystems. This study assesses the concept of environmental flow within the Meenachil River in Kerala, using 20 years of flow data and methodologies such as the Wetted Perimeter Method, Tennant Method, Tessman Method, flow duration curve, and Indicators of Hydrologic Alterations (IHA) method to determine necessary environmental flow requirements. The study identifies water abstractions and reconstructs natural flow to gauge the impact of human activities. Comparative analysis of the methods reveals varying e-flow values: the Tessman Method suggests minimal ecological flow, while the Wetted Perimeter Method recommends a fixed flow of 12.75 cumec. The IHA Method indicates higher flows, especially during low-flow periods from April to June, to maintain ecological integrity. The current flow pattern largely meets ecosystem needs throughout the year, though incorporating ecological parameters would enhance management. These findings are crucial for policy formulation and sustainable development, providing guidance for researchers, planners, and stakeholders focused on river ecosystem conservation and management.

Managing the Bharathapuzha River Basin of Kerala for Sustainable Water and Flood Management

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KEYWORDS
Bharathapuzha River, River basin management, Water availability, Climate change, Flood management

ABSTRACT
The Bharathapuzha River, Kerala's second-longest river, is a critical water source for three districts, with its catchment spanning diverse topographies from the Western Ghats to coastal plains. The region faces increasing extreme events, exacerbated by climate change, variability, and anthropogenic activities, leading to significant land-use changes and a lowering water table. The river's flow is highly regulated by thirteen major hydraulic structures, necessitating an efficient river basin management plan to sustain life and agriculture. This study aims to develop a decision support framework for flood management in the Bharathapuzha basin, focusing on assessing current conditions, establishing ecological flows, and conducting historical drought assessments. Additionally, it explores optimal reservoir operations, considering flood cushions and mapping floodplains for selected design hydrographs. The study concludes with the operationalization of an optimized reservoir operation plan, ensuring synchronous management of all major reservoirs for effective flood control. This comprehensive approach is essential for addressing the region's water management challenges and sustaining the basin's ecosystem and communities.

Urban Flood and Drought: Concepts & Contexts

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ABSTRACT

Flood and Drought are the two extreme events of Water resources and This largely depends on Natural events rainfall and geography of the area. Occurrence of these events are but natural place to place. Occurrence of two extreme phenomena within lesser time interval in the same area is big reason of worry. Delhi, Chennai, Mumbai, Bengaluru and Hyderabad are the recent examples of the same. One major factor which is common in the above-mentioned cities are Densification. Densification is a common phenomenon, particularly in rapidly urbanizing areas where factors such as economic pressures, population shifts, and massive transportation infrastructure investments are combined. As per united nation, Within the next few decades, the majority of the world's population will reside in cities and ultimately increase the pressure on urban areas. In that case; urban hydrology, hydraulics, data management, social water planning, demand management and integrated water planning is having immense importance. In the Indian context, almost 31% of the urban population resides within 6% in the land area. To increase the economic growth, most of the states are also making polices to promote the urbanization. However, the municipalities, managers, and policymakers have to facilitate people with the development in urban areas to support economic growth rather than making faster urbanization. Addressing and clearly differentiating between structural and functional density is a crucial challenge for urban planners and decision-makers. Differences that have been noted between the two dimensions over time and space might teach us a lot about current urban problems, such as overpopulation, speculative behavior, and abandoned buildings. The time dimension of densification still has to be developed, particularly for shorter time periods.

Key Words: Urban, Flood, Drought, De-densification, economic growth

Towards Improved Water, Energy and Environmental Security through Reduction in Food Losses: A First Order Assessment

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KEYWORDS

Food Loss, Water Footprints, Carbon Footprints, Value Chain, Public-Private Partnership

ABSTRACT

Reduction in food loss and waste((FLW) has become an important development policy issue and constitutes an agenda item of the UN Sustainable Development Goals because of their impacts on the health of food, water, energy, and the environment. This paper synthesizes research-based information on food losses and their water, land, energy, and carbon footprints to develop quantitative estimates of lost resources for selected food commodities, representing close to 85 per cent of water and 70 per cent of land under cultivation. Our estimate indicates that the food loss in the supply chain from farm operations to retail accounts for over 70 billion cubic meters (BCM) of scarce water resources, which is nearly seven times the storage capacity of the massive Bhakra Reservoir. The energy loss embedded in lost food was 71.94 Gigawatts. The greenhouse gasses (GHG) emissions associated with food loss (FL) are estimated at 56.38 MtCO2e/year; and 7.82 million hectares are estimated to be the land waste resulting from FL. This area might be released from crop cultivation for afforestation to close a portion of the anticipated area gap in forests, or it could be utilized for agrivoltaics farming to help reach the net-zero carbon aim by 2050 as part of a climate management strategy.

To increase efficiency and reduce food loss, policies that address the food systems' supply chains—which span over several industries and sectors, including agriculture, transportation, and industry—must be introduced .Strengthening the FLW data base, increasing public-private partnerships to scale up FLW research, making use of technologies developed in research institutions, and expanding some of the successful business models based on the patterns of dairy, fruit, and vegetable value chains are some of the identified action programs. The present PM Kisan Sampada Yojana (PMKSY) efforts are a positive start, and these might be enhanced even further through legislation akin to the ones that were abolished in 2021.

Near future projection of meteorological droughts in the districts of Assam under CMIP6 climate projections

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ABSTRACT

This study projected the meteorological drought characteristics in various districts of Assam using a standardized precipitation index (SPI). Floods have always been a problem for Assam, but in recent decades, unpredictable rainfall patterns have led to droughts. It is anticipated that in the future, prolonged dry spells would be correlated with an increasingly intense rainfall pattern. Thus, meteorological droughts have been determined for districts in Assam based on rainfall projections provided by five climate models (BCC-CSM2-MR, EC-Earth3, MIROC6, MIROC-ES2L, and MPI-ESM1-2-HR) under CMIP6 scenarios. In this study, an ensemble of the five climate models was employed for five different scenarios (baseline, SSP126, SSP245, SSP370, and SSP585). Thirty years duration was considered for both baseline (1984–2013) and future (2026–2055) periods. According to the SSP126, SSP245, SSP370, and SSP585 scenarios, Assam state's rainfall is expected to decrease by 0.4%, 1.5%, 4.1%, and 1%, respectively, in the future period compared to the baseline period. The SSP370 scenario predicts a 2–5% decrease in rainfall across all 33 districts in the upcoming timeframe (2026–2055). The average percentage of meteorological drought under SSP126, SSP245, SSP370, and SSP585 was estimated to be roughly 16%, 17%, 18%, and 17%, respectively, between 2026 and 2055. Under all climate scenarios, some districts—like Tinsukia, Dibrugarh, Majuli, Nagaon, Morigaon, Hojai, Dima Hasao, Cachar, Hailakandi, and Karimganj—would see more regular occurrences of meteorological drought. Based on the cumulative rainfall of six months from April to September, on an average, five meteorological drought years is projected to occur during 2026–2055 in all future scenarios in the state of Assam. The study's conclusions will support the various departments' attempts to plan, act, and manage numerous entities in an appropriate manner in relation to the state's projected meteorological drought.

Keywords: meteorological drought; standardized precipitation index; climate models; CMIP6; Assam

Pune's Precarious Thirst: Echoes of Bangalore's Water Crisis Alarming in Pune

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KEYWORDS
Water scarcity; Challenges; Sustainable Water management; Adaptation strategies; Pune

ABSTRACT:

Water scarcity poses an alarming threat to urban cities like Pune, necessitating urgent action learned by the experiences of cities like Cape Town and Bangalore. As per current data, the four large dams in Pune, namely Khadakwasla, Temghar, Panshet and Varasgaon, had 10.31 TMC of water whereas on the same day last year it wasrecorded as 12.91 TMC. Climate change impact viz., changing rainfall pattern exacerbated by population growth, declining groundwater levels and insufficient water availability per capita, major urban cities are facing significant water crisis.This abstract explores the water demand and future scenario of Pune, where in MNCs and tech centres have developed, similar to what we've seen in Bangalore. With a burgeoning population, Pune's demand for water has surged, placing immense pressure on existing resources. Non-Domestic water demand has also surged because of rise in temperature, expansion of industries etc., Due to lack of proper treatment capacities and regulatory monitoring, untreated water from Effluent and Sewage treatment plant is getting mixed with surface and ground water. Consequently, this compromises the quality of available water sources, further deepening the crisis.This abstract advocates for a comprehensive approach to Pune's water crisis, stressing sustainable practices viz., re-use of treated water for horticulture, washing, dual plumbing etc., infrastructure investment, community involvement and policy interventions. Learning from the experiences of other cities can guide Pune towards greater resilience and water security, ensuring a sustainable future for its residents.

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Jal Sanjeevani Project
INDIVISH WELFARE FOUNDATION
MUMBAI.

Main Theme: Partnership and cooperation for inclusive water development and management
Sub Theme: Integrated Water Resources Development & Management
Topic: Issues in Water Scarcity and Way Forward.

ABSTRACT:

Water conservation is a key element of any strategy that aims to alleviate the water scarcity crisis in India. With rainfall patterns changing almost every year, the Indian government and local community has started looking at means to revive the traditional systems of water harvesting in the country. At Indivish Welfare Foundation, we have channelized our focus on *"WATER AVAILABILITY FOR EVERYONE "*, however remote or dry the region may be. With this core idea being our guiding philosophy, our Jal Sanjeevani Projects ensure ecological balance and are self-sustained in the long run. One aspect of Jal Sanjeevani is about rejuvenating lakes /ponds accumulated with silt over long time lines. Silt is excavated with the help of machinery and spread in nearby farms if is it rich in nutrients. It is used in construction or making boundaries / roads in case the its unusable in farms. The increased capacity which is the outcome of excavation, results in increasing not just the storage capacity but also the water table of the region due to percolation. This thereby improves the availability of water to the surrounding farmlands in the periphery. Additionally, it solves the problem of access to drinking water due to the recharge of wells. The results of utilizing the nutrient rich silt have been extremely encouraging. Farmers have been able to take a second crop due to water availability post monsoon and the villages no longer have a dependency on tankers for domestic use. There is a significant increase in the agricultural gain and in some areas, this is a stand out example of growth and sustainability even when the rainfall has been below average or almost nil. The community impact is significantly larger in comparison to the cost incurred. This work can be done in collaboration with Government schemes, local contribution in the form of cost sharing or participation, CSR and involving the community on a large scale. Given that these methods are simple and eco-friendly in a major way, they are highly effective for the people who rely on them and the overall outcomes are a prosperous farmer, sustainable ecology and a happy community at large.

Keywords: desilting, water conservation, ponds, storage, lakes,

Central-Theme: Partnerships and Cooperation for Inclusive Water Development and Management

Sub-Theme: Integrated Water Resources Development and Management
Topic: Issues in Water Scarcity and Way Forward

Access and Equity Issues in Domestic Water Supply in India and Water Crisis in Bangalore

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ABSTRACT

The right to safe water is not stated in the Constitution but Indian courts have interpreted the constitutional right to life as including the right to clean and sufficient water (Sangameswaran, 2007). The National Water Policy of 2002 and 2012 also gave primacy to water for drinking purposes. Although the national and state governments have promulgated several acts regarding drinking water supply, neither the State Water Policies nor the National Water Policies (Government of India, 1987, 2002, and 2012) on which they are based, legally guarantee the right to drinking water.

Annual groundwater availability and extraction in rural and urban areas of Bengaluru show that groundwater recharge rates significantly lag extraction rates. Introducing NRW reduction schemes could lead to a decline in groundwater recharge. To counterbalance this, the city must prioritize investments in rainwater harvesting. This option proves more viable--both in terms of economics and prudent energy use--compared to importing additional surface water.

Key Words : Access, Equity, Drinking, Water, Conservation.

Tackling water scarcity in India from management to governance perspective for water security and sustainability

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Keywords

Scarcity, Governance, Climate, IWRM, Public, Policy, Institutional, Regulation, Decentralized, Management

ABSTRACT

Water is recognized as vital to India's economic growth, the well-being of its people and the sustainability of its ecosystems. With our increasing population, the demand for water resources in India will leapfrog in the future. Along with food security needs, demands for water resulting from rapid urbanisation and industrialisation will further exacerbate pressure on water resources. India experiences high water stress levels, with demand exceeding available supply in many regions. This stress is exacerbated by uneven distribution, seasonal variability, and pollution. Changing precipitation patterns, rising temperatures, and increased frequency of extreme weather events are altering India's hydrological cycle, exacerbating water scarcity and variability.

Water scarcity poses a significant challenge to India's sustainable development and water security, Addressing water scarcity in India requires a multifaceted approach that involves both management strategies and governance reforms. This paper outlines a comprehensive approach to address water scarcity in India, focusing on the integration of management strategies including IWRM and governance reforms. By combining effective management strategies with governance reforms and international cooperation, India can make significant progress in tackling water scarcity and ensuring sustainable water security for its growing population.

Effects of Marginal Irrigation Water on Soil Properties

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KEYWORDS
Marginal irrigation water, physicochemical interaction, pore size distribution, water repellency, preferential flow

ABSTRACT:
Scarcity of fresh water resources especially in arid and semi-arid regions has compelled the farmers to use marginal water increasing irrigation demand. The marginal water is used either solely or conjunctively depending on the water requiremen and its threshold for salinity. One one hand marginal water because of its ionic or mineral composition may add to the gro specific crops having higher salinity threshold (such as citrus crops), while on the other hand it affects soil physical propertie induction of water repellency) and water retention and hydraulic properties (hydraulic conductivity). The physicochemical ir salt ions in the irrigation water with the soil minerals results in the change in pore size distribution. These changes in the pre ions in the soil-water results in the reduced retention water content and affecting the hydraulic conductivity. Another conc use of marginal water is reported to induce water repellency in the soils in long term. Water-repellent soils are hard to wet, c by high initial contact angle and water drop penetration time, leading to uneven wetting and development of preferential flo Reduction in water retention and induced water repellency both are undesirable properties for an agricultural soil, which w loss of water, crop and arable land. In conclusion marginal water can be used for specific crops having higher salinity thres conjunction with fresh water with proper drainage of salts from the root zone.

Benefits of the JalTara Project on Eco-Restoration and Climate Change

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KEYWORDS
JalTara Structures, Groundwater Level, Tree plantation, Eco restoration, Climate change

ABSTRACT: BENEFITS OF THE JALTARA PROJECT ON ECO-RESTORATION AND CLIMATE CHANGE
The United Nations has designated 2021-2030 as the "Decade on Ecosystem Restoration," emphasizing the importance of enhancing green cover to restore ecosystems effectively. Ecosystem restoration is crucial for providing nature-based solutions to food insecurity, climate change mitigation and adaptation, and biodiversity loss. The depletion of trees and vegetation can lead to adverse effects such as climate change, reduced groundwater levels, desertification, soil erosion, lower crop yields, flooding, increased atmospheric greenhouse gases, and numerous problems for indigenous communities. The JalTara project has achieved significant milestones in eco-restoration. To date, 45,000 JalTara structures have been constructed, and 90,000 trees have been planted across 115 villages in Jalna, Maharashtra. This initiative has resulted in increased crop yields, improved crop rotation, enhanced soil health, increased farmer's income, better land productivity, the ability to plant additional Rabi season crops, reduced flooding, faster land drainage, decreased crop spoilage and soil erosion, reduced drought impact, and more groundwater availability during droughts. The JalTara project incorporates a significant tree plantation initiative, with each recharge structure accompanied by two fruit-bearing trees. This effort offers multiple environmental and community benefits. Trees act as crucial carbon sinks, sequestering approximately 25 kg of CO_2 annually per mature tree, thus contributing to climate change mitigation. They also boost biodiversity by providing food and natural habitats for various wildlife species, including birds, insects, squirrels, and bees. Additionally, tree plantations aid in soil conservation by preserving soil moisture, enhancing water infiltration, improving fertility, and reducing erosion, which in turn creates favorable farming conditions. The project benefits local farming communities through enhanced ecosystem services, leading to improved livelihoods. Furthermore, the JalTara project addresses the problem of waterlogging in Jalna villages, where excess water has negatively impacted crops by reducing oxygen and nitrogen availability. By constructing structures at the lowest points within arable plots, the project allows rainwater to bypass dense topsoil and recharge underground aquifers, effectively reducing waterlogging and improving agricultural productivity. Additionally, the project's large-scale groundwater recharge efforts enable farmers to harvest additional Rabi crops, boosting economic gains. The impact of these structures extends beyond the immediate areas, as water permeates through soil layers, raising groundwater levels in neighboring regions and supporting eco-restoration efforts. The JalTara project thus offers a comprehensive approach to ecosystem restoration and climate change mitigation, delivering significant benefits to the environment and local communities alike.

Deriving a drinking water quality surveillance index and its mapping for Maharashtra

ABSTRACT

The paper discusses the derivation of a drinking water quality surveillance index, which helps identify vulnerable areas for surveillance of water pollution or water quality deterioration and which requires stringent monitoring. The index helps compute the vulnerability of an area to public health risks associated with poor quality of water resources. This composite index has three dimensions, viz., Threat, Exposure and Vulnerability and to cover these dimensions, seven sub-indices have been identified, as follows. 1] availability of drinking water resources and pollution; 2] accessibility of water; 3] infrastructure characteristics; 4] public health outcomes; 5] water quality index; 6] institutions and management index; and, 7] climate, population density and flood proneness. The number of "minor" factors (22 of them) which together are considered to have influence on the measure of these sub-indices, the underlying assumptions, the methods for methods and procedure to compute and the data sources are also discussed. Lower the value of the index, higher is the vulnerability of the region to public health hazards associated with exposure to contaminated or polluted water. The values of the index are computed for all the 354 blocks from the 36 districts of Maharashtra are computed using secondary data on all the and the areas that require surveillance are identified. Though the index is developed for the state of Maharashtra, it can be used for any region in the country.

Keywords: Water supply surveillance; water quality monitoring; water quality surveillance; composite index; public health risk

Integrated Hydrogeochemical Evaluation of Groundwater Quality for Diverse Water Uses in the Ayad River Basin, Udaipur, India

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ABSTRACT

Globally, about 5.25 billion people rely on groundwater, with quality significantly impacting human health and agriculture. Factors influencing groundwater composition include landuse, waste seepage, soil properties, and geological settings. In Rajasthan, primary groundwater quality issues are due to fluoride, nitrate, chloride, and calcium. This study analyzed data from the Ground-Water-Department (GWD) and Central-Ground-Water-Board (CGWB) from 2000-2021, along with citizen science data from 2022-2023, focusing on the Ayad River Basin, Udaipur. Physico-chemical parameters were evaluated to determine suitable and unsuitable areas for groundwater abstraction for drinking and irrigation. The Weighted Arithmetic-Water-Quality-Index (WAWQI) method was used to compute the Groundwater-Quality-Index (GWQI) from 2000-to-2023, revealing a decreasing quality trend from west to east. The southern basin areas, including Umarda, Ramgiri, Undri, and Hariyab, showed a GWQI below 50, indicating good quality, while Bhoyana, Khemli, and Sisarma had the highest indices. The results of the salinity hazard test showed that salinity is the major issue in the eastern Ayad River Basin. Though the groundwater is notably hard, a comprehensive analysis of various parameters nevertheless suggested its suitability for irrigation purposes. These findings provide critical insights for decision-makers to develop strategies to preserve groundwater quality.

Keywords: Hydrochemistry, arid regions, groundwater quality index, Ayad River Basin in the state of Rajasthan.

Assessment of Yamuna River Water Quality for Its Impact on Biotic & Abiotic Components.

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ABSTRACT

The aquatic ecosystem very often serves as the mirror of environmental deterioration due to various anthropogenic activities. The overall impact of poor water quality on biotic and abiotic components needs to be understood to monitor and manage the water resources systems. River Yamuna, in the national capital territory (NCT), has been subjected to immense degradation and pollution due to the huge amount of domestic and industrial wastewater entering into the river. The effect on aqueous flora and fauna due to low level of Dissolved Oxygen (DO), high Biochemical Oxygen Demand (BOD) & Chemical Oxygen Demand (COD), high concentration of toxic metals need to be evaluated for health of river ecosystem. The impact on abiotic components which includes water quality, surrounding soil structure, concrete structures like bridges, barrages etc also needs to be monitored. A detailed research study was conducted during the year 2021-2023, which includes periodic investigations of Yamuna river quality. The study contains water quality assessment of a most polluted stretch of Delhi i.e. from Wazirabad to Okhla barrage in three different seasons viz. pre monsoon, monsoon and post monsoon period. The in-situ water quality observations shows wide variations in parameters like pH, Conductivities, Total Dissolved Solids and Salinity as move downwards from Jagatpur village to Okhla barrage. The confluence of 18 major drains makes river water highly contaminated. The decreasing trends of dissolved oxygen (DO) and high level of BOD and COD shows deterioration of aquatic life downstream of Wazirabad. The aggresivity of water towards various uses for biotic and abiotic components was also evaluated based on various national and international codes and practices. In order to establish any relation between poor water quality and structural deteriorations, impact assessment studies were also carried out. Non Destructive Testing (NDT) tests were conducted on the civil engineering structures situated along the Yamuna river bed for assessing health impact on concrete due to exposure in poor water quality in long run. The results of different studies reveal that the poor water quality of river affecting aquatic health and durability of concrete structures along the polluted riverbed. Phytoremediation experiments conducted for improving health of the river shows positive results.

Keywords: Water Quality, Biotic Componente, Abiotic Componente, Concrete structures, Aggresivity and Durability.

Phytoremediation Study For The Removal of Heavy Metals From Polluted River Systems.

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ABSTRACT

River Yamuna water quality mainly Delhi stretch has been degraded over the years due to influx of substantial volumes of industrial wastewater and thus highlighting the severe impact of urban wastewater on the river's ecosystem. Phytoremediation is the only sustainable and eco-friendly technique that utilizes plants to remediate river water. This study explores the efficacy of Canna indica in phytoremediating the heavily polluted Yamuna River, focusing on its ability to correct the concentration of heavy metals. Canna indica, known for its robust growth and tolerance to harsh environmental conditions, was selected for this study due to its potential for heavy metal uptake and accumulation. Experimental setups were established where Canna indica plants were grown in hydroponic systems containing water samples from the Yamuna River. The concentrations of heavy metals were measured before and after the introduction of Canna indica over a period of 48 hrs.,7 days, 1month, 2month. The results demonstrated that Canna indica effectively reduced the concentrations of As, Cd, Pb, Cd, Fe, Mn, Cr, Zn, Ni and Cu in the water samples. This study highlights the practical application of Canna indica in the phytoremediation of heavy metals in polluted river systems. The implementation of Canna indica along the banks of the Yamuna River could serve as a viable and sustainable strategy to mitigate heavy metal pollution, improve water quality, and contribute to the ecological restoration of the river. By enhancing biodiversity and creating

additional habitats for local wildlife, the use of Canna indica offers multiple ecological benefits beyond pollution remediation.

The future research should focus on optimizing field applications, assessing the long-term sustainability of phytoremediation projects, and exploring the integration of Canna indica with other complementary plant species to enhance overall remediation efficiency. Studies should also investigate the genetic and physiological mechanisms underlying heavy metal uptake and tolerance in Canna indica, to further improve its effectiveness in phytoremediation applications. Additionally, socio-economic assessments of phytoremediation projects using Canna indica could provide insights into cost-benefit ratios, public acceptance, and policy implications, facilitating broader adoption of this green technology. The findings underscore the importance of phytoremediation as a critical component of integrated water resource management and pollution control strategies. Implementing Canna indica-based phytoremediation systems offers a promising approach to address the pressing issue of heavy metal pollution in the Yamuna River, promoting sustainable development and environmental health in the region.

Keywords: Phytoremediation, Heavy metals, Water quality, Sustainability.

Water Quality Index Modelling, Multivariate Statistical Analysis, and Geochemical Analysis to Monitor the Controlling Processes of Groundwater Quality in the Lower Narmada Basin, India.

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KEYWORDS
Groundwater quality, NSF-WQI, PCA, Ion-exchange Process, Pollution, Sea-water Ingress.

ABSTRACT

Groundwater quality monitoring is a crucial process for understanding the rapidly changing groundwater-surface water environment. Surface water commonly is hydraulically connected to groundwater, but the interactions are difficult to observe. The study reports the ionic concentrations in groundwater. Spatial controlling processes for groundwater are observed using multivariate statistical analysis of 90 groundwater samples. The PCA confirmed the primary controlling processes of groundwater quality are salinity and silicate weathering. The physical and chemical analysis showed that the groundwater in the study area is Ca-Mg-HCO_3 type which is controlled by weathering processes and rock-water interactions followed by Na-K-Cl type controlled by sea-water ingress and salinity. To assess drinking water quality, the NSF-WQI method is used by innovative subjective and objective weights. The WQI indicated that 28.88% of the samples have dubious water quality. The hydrochemical analysis and hydrogeological mapping assessed the flow of groundwater concerning the river and its effect on the movement of water between the two water bodies. The effect of pollution of the Narmada River and its effect on groundwater thus on drinking water is reported. It is observed that the mixing of groundwater and surface water takes place in the hyporheic zone but it does not affect the water quality of groundwater. The statistical analysis indicates that EC is strongly correlated with TH, Mg^{2+}, Na^{+}, SO_4^{2-}, Cl^{-}, and HCO_3^{-} showing a predominance of silicate weathering in the region, and the hardness is controlled by Bicarbonates, Calcium, Magnesium, and Sodium ions. The good correlation of Nitrate with total hardness and Calcium indicates the excess use of fertilizer and the effect of anthropogenic activity in the study area. The major elements controlling the groundwater chemistry are EC, TDS, TH, Mg^{2+}, Na^{+}, Cl^{-}, SO_4^{2-} and HCO_3^{-} showing geogenic influence. The factors controlling the geochemistry are analyzed by the Gibbs ratio, ion exchange processes, hardness, etc. The present study can guide the policy maker for pollution control and management of groundwater in arid and semi-arid regions.

Water Quality Index Modelling, Multivariate Statistical Analysis, and Geochemical Analysis to Monitor the Controlling Processes of Groundwater Quality in the Lower Narmada Basin, India.

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ABSTRACT
Groundwater quality monitoring is a crucial process for understanding the rapidly changing groundwater-surface water environment. Surface water commonly is hydraulically connected to groundwater, but the interactions are difficult to observe. The study reports the ionic concentrations in groundwater. Spatial controlling processes for groundwater are observed using multivariate statistical analysis of 90 groundwater samples. The PCA confirmed the primary controlling processes of groundwater quality are salinity and silicate weathering. The physical and chemical analysis showed that the groundwater in the study area is Ca-Mg-HCO_3 type which is controlled by weathering processes and rock-water interactions followed by Na-K-Cl type controlled by sea-water ingress and salinity. To assess drinking water quality, the NSF-WQI method is used by innovative subjective and objective weights. The WQI indicated that 28.88% of the samples have dubious water quality. The hydrochemical analysis and hydrogeological mapping assessed the flow of groundwater concerning the river and its effect on the movement of water between the two water bodies. The effect of pollution of the Narmada River and its effect on groundwater thus on drinking water is reported. It is observed that the mixing of groundwater and surface water takes place in the hyporheic zone but it does not affect the water quality of groundwater. The statistical analysis indicates that EC is strongly correlated with TH, Mg^{2+}, Na^{+}, SO_4^{2-}, Cl^{-}, and HCO_3^{-} showing a predominance of silicate weathering in the region, and the hardness is controlled by Bicarbonates, Calcium, Magnesium, and Sodium ions. The good correlation of Nitrate with total hardness and Calcium indicates the excess use of fertilizer and the effect of anthropogenic activity in the study area. The major elements controlling the groundwater chemistry are EC, TDS, TH, Mg^{2+}, Na^{+}, Cl^{-}, SO_4^{2-} and HCO_3^{-} showing geogenic influence. The factors controlling the geochemistry are analyzed by the Gibbs ratio, ion exchange processes, hardness, etc. The present study can guide the policy maker for pollution control and management of groundwater in arid and semi-arid regions.

Appraisal of Uranium in groundwater in Karnal division of Haryana state, India

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ABSTRACT
There is a new addition to the list of groundwater quality problems plaguing India's groundwater. Uranium is a lithophilic, potential toxic heavy element ubiquitously present in groundwater and exists in forms of oxide or complex salts such as uraninite, pitchblende, and carnotite. Karnal division is one of the six divisions of Haryana state, India. It comprises three districts of Karnal, Panipat and Kaithal. The present study aims to investigate Uranium contamination in groundwater of Kaithal, Karnal and Panipat districts of Haryana based upon the evaluation of 29 groundwater samples of Kaithal district, 41 groundwater samples from Karnal district and 24 groundwater samples from Panipat district scattered in the study area collected during June 2022 by the team of CGWB, Chandigarh. Uranium and other heavy metals were analysed by ICP-MS method at CGWB, Chandigarh. Geophysical study reveals that in Kaithal district, the thickness of the freshwater column decreases in southern and south-western parts accompanied by an increase in salinity levels from the top whereas in Panipat

district a substantial thickness of the freshwater aquifer is observed towards the Yamuna River and thickness of fresh water column decreases toward western and south-western parts. The data of Uranium concentration in the groundwater samples of Kaithal district revealed that 55% of samples of the district was above the acceptable limit of 0.03 mg/L as per IS: 10500 drinking water standards and 37% of samples exceeding the acceptable limit in Karnal district. 25% of groundwater samples of Panipat district were observed to be exceeding the acceptable limit of BIS for drinking. The maximum value of Uranium concentration in study area was found 0.456 mg/L at Israna in Panipat district with an average value of 0.042 mg/L and a standard deviation of 0.091. Uranium showed strong positive Pearson's correlation coefficient with bicarbonate (values between > 0.5 and 1) in groundwater samples collected from Karnal and Panipat districts and moderate correlation coefficient (value < 0.5) with bicarbonate in groundwater samples collected from Kaithal district indicating the possible formation of highly soluble anionic hexavalent uranyl carbonate complexes resulted in elevated uranium concentrations in groundwater of the study area..Ground-water table is declining in many areas in the unconfined alluvial aquifers of study area. This hydrogeological condition likely promotes oxic conditions, which favour the occurrence of uranium as a soluble complex. Although neither oxidation-reduction potential nor dissolved oxygen concentration was directly measured, relatively low concentrations of iron, manganese and arsenic in groundwater samples of the study area further support oxidizing conditions in the shallow U-rich groundwater of the study area. Nitrate concentration was found low in our studied groundwater; nonetheless, correlation between uranium and nitrate is not significant in the study area. The possibility of high uranium in groundwater in these three districts of the study area may be due to the natural dissolution which is exacerbated by human activities.

Key words: Karnal division, Uranium contamination, Descriptive statistics, Correlation coefficient

Assessment of ground water quality using Water Quality Index (WQI) and Agricultural Quality Index (AQI) of Spring Sheds Region of Upper Narmada River Basin, Central India

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KEYWORDS

WQI, Amarkantak Plateau, Irrigation Indices, Hydrochemical Facies, Springs

ABSTRACT

Large number of populations residing in upper Narmada River Basin depends on water of springs and dugwells. In addition to this, study area is a critical hydrogeological zone having the origins of both the Narmada and Johila rivers and features a complex network of streams and springs that continuously interact with the groundwater. This study aims to evaluate the suitability of water of springs and shallow dug well used for drinking and agriculture purpose in the upper Narmada basin. Water Quality Index (WQI) was calculated to determine suitability of water for domestic use, revealing that the majority of the water were of excellent quality (WQI ranges between 0 to 50). Agricultural index such as SAR, RSC, SSP, KI, MH and PI indicates that the water is also suitable for agricultural use. Piper trilinear diagram shows that the water of Ca-Mg-HCO3 types which indicates water is of temporary hardness and a freshwater origin. The hydrochemical facies analysis shows that alkaline earth metals (Ca, Mg) are more prevalent than alkali metals (Na, K), and weak acids (HCO3) are more abundant than strong acids (Cl, SO4). The USSL diagram classified most waters as having medium salinity and low sodium content. Overall the study reveals that the ground water in such a spring dominated region is suitable for drinking after suitable disinfection, domestic and agriculture purposes. The analysis will provide detail insight of water quality to policy makers and stakeholders involved in groundwater management, supply and policy making in the region.

Advanced Carbon-Based Electrocatalysts for Enhanced Detection of Waterborne Pollutants

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KEYWORDS
carbon-based electrocatalysts; waterborne pollutants; electrochemical sensors; environmental monitoring; functionalization strategies

ABSTRACT:
The detection of water pollutants is critical for ensuring environmental safety and public health. Carbon-based electrocatalysts have emerged as a promising solution due to their unique physicochemical properties, including high surface area, excellent electrical conductivity, and tunable surface functionalities. This review provides a comprehensive overview of recent advances in carbon-based electrocatalysts for the electrochemical detection of various waterborne pollutants. We discuss the synthesis and modification techniques of different carbon materials, such as graphene, carbon nanotubes, carbon nanofibers, and activated carbon, to enhance their electrocatalytic performance. Key factors influencing their sensitivity, selectivity, and stability are examined in detail. Furthermore, the integration of carbon-based electrocatalysts with other materials, including metals, metal oxides, and conducting polymers, is explored to highlight the synergistic effects that improve detection capabilities. We also address the current challenges and future perspectives in the field, aiming to provide valuable insights for the development of efficient, reliable, and scalable carbon-based electrochemical sensors for real-world water quality monitoring.

Issues and Challenges in Water Quality of India and Use of Circular Economy

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KEYWORDS
contamination, heavy metals, human health, circular economy, recycle

ABSTRACT:
Water is quintessential for life and indispensable for survival of humans. The quality of water determines the usage of water. People across different parts of India are facing various issues and challenges related to water. Industrial and pharmaceutical wastes along with the household sewage become the major source of contamination of water. Heavy metals like arsenic, chromium, cadmium, lead etc have detrimental health impacts leading to rise in cancer and various water related health issues. This paper discusses issues related to water quality faced in India and it also reviews the studies carried out in context of heavy metals. Recently concept of circular economy is gaining acceptance in water sector as sustainable approach. This paper reviews and recommends the policy measures like promoting circular economy by use of 6 Rs-reduce, recycle, reuse, recover, reclaim and restore of water resources which will help in efficient use of water and help to overcome water scarcity. This paper also suggests advanced techniques like continuous monitoring of water quality through real time water quality monitoring system or use of remote sensing based information will help to deal with issues and challenges related to water quality in India.

Delineation of Fresh & Saline Groundwater and the Influence of the Satluj River in a Salinity-Prone Area of Southwestern Punjab

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KEYWORDS
VES, Geoelectrical Parameters, Younger Alluvium, Groundwater, Electrical Conductivity

ABSTRACT
Forty-eight Vertical Electrical Soundings (VES) were conducted using a Schlumberger array, with a maximum current electrode spacing of 1000 meters, to delineate the interfaces between fresh and saline water in the salinity-prone area of southwestern Punjab, specifically the Jalalabad block of Fazilka district. This geophysical investigation is essential for understanding the hydrogeological dynamics of the region, where water quality poses a significant concern
The interpretation of geophysical data was performed using partial curve matching and the Automatic Iterative Method via IPI2Win software, providing a detailed subsurface profile. Additionally, eighteen water samples were collected to validate and correlate the geophysical interpretations. By employing the geoelectrical parameters derived from VES, 2D sections and 3D fence diagrams were generated, offering a comprehensive visualization of the subsurface water distribution.
The results revealed that the western and northwestern parts of the study area, influenced by the Satluj River, predominantly exhibit thick freshwater zones. In contrast, the eastern and southeastern regions are characterized by high salinity levels and shallow water tables. The freshwater aquifer is thickest in the northwestern parts, whereas saline groundwater is prevalent at all depths in the eastern and southeastern areas. Electrical conductivity (EC) values range from 628 µS/cm to 6612 µS/cm across the study area, indicating varying water quality. Resistivity values from VES data highlight that younger alluvium contains freshwater, whereas Aeolian alluvium is associated with saline groundwater.
In conclusion, the study underscores the indispensable role of VES in elucidating groundwater dynamics and salinity patterns in southwestern Punjab. The findings provide critical information for groundwater resource management and environmental planning. Understanding the spatial distribution of freshwater and saline zones helps in making informed decisions regarding groundwater extraction, irrigation practices, and the management of salinity issues. This information is vital for ensuring sustainable water resources and addressing the challenges of groundwater quality in the region.

Presence of Emerging Contaminants in Groundwater of Krishna Godavari Deltas, Andhra Pradesh, India

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Abstract

The Krishna and Godavari rivers are among the major and large rivers in Peninsular India, with the Godavari River having a higher water availability. Krishna delta has the water scarcity problem due to unavailability of water in Krishna River. Historically both deltas are very fertile and densely populated. Geo-environmental and anthropogenic conditions have a marked influence on the groundwater quality. Hydrogeochemical studies relevant to the water quality explain the relationship of water chemistry to aquifer lithology. Such relationship would help not only to explain the origin and distribution of dissolved constituents but also to elucidate the factors controlling the groundwater chemistry. The term emerging contaminants (ECs) due to anthropogenic activities is generally used to refer to compounds previously not considered or known to be significant in groundwater in terms of distribution and/or concentration, which are now being more widely detected and which have the potential to cause known or suspected adverse ecological or human health effects. ECs include perfluorinated compounds (PFCs), nanomaterials, pesticides, pharmaceuticals, industrial compounds, personal care products, fragrances, water treatment by-products, flame retardants and surfactants, UV-filters as well as caffeine and nicotine. Because of their rapidly increasing use in industry, transport, agriculture, and urbanization, these chemicals are entering the environment at increasing levels as hazardous wastes and non-biodegradable substances. In the present investigation, ground water samples were collected from Krishna and Godavari Deltas during pre-monsoon (June 2022) and post-monsoon seasons (December 2022) and analyzed for emerging contaminants viz; pesticides, polynuclear aromatic hydrocarbons (PAHs), Polychlorinated biphenyls (PCBs) and volatile organic compounds (VOCs). Presence of many pesticides were observed in many samples of the study area and BHC-Alfa has exceeded the maximum prescribed limit in few of the samples of the study area. Polychlorinated Biphenyls have also been detected in the samples of the study area but within the permissible limit of Total PCB. Total PAHs exceeded the maximum prescribed limit in more than 60% of the samples collected from the Godavari delta. The presence of volatile organic compounds (Benzene) was also observed in few of the samples of Godavari and Krishna deltas. The investigation's findings highlight an alarming situation regarding the groundwater quality in the Krishna and Godavari Deltas.

Keywords: Emerging Contaminants, Krishna Godavari Delta, Polynuclear Aromatic Hydrocarbons, Polychlorinated biphenyls, Pesticides

Strategic Management to develop understanding and limiting exposure of PFAS in drinking water in India.

ABSTRACT

The presence of per- and polyfluoroalkyl substances (PFAS) in drinking water poses a public health challenge due to their persistence and adverse health effects. This article focuses on strategic management to understand and limit PFAS exposure in drinking water and manage its public health implications in India. It examines the baseline status, identifies critical gaps, and develops thorough knowledge on the health impacts of PFAS exposure pathways. Regarding policy implications, the regulatory regimes of the United States and the European Union are compared, and the need for India to improve its regulatory measures, is highlighted. Further, it emphasizes the significance of interdisciplinary collaboration and international cooperation to integrate scientific research and engineering solutions. A case study on the presence of PFAS in surface water and groundwater in the Ganga River Basin, pertaining to these being potential sources of drinking water, is used to illustrate the health risk of large population groups to these forever chemicals. The article outlines the key management aspects, suggests specific actions for policymakers/stakeholders, advocates for safety standards, and continuous monitoring, for reducing PFAS exposure in drinking water.

Keywords: per- and polyfluoroalkyl substances, PFAS, Health risk, Drinking water safety, River Ganga

QUANTIZATION OF RADIOACTIVE ELEMENTS URANIUM AND LEAD IN GROUND WATER OF UTTAR PRADESH, INDIA

By

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Abstract

Uranium (U) and Lead (Pb) are prevalent in the natural environment because of geological deposits and geochemical transformation in which lead is the last product of radioactive decay series, which can be measured either as radionuclide in radioactivity or chemicals in mass. In groundwater, a wide range of uranium and lead concentrations has been found influenced by pH and oxic conditions. Taking into consideration of health impacts of these radioactive elements, the BIS 10500 has fixed limit for drinking water 30 and10 microgram/ litre respectively.

The chemical analysis of ground water in Uttar Pradesh, it was found that Uranium concentrations showed a wide range from nil to189 µg/L with an average value of 8.98 µg/L and a standard deviation of 11.94 µg/L. The concentration of Uranium was found less than 2 µg/L in 28.16% samples. Its concentration was mainly found in the range of 2 to 30 µg/L in nearly 67% ground water samples. The concentration of Uranium in 4.37 % samples was found more than 30 µg/L. The concentration of lead was found more than 0.01 mg/l in 39 ground water samples. The value of maximum concentration of lead was found to be 0.03 mg/l at Aliya block of Sitapur district, UP. The Uranium and Lead concentrations correlation in ground water indicates the recent origin of uranium to phreatic aquifer and radioactive decay series will take years to get it converted into the final element lead and will contaminate the ground water.

Key words: Quantization, Radioactive, Uranium, Lead, Ground water.

Comprehensive Assessment and Management of Water Quality: Development of a New River Water Quality Index for Effective Water Resource Management

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KEYWORDS
Water Quality index, Drinking water, Irrigation water, water pollution, rivers

ABSTRACT
Accurate assessment of water quality is paramount for shaping effective public policy and implementing water quality improvement programs. Various methods exist to analyze water quality data, but one of the most effective ways to communicate trends is through indices. The Water Quality Index (WQI) is a widely used tool for assessing and managing river water quality. It provides a composite rating reflecting the influence of different water quality parameters. The main objective of the WQI is to transform complex water quality data into understandable and usable information for the public and policymakers. The development of a new water quality index (WQI) is essential for comprehensive assessment and management of water resources. This index provides a standardized approach to evaluate various water quality parameters, transforming them onto a single scale for ease of interpretation and comparison. The process involves several steps, starting with the transformation of diverse parameter values into a unified scale termed as Sub Index. This is followed by assigning weightage to each parameter to reflect their relative importance in determining water quality. Subsequently, the water quality index is calculated using a formula that aggregates the sub index values with their respective weightages. For drinking water quality assessment, sub index functions are derived for parameters such as pH, TDS, alkalinity, chloride, hardness, and heavy metals among others, based on established standards. Similar approaches are applied for irrigation water quality and pollution parameters including SAR, EC, % Sodium, DO, BOD, and COD. Weightage assignment is a subjective process, prioritizing parameters based on their health impacts. Once assigned, the weightage ensures that the sum of all parameter weights equals 1.0. A study was conducted on the Chambal River and its tributaries to develop a new Water Quality Index (WQI) for different purposes - drinking, irrigation, and pollution - using important water quality parameters. The calculation of DWQI for specific sites involves multiplying each parameter's sub index by its weightage, summing these products, and then applying the formula to obtain the final DWQI value. Similarly, Irrigation Water Quality Index (IWQI) and Pollution Index (PI) are calculated for irrigation and pollution indices respectively. Analysis of DWQI reveals the classification of water into safe, permissible, and unsafe categories, providing insights into the quality of water resources over time. In the study area, most sites exhibit safe drinking water quality, with occasional instances of permissible quality necessitating closer monitoring. On the other hand, IWQI indicates excellent suitability for irrigation across all sites, while pollution indices suggest varying degrees of pollution, with the majority falling into the less polluted category. Contouring of DWQI and pollution indices further aids in visualizing spatial patterns of water quality, identifying areas of concern such as urban and industrial zones impacting river health. Overall, the new water quality index framework provides a valuable tool for informed decision-making and sustainable management of water resources.

SATELLITE DATA BASED ASSESSMENT OF EUTROPHICATION STATUS OF REWALSAR LAKE, DISTRICT MANDI, HIMACHAL PRADESH

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ABSTRACT

Himalayan lakes are pristine and they have versatile ecosystems. These lakes play a crucial role in the recycling of nutrients, recharging groundwater, and serving the human population's water needs. Nowadays quality of the surface water is deteriorating at a rapid place due to excessive water withdrawal and various anthropogenic activities. The excessive nutrient load in lakes lead to the eutrophication conditions and algal bloom of lakes. Eutrophication of lakes has become one of the world's most serious environmental problems, resulting in an urgent need to monitor and provide safeguards to control water quality. In the present study, the eutrophication status of Rewalsar Lake, a freshwater lake in Himachal Pradesh is determined in terms of eutrophication status based on the water quality parameters. The present study investigates the potential of using Landsat 7 & 8 and Sentinel-2 imagery to map the Trophic Status of Index (TSI) of Rewalsar Lake. The parameters such as Secchi Disk Depth (SDD), Chlorophyll-a (Chl-a), Total Phosphate (TP), and Total Nitrogen (TN) at different sites in Rewalsar Lake were monitored/evaluated their values. Based on the TSI Values, the lake can be distinguished as oligotrophic (TSI<38), mesotrophic (38 - 53), eutrophic (53 - 61), and hyper-eutrophic (>61). The maximum and minimum values of TSI ranged from 2011 (44.53 – 41.59), 2014 (82.76 – 40.21), 2017 (88.07 – 59.48), 2020 (92.39 – 53.66), and 2023 (94.69 – 35.23). The average values of the TSI were in 2011 (42.83), 2014 (49.24), 2017 (78.38), 2020 (77.54), and 2023 (84.60). The overall results of the study showed that Carlson's TSI of Rewalsar Lake indicated that the lake during 2011 & 2014 was in mesotrophic condition and 2017, 2020, and 2023 during this period hyper-eutrophic condition. The study indicates that the remote sensing data was used for the rapid and effective monitoring of eutrophication in lakes.

Keywords: Rewalsar Lake, Landsat 7&8, Sentinel-2, Eutrophication, Trophic Status of Index (TSI).

Sea Water Intrusion in Coast of Kerala State

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KEYWORDS
Salinity, river basin, estuary, salinity intrusion, tidal range

ABSTRACT

Salinity intrusion showcases the complicated inter linkages of climate change and challenges faced by the public in their daily life. Considering the long coastal stretch of Kerala, the threat of salt water intrusion may potentially disrupt the drinking water supply and food production. The study area basins were representative of coastal stretch spatially with Anjarakandy basin in the north, Kadalundi basin in the central part and Pallikkal river in the southern part of Kerala. The spring tide day observations of the order of 25-30 hours in continuous, were taken in the river basins for the years 2019-2022. Ketchum's modified Tidal Prism method was used for the analysis which was validated by Mike Hydro River software. Dynamics of each estuaries were analysed for its tidal range, extent of salinity in the river in different seasons. Salinity of Pallikkal river was found to be in the order of 18 to 21 km in its river stretch from the estuary. In Kadalundy river the salinity intrusion varied from 14-16 km, whereas in Anjarakandy it varied from 21-24 km. The study and the analysis shall pave the way for river basin centered salinity control measures and its design to counter the ill effects of salinity intrusion in the state of Kerala.

Comprehensive Groundwater Quality Analysis in Punjab State

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KEYWORDS

Water Quality, Electrical Conductivity (EC), Sodium Adsorption Ratio (SAR), Salinity, Piper trilinear

ABSTRACT

Groundwater quality is a critical component for ensuring the sustainable development and health of populations in regions like Punjab, India. This study presents a comprehensive analysis of groundwater quality in Punjab State, utilizing data from the 2022 groundwater quality assessments conducted by the Central Ground Water Board, Ministry of Jal Shakti. The primary objective of the study is to evaluate the current status of groundwater in terms of chemical parameters, identifying areas of concern and potential health risks to the local population. Key indicators such as pH, total dissolved solids (TDS), heavy metals, and nitrates were considered. The findings reveal significant spatial variability in groundwater quality, with certain regions exhibiting elevated levels of contaminants beyond permissible limits set by national and international standards. The study highlights critical hotspots requiring immediate intervention and suggests potential sources of contamination, including agricultural runoff, industrial discharges, and inadequate waste management practices. These insights are crucial for policymakers and stakeholders to implement targeted measures to mitigate contamination and ensure safe drinking water for the population of Punjab. The research underscores the importance of continuous monitoring and sustainable management practices to preserve groundwater resources in the face of increasing anthropogenic pressures and climate change impacts. The parameters considered for the study included pH, electrical conductivity (EC), TDS, hardness, calcium, magnesium, sodium, potassium, carbonate, bicarbonate, chloride, and sulphate etc.

Water Quality Testing Kits – Methods, Challenges, and Future Prospects

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Abstract:
Water quality testing is critical for ensuring safe and clean water, particularly in regions with limited access to centralized water treatment facilities. This review examines the effectiveness of various water quality testing kits, focusing on methods such as IMViC (Indole, Methyl Red, Voges-Proskauer, and Citrate tests), H2S (Hydrogen Sulfide) detection, and nanostrip-based assays. Each method offers unique advantages in terms of sensitivity, specificity, and ease of use, yet they also present challenges, including cost, accessibility, and the need for technical expertise.

The IMViC series, while reliable for distinguishing between different types of coliform bacteria, requires precise execution and interpretation, which may not be feasible in all settings. H2S testing provides a simple and low-cost alternative but may suffer from lower specificity, potentially leading to false positives. On the other hand, nanostrip technologies offer rapid and susceptible detection of contaminants. Still, high costs and the need for further validation in diverse environmental conditions currently limit their application.

This review identifies critical challenges in deploying these technologies, such as the need for standardization, cost reduction, and the development of user-friendly interfaces that can be operated with minimal training. Prospects for water quality testing kits include the integration of advanced materials, such as nanomaterials, and the use of digital platforms for data collection and analysis, which could significantly enhance the accuracy and accessibility of water testing in resource-limited settings.

The review offers key recommendations for future research and development, emphasizing the need for more robust field validation, cross-method comparison, and the exploration of emerging technologies to overcome current limitations. These suggestions aim to guide the development of next-generation water quality testing kits that are both effective and accessible to a broader population.

Assessment of water quality of River Ganga and suitability of river water for different uses.

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KEYWORDS
Surface water, Ganga, Water quality, Designated usages, Polluted stretches, Trend analysis

ABSTRACT:
River Ganga flows in the northern part of India and is treated as sacred water resource. The mainstream of river Ganga falls in the States of Uttrakhand, Uttar Pradesh, Bihar, Jharkhand and West Bengal. The river receives waste from industrial, agricultural, and religious activities of these states. The present study aims to assess the quality of river water as per CPCB classification and trend of various parameters based on last three-decade data from various sites using graphical analysis. The river water was suitable at all studies sites for agriculture activity as pH, EC, Ammonia-N, Boron, SAR value at all stations found well within the limits for all class of water as per CPCB norms except under very few occasions. Middle Ganga stretch was found to be critical with respect to BOD. However, the decadal average value of DO for all sites were above the minimum required DO for Class B. The present study may provide a strategic framework for managing water quality in other significant rivers across India.

Arboreal Reservoirs: How Trees Store Water for Life

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KEYWORDS
Arboreal reservoirs, Water Storage, Indigenous Communities, Arid Regions, Climate Adaptation

ABSTRACT:

Humans rely on trees for oxygen, habitat, and resources. However, they have a surprising adaptation: the capacity to store large amounts of water. These arboreal reservoirs are lifelines for indigenous populations in arid and semi-arid locations, delivering water under harsh weather conditions. Trees have evolved a sophisticated vascular system to effectively carry water, which includes roots that receive water from the earth, a network of xylem arteries that move water upward, and stomata on leaves that regulate water release via transpiration. Some tree species have developed extra water storage systems, such as succulent tissues in their stems, trunks, or leaves that include parenchyma cells with enormous water-storing vacuoles. Examples include African baobab trees, and Namibia's renowned Welwitschia Mirabilis. Arboreal reservoirs are vital to indigenous cultures across the world, providing water for drinking, cooking, and cattle watering. Some examples are the baobab, Welwitschia Mirabilis, Saguaro Cactus, Bottle Tree, Kapok Tree, Monkey Bread Tree, Palmyra Palm, and Cannonball Tree. Understanding these adaptations as well as indigenous groups' traditional knowledge is critical for long-term water management methods, particularly in water-scarce locations. India offers a diverse range of water-storage tree species that can help manage water scarcity and boost community well-being. Research should concentrate on discovering and describing these species, creating sustainable tapping methods, incorporating indigenous knowledge, and assessing their ecological effect. These trees can be utilized for afforestation and reforestation projects, community-based water management plans, agroforestry techniques, and climate change adaption measures. By focusing on these places, India can leverage the plants' inherent capacity to manage water scarcity and improve the well-being of its citizens.

WC-5

Development of a Methodological Outline for Sand Budgeting in Rivers: A Case Study with Reference to Chaliyar River

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KEYWORDS
Sand budgeting, Sediment transport, Modelling, Methodology, River flow

ABSTRACT

The flow and sediment transport in rivers are complex natural processes which critically affect the overall equilibrium of river and hence the sand accumulated at various locations in the rivers. Proper understanding of these processes is essential for developing scientific sand audit reports of rivers. The present study attempts to develop a framework to perform scientific sand auditing with specific reference to Chaliyar River in Kerala using hydrologic, hydraulic and sediment transport modelling. In the proposed framework, rainfall-runoff modelling was carried out using HEC-HMS software and erosion from the sub-basins was computed based on the MUSCLE method. Hydraulic modelling and sediment transport modelling were performed using HEC-RAS software. The hydrologic and hydraulic models were successfully calibrated and validated. Overall, a reasonably close agreement is observed between the computed and observed flows. Results of sediment transport modelling indicate that the change in the sediment level in the downstream of the river is more pronounced as compared to the upstream of the river. The volume of mineable sand at various locations in the river was computed. The proposed framework can be considered as a starting point towards the development of a scientific approach for understanding the sediment dynamics in rivers of Kerala.

Morphometric Analysis of Bharathapuzha River Basin in Kerala

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KEYWORDS
Flood forecast, Run off, Flooding, Integrated flood management, Flood modelling

ABSTRACT

The present work provides a detailed examination of Kerala's river basins through morphometric analysis, which quantitatively assesses landforms to understand hydrological and geomorphological characteristics. The study focuses on twenty two major river basins in Kerala, analyzing parameters such as stream order, drainage density, basin shape, relief ratio, and elongation ratio. These factors are important for analysing environmental problems like soil erosion, floods, landslides, and surface runoff. Using DEM data and GIS tools, the study employs topographic indices and linear aspects to quantify these morphometric parameters. The results highlighted significant variations in relief ratios, with Neyyar basin having the highest at 46.12, indicating rugged terrain, while Mamom, Ayiroor, Ithikkara, and Pallickal basins have flatter terrains. High drainage density in basins like Periyar and Bharathapuzha suggests increased susceptibility to soil erosion, necessitating targeted environmental management strategies. The basins with high drainage density like Periyar and Bharathapuzha might be more susceptible to soil erosion, requiring targeted control measures. The results indicated that the basins with high drainage density and significant relief (Neyyar, Meenachil basins) necessitate proper floodplain management practices. The stream network capacity and terrain characteristics inferred from drainage density and relief ratio can be used for water resource management strategies.

Integrated Smart Water Resource Management using Private 5G Wireless Technology: A Study on 5G Use Case at CWPRS

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Abstract: 5G service was inaugurated by Prime Minister of India on October 1st 2022. This newly launched 5G technology is the latest wireless communication technology which can help in managing the water resources locally as well as remotely. Efficient water resources management requires comprehensive and real timely data to disseminate with stake holders for taking effective decision and making the policies. The advancement of Information and Communication Technology (ICT) techniques is capable of collecting the data, analyzing and disseminating the information to management without visiting the sites in remote locations. The uses of advance ICT techniques may bring more transparency and accountability in water resource sector. The emergence and development of 5G wireless communication technology can provide efficiency and convenience for the transmission of water resource information. It has capacity of high speed of data transmission with low latency, transmit the data with 100 times faster than the 4G speed and supports higher number of devices with more coverage compare to other technology. The 5G technology will enable Internet of Things (IoT) to expand from existing connections to billions of connections. 5G promised to support more than one million Machine to Machine (M2M) devices communication per square kilometer. National Water Informatics Center (NWIC) under Ministry of Jal Shakti (Govt. of India) has setup the Working Group Committee for adoption of 5G technology for identifying the possible 5G based use cases (applications) in Water Resource sector in which CWPRS is the member. CWPRS is in process of setting-up the Center of Excellence (CoE) for testing the 5G communication. CWPRS successfully demonstrated the transmission of hydrometeorological data from the existing Automatic Weather Station (AWS) at its campus using private 5G network communication. The proposed use case data has been acquired, transferred, analyzed and presented using private 5G network technology. This paper discus about the 5G use case for Integrated Water Resource Management (IWRM).

Keywords: 5G Technology, IoT, Wireless Network, Water Resource Management, Use Cases.

Capacity Development and Knowledge Transfer on Integrated Water Resources Management from the Learning at Grassroots1

(Traditional Wisdom, Innovative Technologies and Water Literacy to All)

A.Gurunathan, Programme Leader

Key Words : Eco-system Services, Tank Conservation, Water and Development, Agri-water Pollution, Virtual Water

Abstract

Water Sector in India faces many challenges in the era of increasing population and demands from different sector. Integrated Water Resources Management Principles and approaches are being integrated in Policy and Planning at different levels from Government to Basins to Local Panchayats. The missing link is contextualising the water issues at ecosystem level and develop suitable easy to understand education for creating awareness and bringing sustainable behavioural change communications among the People especially the future generation Students, School children, Women, Panchayat Leaders, Ward members etc.

The DHAN Academy, a Development Management Institution set up by DHAN Foundation as an autonomous institute in 2000 has indeed set up Water Education and Training Centre (WETC) in 2008 and later got renamed as Water Knowledge Centre (WKC). The Centre's major role is undertaking field pilots, action research, virtual education, field immersion programmes etc. to enable the world of development practitioners to youths. In its decade long experience, Water Knowledge Centre has developed curricula and customized capacity building programme on Surface Water, Green Water (Soil Moisture) and Grey Water (Used Water) management including Water Quality monitoring and water testing. The paper is covering the curricula offered by the centre at present and explore partnerships with National Water Mission and other development stakeholders.

Strengthening JJM Capacity Building Interventions (Rural): Empowering Government Officials in the Water Sector

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KEYWORDS
Capacity building, Water management, Sustainability, Community involvement, Jal Jeevan Mission

ABSTRACT: (9 pt)
Significant reforms in 'Knowledge Transfer and Skill Development in the Water Sector' highlight the contributions of the Indian Institute for Human Settlements (IIHS), a national educational institution dedicated to fostering an equitable, sustainable, and efficient transformation of Indian settlements. IIHS, designated as a Key Resource Centre under the Ministry of Jal Shakti for the Jal Jeevan Mission (JJM), alongside other ministries tasked with the responsibility of developing and executing customized capacity building programmes.

India's diverse geography presents unique water management challenges. The Andaman & Nicobar Islands rely on rainwater harvesting and resilient infrastructure due to cyclones and coastal salinity. Assam faces recurring floods and groundwater contamination. Bihar struggles with groundwater depletion and sanitation issues from high population density. Gujarat deals with droughts, salinity, and urban-rural disparities. Karnataka confronts groundwater depletion, interstate water disputes, and urbanization pressures. Kerala has water quality issues from industrial and agricultural runoff and frequent natural disasters. Meghalaya's rugged terrain and heavy rainfall complicate infrastructure development. Odisha needs resilient systems against cyclones and saline groundwater. Punjab suffers from groundwater depletion and contamination from agricultural and industrial sources. West Bengal contends with arsenic contamination, floods, and high population density. Each state faces challenges influenced by climate, terrain, resource availability, and water quality.

To address these issues, from 2021 to 2024, IIHS designed and conducted comprehensive capacity building programmes recommended by the Jal Jeevan Mission Department, GoI, reaching 1,643 learners from 25 states and 3 Union Territories. These programmes equipped senior and middle-level officers with essential skills and knowledge for effective water resource management, focused on rural water supply, policy shifts, infrastructure design, sustainability, and community-led strategies, transforming Gram Panchayats and Village Water Sanitation Committees into efficient utilities with a strong emphasis on knowledge dissemination.

Key enhancements addressed via these programmes include:
- ✓ Enhanced Infrastructure: Developing resilient infrastructure to withstand natural disasters and geographical challenges.
- ✓ Water Quality Monitoring: Implementing regular monitoring and treatment Programmes to ensure safe drinking water.
- ✓ Community Involvement: Engaging local communities in planning and maintenance to foster ownership and sustainability.
- ✓ Technological Solutions: Utilizing technology for efficient water management and real-time monitoring systems.
- ✓ Financial Models: Establishing sustainable financial models to ensure the long-term viability of water and sanitation services.

In the realm of community empowerment, IIHS conducted a study on ‘Women Empowerment: Water Quality Monitoring Using Effective Communication Tools’. Women were trained in graphical illustration tools and became trainers of trainers (ToT) for raising awareness in rural villages. The study concluded that long-term sustainability hinges on robust communication tools combined with a participatory approach.

This research on IIHS’s capacity-building efforts enabled government officials to transform their learnings into strategic planning, implementation, and monitoring, fostering collaboration with the community for lasting impact.

Optimization Modelling for Sustainable Irrigation Water Management

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KEYWORDS
Optimization, Modelling, Irrigation, Water Management, Linear Programming (LP)

ABSTRACT:
Sustainable irrigation water management becomes crucial for achieving food security due to increasing trend of world population. Irrigation is essential to enhance agricultural productivity and meet the growing food demand. However, unchecked intensification of irrigated agriculture can lead to the issues like loss of biodiversity, waterlogging, salinization, ground water depletion, contamination of water etc. These are prevalent on a significant portion of the irrigated lands, threatening both food production and environmental conservation. Rising demand for water across various sectors (industrial, domestic, and agricultural), efficient and wise use of water in irrigation becomes imperative. This involves employing scientific water and land management strategies to maximize irrigation efficiency and optimize water use per unit area of cropped land over time and has become one of the challenges in irrigation management. This study emphasizes the use of programming techniques to address these challenges effectively. The applications of these programming techniques for the sustainable management of irrigation projects are grouped into four categories: linear programming, nonlinear programming, dynamic programming, and genetic algorithms. Linear programming (LP) is widely used due to its simple formulation and computational comfort for solving optimization problems where both the objective function and constraints are linear. However, many problems in irrigation system management involve nonlinear relationships, making LP inadequate for these cases. Nonlinear programming (NLP) models address this limitation by allowing for nonlinear relationships between variables although it is complex and slow in convergence of the algorithms. Incorporating stochastic elements into NLP can also be challenging. On the other hand, Genetic algorithms are particularly well-suited for solving complex nonlinear and nonconvex optimization problems where traditional optimization methods may struggle. The dynamic programming is particularly effective for problems that involve making a sequence of decisions over time incorporating stochasticity. Decisions regarding irrigation scheduling and water allocation often need to be made sequentially over time to optimize objectives such as crop yield, or water use efficiency etc. These programming techniques are applied to various aspects of irrigation management, including maximizing benefits, minimizing waterlogging and groundwater depletion, improving irrigation application efficiency, and optimizing irrigation schedules. Applications of LP model for water management in command areas are highlighted here for benefit of researchers, planners, policymakers and implementing departments for adoption of the methodologies tailored to their specific irrigation projects, thereby promoting sustainable irrigation management.

CHALLENGES IN WATER SECTOR INFRASTRUCTURE

WC-6

Accelerating coverage of Micro Irrigation in India

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Abstract

In order to meet the food grain consumption demand and some surplus amount for export, India will need to produce not less than 500 million tons by 2050. The National Institution for Transforming India (NITI Aayog) also stated that around 600 million Indians are now facing extreme water stress because of growing population and ever-increasing demand for food. The total potential utilizable volume of water in India is estimated to be around 105-million-hectare meters (MHM) and even with full exploitation of this potential, a little less than 50 percent of India's cultivated area will remain rainfed thus, the development of reliable low-cost water saving technologies has long been recognized as a critical need in developing countries such as India. Despite of many persuasive arguments in favour of drip irrigation system, convincing financial and economic viability and the subsidies provided by the Government of India, the expected large-scale adoption of drip irrigation systems by farmers in the country. Recent advances in the science of sensor technologies and the internet of things (IoTs) can be useful in the automation of drip irrigation systems; this automation can help in addressing the emerging challenges of labour shortages and inefficiency of water use in agriculture. Presently state implementing agencies along with MI system suppliers have demonstrated some large-scale canal command projects wherein automation is the major component, and the cost of this automation is borne by the respective state as pilot projects.

Community Micro Irrigation Projects in Kerala

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COMMUNITY MICRO IRRIGATION, KMM-CMI, MICRO IRRIGATION POLICY, MOONGILMADA, SMIM

ABSTRACT:

Micro irrigation is one of the most important climate resilient irrigation systems that can perpetuate the practice of Per Drop More Crop. Addressing the challenges in sustainability governance in the water sector must therefore attribute substantial importance to the micro irrigation practice. Community Micro Irrigation (CMI) projects largely address these challenges by integrating micro irrigation technology with water conveyance and on-farm water productivity. Kerala Irrigation Infrastructure Development Corporation (KIIDC) recently commissioned few CMI projects which are the first of its kind in India for very long duration crops. Based on the success of these projects and its acceptability by the farming community in Kerala, the government of Kerala state has launched a statewide CMI scheme titled KM Mani Community Micro Irrigation (KMM-CMI) scheme. In this paper, the evolution of this scheme with the key findings of the pilot project that shaped up the KMM-CMI scheme are presented. The pilot projects commissioned at Karadippara, Moongilmada Valiyeri, Navithankulam and Kunnamkattupathy in the rain shadow belts of Palakkad district in Kerala helped gaining several insights on the sustainability governance of this scheme. An important feature of these pilot projects is the interlinking of the effective engagement of technology and proper community participation with duly evolved in-group governance principles. This underpinned the implementation protocol of the KMM-CMI scheme. The capacity built through the implementation of the pilot projects is replicated at state level for increased agricultural productivity and better water management. This paper is organised in five sections. In the first section the irrigation scenario and the cropping pattern of the state is discussed. This is followed by the salient features of the pilot project at Moongilmada including its solar energy augmentation component. Third section describes the key inputs of the pilot project that shaped up the state level scheme. Fourth section discusses the projects that are already initiated under KMM-CMI. Final section discusses the way forward and plan of action proposed for the State Micro Irrigation Mission (SMIM).

Modernizing Water Infrastructure with Innovative Rubber Dam Technology, as Cutting-Edge Solution to Water Scarcity

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Abstract

Water scarcity is a pressing issue in India, particularly in regions such as Vidarbha, eastern part of Maharashtra, where environmental, economic, and social factors exacerbate the strain on water resources. This paper explores the implementation of innovative solutions to mitigate water stress, focusing on the utilization of Rubber Dams as cutting-edge technology. The Bandhara (i.e. Check dam in Marathi language) project, initiated as a pilot endeavor, showcases the efficacy of Rubber Dams in addressing acute water shortages in eastern Maharashtra.

Leveraging Collapsible Rubber Dam technology, the project demonstrates a sustainable, technologically feasible, and financially viable approach to water conservation and management.

Located at Ajra Phata in Wardha district, the Bandhara project utilizes Rubber Dam, constructed on a non-perennial local river, effectively replenishing over-exploited water sources in the vicinity. Despite design and construction challenges, the project achieves notable milestones, including the timely completion, with technology at its advantage. Through streamlined processes, optimized efficiencies, and effective stakeholder communication, project management consulting expertise, rendered by WAPCOS, ensured project success.

The tangible outcomes of the Bandhara project surpass expectations, with significant increases in water levels observed in surrounding dug wells. Local communities report dramatic improvements in water availability, enabling agricultural activities even during non-monsoon seasons and facilitating livestock rearing. These achievements underscore the collaborative efforts of multidisciplinary teams guided by thorough analysis and research.

Moreover, the project identifies key insights for future integrated water resource management initiatives in India's stressed regions. Recommendations include the exploration of small channels for check dam construction, utilization of excess monsoon water, and further adoption of Indigenous Rubber Dam technology for its time and cost-effectiveness.

The paper delves upon intricate aspects of project inception, hydrological & geological considerations, merits of collapsible rubber dam technology, design engineering & financial aspects, challenges of project implementation, and operation & maintenance aspects.

In conclusion, the Bandhara project exemplifies the successful integration of innovative, indigenous technology and strategic decision-making to address water scarcity challenges. Insights gleaned from this endeavor serve as valuable guidance for future water resource management efforts in India and beyond.

Keywords: Water scarcity, Integrated water resource management, Rubber Dams, Sustainable solutions, Indigenous, Bandhara project, Technological innovation.

DEVELOPING CRITERIA FOR ANCHORING FLOATING SOLAR PANELS IN RESERVOIRS

By
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Abstract

The adoption of floating solar panels in reservoirs represents a promising avenue for renewable energy generation in India, which is why it is being considered as a favoured option recently. However, the absence of specific design criteria for anchoring these panels poses significant challenges to their reliability and stability. Should the anchoring fail during a flood, it could potentially impact the spillway operations, which should continue unhindered in all circumstances. This paper is based on the studies carried out by the authors for the Bakreshwar Dam, in West Bengal. An approach has been presented to decide the design flood based on the risk analysis to evaluate the resilience of floating solar installations under different flood scenarios, emphasizing the importance of considering factors such as design flood for anchors, safety of spillway gates, and prevention of blockage. Based upon the risk analysis carried out using the concept of complementary probability, the paper recommends the adoption of a 100-year as the design flood as a minimum requirement to ensure the safety and longevity of floating solar panel projects. Furthermore, it advocates for the development of an Indian standard for anchoring floating solar panels to establish uniform guidelines and best practices. By prioritizing safety and risk considerations, India can accelerate its transition towards sustainable energy while mitigating potential hazards associated with floating solar installations.

DEVELOPMENTAL CHALLENGES IN IRRIGATION SECTOR OF ASSAM

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Abstract

Irrigation has been a cornerstone of agriculture in India since ancient times, with its development, closely intertwined with the advancement of agricultural tools and techniques. Assam has a predominantly rural and agrarian economy with a total geographical area of 78.50 lakh hectares, the Gross Cropped Area (GCA) of 38.88 lakh hectares and net cropped area of 27.23 lakh hectares. Despite the state's efforts to enhance its irrigation capabilities to 10.24 lakh hectares of irrigation potential created till March, 2024, merely 4.97 lakh hectares (13% of GCA) is currently available for irrigation. The underutilization of irrigation potential at 50- 60% level is a significant issue in Assam. Low level of irrigation development stands in stark contrast to the national average. The gap between the available irrigation potential and its actual utilization underscores the pressing need for a strategic and comprehensive approach to improve the state's irrigation infrastructure. Addressing these challenges requires a multifaceted strategy that includes re-engineering existing irrigation projects using modern technology, fostering Information and Technology tool to plan, implement and monitor, community engagement through PIM techniques, and implementing eco-friendly, innovative approaches to provide low-cost, optimal irrigation solutions for the farming community. Integration of Information Technology is crucial for better understanding field requirements and for the effective management of funds, which can be facilitated through GIS and AI based analysis. Assam is focusing on irrigation planning cum implementation of projects with quality monitoring

through technological interventions. These efforts aim to bring about a social transformation by promoting the development of agriculture and allied sectors. One of the focus areas is adoption of low-cost irrigation techniques that leverage sustainable solar power. Some of the innovative techniques currently practiced in the state include the use of eco-friendly low-cost mobile surface mounted/static solar pumping systems operated on hybrid modes. The innovative flexible/ Mobile Solar Irrigation Schemes are very efficient for irrigation coverage for multiple area .Hybrid tube wells are being utilized for irrigation. These approaches are designed to be cost-effective and environmentally sustainable, providing practical solutions to the irrigation challenges. The paper also highlights the importance of preparedness / responsibility among stakeholder departments to increase agricultural productivity through market-driven initiatives that promote profitability and sustainability. By focusing on these aspects, the state aims to enhance the overall efficiency and effectiveness of its irrigation sector, ensuring that more land is brought under irrigation and that the agricultural community can thrive. An attempt has been to highlight the significant challenges as well as the opportunities for innovation and improvement in State Irrigation Sector. By adopting a strategic approach and on integration with modern technology using IoT and AI tools, community engagement, and sustainable practices, the state can bridge the gap between irrigation potential and utilization, ultimately fostering a more productive and resilient agricultural sector

Key words: ***Agriculture, Innovation, Productivity, Gross/Net Cropped Area, Solar Energy. Hybrid, Mobile, Static***

SOLAR POWERED MOBILE LIFT IRRIGATION SCHEME

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1.0 ABSTRACT :

Solar Powered Mobile L.I.S. is a Lift Irrigation Scheme where the Pump Station can easily be moved from one position to another in need of covering optimum command area. The pump is mounted on a platform floating by means of Recycled UPVC Barrels and the solar panels are also mounted on the same platform. It is cost effective and light in weight. Using of self-priming BLDC surface pump allows it maximum running hour in a day even in cloudy days. Introduction of IoT based Remote Monitoring System allows real time monitoring of running hour, discharge, voltage, current etc. It floats quite easily and it mitigates the possibility of any damage of pump station during flood.
Mobile L.I.S. offer advantages in terms of adaptability and water efficiency. These systems can be easily transported to different locations within a same water source. This flexibility allows farmers to respond to changing irrigation needs or varying water availability in different parts of their fields. By utilizing this approach, farmers can optimize water usage, ensuring that crops receive adequate irrigation while minimizing water wastage. The ability to move the irrigation system also makes it suitable for areas with uneven topography or where fixed infrastructure may be challenging to implement. Additionally, Mobile L.I.S. can be particularly beneficial for smallholder farmers or those with limited access to permanent irrigation facilities. It provides a cost-effective solution that doesn't require extensive investment in fixed infrastructure. Overall, mobile lift irrigation schemes offer a dynamic and resource-efficient approach to agricultural water management, contributing to sustainable farming practices.

Keywords : *Mobile L.I.S., IoT based RMS, BLDC Pump, Solar Panels, Recycled UPVC Barrels*

APPLICATION OF RISK SCREENING TOOL TO DRIP DAMS

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ABSTRACT

India's Dam Safety Act, 2021 mandated risk assessment of the specified dam studies within the next five years. With an objective of Risk screening and evaluation, an Excel-based program developed by World Bank experts is under validation in the Dam Rehabilitation and Improvement Project (DRIP 2 &3) as a first-tier risk assessment tool. The primary objective of the tool is to provide a quick qualitative assessment of the risk in dams and to identify dams with a relatively high-risk index for second-tier risk assessment. The tool's integration into dam safety management emphasizes rapid, qualitative assessments, facilitating the prioritization of remedial actions and improving safety protocols across India's extensive portfolio of over 6281 large dams.

Keywords: Risk, Dam Safety, Risk Screening, Training, National Dam Indexing Assessment (INDIA)

SIMULATING RIVER BRAHMAPUTRA'S DYNAMICS: A MOVABLE-BED, DISTORTED MODEL STUDY FOR OPTIMIZING BRIDGE PIER SPACING

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Abstract

This research undertakes a comprehensive examination of the hydraulic complexities inherent in the construction of a second rail-cum-road bridge over the Brahmaputra River, near the existing Saraighat Bridge. Under the aegis of the North Eastern Hydraulic and Allied Research Institute (NEHARI), the study leverages a physical hydraulic model to simulate a 25-kilometer segment of the river, meticulously replicating its intricate flow regimes, scour processes, and sediment transport mechanisms. To ensure precision in the outcomes, the investigation employs a distorted scale model grounded in Froude number similitude, facilitating an in-depth analysis of the river's hydraulic responses to the proposed bridge construction.

A primary focus of the research is to determine the optimal pier spacing for the new bridge to ensure structural stability and minimize hydraulic interference between the existing and proposed bridges. The model analysis revealed that a minimum center-to-center spacing of 74.9 meters is necessary to prevent detrimental interactions between the scour holes formed around the bridge piers. This recommended spacing is critical for safeguarding the structural integrity of both the existing and new bridges, particularly in the context of the dynamic and braided nature of the Brahmaputra River.

Furthermore, the study validates the use of the Melville and Sutherland equation for estimating scour depth in this specific hydraulic environment. The findings demonstrate that this equation provides reliable

estimates for scour depth, confirming its applicability in the challenging conditions of the Brahmaputra River. By offering these insights, the research contributes valuable guidelines for the design and construction of the new bridge, ensuring enhanced safety, stability, and longevity in the face of the river's complex hydraulic behaviors. These results have significant implications for engineering practices in similar riverine environments, providing a foundation for future studies and applications in bridge design.

AN INITIATIVE TO MODERNIZE IRRIGATION INFRASTRUCTURE OF JHARKHAND

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KEYWORDS
Irrigation Modernization, Traditional Canal System, Pipe Line Projects, State Development

ABSTRACT
With the progressively higher demand on restricted water supplies in various parts of State of Jharkhand and considering its hilly and undulating terrain, there is an urgent need for systematic utilization of water by reducing losses at different reaches in the irrigation system of the state. To enhance irrigation efficiency; substituting the traditional canal system with pipe lines projects and promoting field application of water through micro irrigation methods have become the essentiality of the State. Recently, the State of Jharkhand has started the various pipeline projects to facilitate irrigation in different parts of the state especially the drought prone areas of Garhwa and Palamu districts that are significantly facing with shorter rainy days and scanty rainfall. Furthermore, some pipeline projects have been launched to promote irrigation in the Dumka, Deoghar, Jamtara, Giridih, Saraikella-Kharsawan districts that possess substantial portion of High Patch (Tand) irrigable land remaining unutilized every year. The implementation of these projects are expected not only resolving the issues of huge land acquisition and Forest Clearance involved in traditional canal projects but also facilitating irrigation in the higher terrain of the state; thus resulting to its remarkable agricultural, economic, social and cultural development in forthcoming years.

INVESTIGATION OF FLOW OVER OBLIQUE WEIRS USING CFD

Abstract

A practical approach to reducing the upstream head while facilitating higher discharge with a constant channel width is the use of an oblique weir. This study explores the effects of orienting a weir obliquely to the flow direction through computational fluid dynamics (CFD) simulations. A weir with rectangular cross-section was examined at four different angles - 90°, 125°, 135°, and 150°, measured anticlockwise from the flow direction. The two-equation RNG turbulence model was utilized to incorporate the effects of turbulence. The discharge coefficients for these oblique weirs were determined from the simulations, and their efficiency was examined in comparison to a linear weir. The simulated discharge coefficients were also compared with existing formulae from the literature. The findings indicate that, for a given head over the crest, the discharge increases with larger oblique angles due to the corresponding increase in the effective length of weir. Therefore, positioning a weir obliquely to the flow direction can effectively enhance its conveyance capacity without exceeding the upstream freeboard limit.

Keywords: Oblique weir, CFD, RNG, Discharge coefficients

NUMERICAL MODELLING OF CHANNEL FLOW OVER A TRAPEZOIDAL CHANNEL USING MOBILE CONICAL FLUMES

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Abstract

Discharge measurement in prismatic channel using mobile flumes is quite effective and easily be man handled. Insertion of mobile flume axially into an open channel creates a critical flow condition. This paper presents the Computational Fluid Dynamics (CFD) simulation results, which has/have been validated with results of laboratory experiments. The Experiments were performed over a trapezoidal channel using conical object as obstruction under various discharges. Numerical simulation is carried out using FLOW-3D software, which uses a Reynold's Averaged Navier-Stokes (RANS) solver with structured orthogonal grid and RNG turbulence model. The Experimental set up is replicated in FLOW-3D software and the simulation results are compared with the Experimental data. The numerical results show good resemblance with the experiment results. The average deviation between the simulation based and experimental water surface profile was found to be less than 2 percent. The comparison between the two flow profiles validated the simulation results. CFD based numerical simulations of the mobile flumes can thus be used to simulate flows with a wider range of discharge and flume dimensions.

Keywords- FLOW-3D, Numerical simulation, Computational Fluid Dynamics, Mobile flumes, Discharge measurement

DEVELOPMENT CHALLENGES IN WATER SECTOR: A CASE STUDY OF JAL JEEVAN MISSION, ASSAM

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ABSTRACT

Assam, situated in northeastern India, grapples with significant challenges in providing safe and sufficient drinking water despite its abundant water resources. The Jal Jeevan Mission (JJM) seeks to tackle these issues but faces obstacles such as groundwater contamination, engineering complexities in utilizing surface water, insufficient technical capacity, and the region's intricate geography. This case study examines the implementation of technological interventions within JJM in Assam, including mobile applications, online reporting systems, and monitoring dashboards. These tools, complemented by comprehensive training programs, have enhanced project management and execution. The outcomes underscore the creation of a sustainable infrastructure for managing Assam's water resources, demonstrating that targeted technological interventions can overcome initial challenges and effectively address water supply issues.

ater security and improved quality of life for the state's rural population.

Challenges in the utilization of water allocated by Krishna Water Dispute Tribunal-I in Upper Bhima (K-5) sub-basin of Krishna Basin, Maharashtra

1.0 Introduction

Water utilization in a river basin refers to the process by which water resources within the basin are allocated and used for various purposes, including agricultural, irrigation, and domestic consumption, industrial activities, energy production, environmental conservation, and recreational activities. The water availability per capita is constantly decreasing due to rising demand relative to the available water (Lakshmi et al., 2018). Factors such as massive population increase, rapid urbanization and industrialization, and changes in people's lifestyles are continuously increasing water demand causing stress on available water resources. To meet the increasing water demands, progressively larger quantities of water are being withdrawn from surface and subsurface water bodies which is highly detrimental to the river as well as the environment (Sharad Jain, 2020). Quantitative evaluation and visualization of water yield is helpful to understand the trends of water supply function of ecosystem and is beneficial to reveal the relationship between human beings and water resources, which is of great significance for scientific management and utilization of water resources (Lian et al., 2020). The sustainable development and management of water resources in large basins has become an important topic worldwide, requiring systematic and comprehensive scientific research (Li et al., 2022). Geographic and physical constraints, seasonal variability, lack of infrastructure or maintenance of existing infrastructure, legal and regulatory restrictions, and extreme weather events due to climate change are some of the factors playing important role in the effective utilization of water.

The Krishna River is the second-largest river in the peninsular India. It rises in the Mahadev Range of Western Ghats near Mahabaleshwar in Maharashtra at an altitude of 1335 meters above sea level, and after flowing through the States of Maharashtra, Karnataka, and Andhra Pradesh, drops into the Bay of Bengal at Vijayawada in Andhra Pradesh. River Krishna drains catchment area of about 2,58,948 sq. km., of which 69,425 sq. km. falls in Maharashtra which is nearly 8% of the total geographical area of the country. The Krishna Basin in Maharashtra State is divided into five sub-basins, Upper Krishna (K-1), Middle Krishna (K-2), Ghatprabha (K-3), Upper Bhima (K-5) and Lower Bhima (K-6). The Bhima River is one of the major tributaries of the river Krishna. The Upper Bhima sub-basin is situated almost entirely within the state of Maharashtra. The headwaters of the three major rivers in the Upper Bhima sub-Basin (the Sina, Bhima, and Nira), drain the upper catchment. The Krishna Water Dispute Tribunal –I have allocated 16564.28 Million Cubic Meters (Mcum) of water to the State of Maharashtra, out of which planned water utilization in Upper Bhima (K-5) sub-basin is 8690.27 Mcum. However, due to sectoral reallocations in many projects and actual water utilization observed in the K-5 sub-basin, it was necessary to check whether actual water utilizations in the K-5 sub-basin are as per planning and to find out the reasons behind non-utilizations of water. The paper highlights the challenges faced in harnessing water resources effectively in the Upper Bhima (K-5) sub-basin of Krishna Basin, in the State of Maharashtra, including issues of water availability, distribution, and management in utilizing water allocated by Krishna Water Dispute Tribunal-I.

WASTEWATER TREATMENT SYSTEM_REED BEDS – A SUSTAINABLE SOLUTION

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Abstract:
Reed beds are constructed wetlands that use natural processes involving vegetation, gravel and associated microbial assemblages to assist in treating wastewater. These systems are designed to mimic the functions of natural wetlands and provide an environmentally sustainable way to manage various types of effluents, including domestic, industrial, and agricultural wastewater. Reed beds operate through a combination of physical, chemical, and biological processes. The advantages of reed beds include low operational costs, minimal energy requirements, and the ability to integrate into natural landscapes. They are particularly beneficial in rural and remote areas where conventional wastewater treatment systems may be impractical or too expensive. Overall, reed beds represent a sustainable and effective solution for wastewater treatment, contributing to water quality improvement and environmental protection. As research and technology in this field advance, reed beds are likely to become even more efficient and widely used in various applications.
This paper will touch on the basic components of reed beds, civil design, and constructability aspects. As our industry is also driven by sustainable environment solutions, this paper will include on how reeds beds are crucial in achieving long – term environmental sustainability and resource conservation. The paper will also demonstrate various types of reed beds. Case studies will be presented with successful commissioned reed beds and on-site challenges with solutions.
Keywords: *Constructed Wetlands, Reed beds, surface flow, subsurface flow, sustainability*

TRANSMOGRIFICATIONS: OPEN CANAL TO HDPE PIPE & INTEGRATION OF SPRINKLER IRRIGATION IN 9,900 HA: A CASE STUDY OF SHIGGAON COMMUNITY IRRIGATION PROJECT, HAVERI, KARNATAKA

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Karnataka is one of the most water starved state in India and characterized by highest concentration of drought prone area. Rainfall pattern, period 1st to 31st Oct 2023, 19 districts out of 31, are deficient rainfall average 59% and 12 districts received normal rainfall. Shiggon, (District-Haveri) is the one most drought prone, water demand is 2023 mm and rainfall 768 mm, means there is deficient of 1255 mm water. That means available rainfall is not sufficient to meet the crop water demand and drinking water demand. The understanding of agricultural drought pattern requires not only analysis of rainfall records but also adequacy of soil moisture status called as moisture adequacy index (MAI) and calculated is the ratio of actual evapotranspiration (AET) to Potential Evapo-transpiration (PET), MAI at Shiggon is 39%, indicates as drought zone. In this area growers were unable to do agriculture and resulted in migration. Government of Karnataka decided to provide canal irrigation system in the territory Shiggon area 9,900 ha. They found that with canal system with discharge 6.1cumec, could water @3,000 ha area. In 2013-14, with limited resources & circumstances Jain Irrigation Systems Ltd made it possible to water 9,900 ha in the same discharge (6.1cumec) by replacing canal system to HDPE pipes and adapting advanced Sprinkler Irrigation by using water balancing and finite element method. Thereby it does not just help to serve the purpose of irrigation but also solves the problem of drinking water for the community and livestock as well.

The said article is highlighted the pre-post scenario of agriculture, design engineering aspects, comparison of Canal vs HDPE and case study.
The said project is an innovative in its nature and remain ideal example for all follow and replicate in drought prone area.

INVESTIGATING FEASIBILITY OF OPEN SOURCES DATA FOR THE ESTIMATION OF CATCHMENT RUNOFF, AND WATER STORAGE CAPACITY OF RAINWATER HARVESTING STRUCTURES: A REVIEW

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KEYWORDS
Rainwater Harvesting; feasibility, DEM, Cost optimization, Optimal Benefits

ABSTRACT:
India generally experiences a diverse rainfall pattern due to its geographical and climatic variations. The country has a monsoon climate, characterized by a southwest monsoon and a northeast monsoon. The temporally concentrated nature of rainfall, it becomes imperative to address the challenge of fulfilling water demands during non-monsoon periods. Therefore, the implementation of rainwater harvesting (RWH) strategies is deemed necessary to efficiently capture and store rainfall for subsequent utilization. The estimation of surface runoff and water storage capacity of the structures in a catchment is a crucial aspect of hydrological modeling and sustainable water resource management. Also, understanding the spatial distribution of water storage capacity is critical for studying saturation-excess runoff. Open-source data can provide valuable insights for estimation of the water storage capacity and possible water spread area in the catchments. It can also help in decision-making on the optimal size and cost-effective selection of RWH structures and also act as a critical tool for enhancing flood risk estimation. Therefore, the systematic review aims to investigate the feasibility of different resolutions of topographic data using open-sources for the estimation of runoff and water storage capacity estimation in a catchment. This review will examine the availability, reliability, and accuracy of open-source data to improve the accuracy of runoff and water storage capacity estimations in catchment. The findings will provide insights into the feasibility of using open-source data for RWH, potential benefits (i.e. optimal benefits, time and cost saving) and identify any potential limitations or challenges for the various stakeholders and decision makers.

Collaborative Strategies for
ADDRESSING WATER SCARCITY: INSIGHTS FROM INDIA-TANZANIA PARTNERSHIP

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Abstract

Access to clean water is not just a basic human necessity; it's a fundamental driver of socio-economic development, particularly in regions grappling with water scarcity. Even today, many parts of the world are still dealing with the water crisis, which India has been able to overcome in the recent years through its meticulous planning, technological advancements.

Tanzania, where water scarcity poses significant challenges, the development of robust water infrastructure is paramount, which is required to be improved through infrastructure development.

WAPCOS, a premier global consultant under the aegis of the Ministry of Jal Shakti, Govt. of India, has established presence in more than 50 countries, backed by its proven track record for overcoming technological and socio-economic challenges is bestowed to render engineering solutions, beyond Indian borders, for resolving water crises internationally through collaborative efforts.

With the backing of a substantial USD 1 billion line of credit and a wealth of technical expertise, the GoI is spearheading initiatives to bolster water infrastructure and alleviate scarcity in Tanzania.

Through the strategic deployment of resources and meticulous planning, WAPCOS has emerged as a key player in Tanzania's water sector, bringing to bear its technical prowess and innovative approaches to overcome complex challenges.

The paper explores the multifaceted nature of the water crisis in Tanzania, shedding light on the various technological, ecological, and financial hurdles that impede progress in water infrastructure development. Outdated infrastructure, limited access to modern technologies, and inadequate technical capacity present formidable technological barriers, while increasing water demand from diverse sectors strains fragile ecosystems, posing significant ecological challenges. Moreover, the high upfront costs associated with constructing reservoirs, treatment plants, and distribution networks exacerbate financial constraints, hindering the realization of sustainable water solutions.

In response to these challenges, the paper delineates the strategic measures adopted to address each facet of the water crisis. From the utilization of suitable materials and cutting-edge technologies to optimize efficiency and mitigate environmental impact, to conducting comprehensive feasibility studies and implementing cost-effective designs to alleviate financial burdens, WAPCOS demonstrates a holistic approach to water infrastructure development.

Through a detailed analysis of successful project executions and lessons learned, the paper underscores the transformative impact of international collaboration in advancing water security and achieving sustainable development goals. By leveraging Indian expertise and resources, GoI-funded water supply schemes in Tanzania hold the promise of improving public health outcomes, fostering economic development, and laying the groundwork for long-term resilience.

In conclusion, this paper serves as a testament to the power of strategic partnerships and technical ingenuity in confronting complex global challenges. As the world grapples with the imperative to ensure universal access to clean water, the collaborative efforts between the GoI, WAPCOS, and stakeholders in Tanzania offer a blueprint for sustainable progress and collective action on the path toward water security.

Keywords: Water Scarcity, Collaborative Solutions, Infrastructure Development, Sustainable Development Goals (SDGs), Technological Challenges, Ecological Considerations, Financial Constraints

A CASE STUDY FOR "IN-SITU" GREYWATER MANAGEMENT IN VILLAGES

Author: A. Mohan, Co-Founder – WSAFE Sustainability Services Pvt. Ltd. MSME, Startup India – Incubated AIC IISER PUNE. A. Mohan is a seasoned IT professional who has developed a strong interest in water conservation and revitalizing water ecosystems. He firmly believes in the restorative abilities of natural waterbodies, provided that their native aquatic ecology is revitalized. A. Mohan is dedicated to advancing year-round water conservation efforts through his initiative "Catch The WasteWater," which aims to promote the significance of water conservation beyond just seasonal "Catch the Rain" campaigns.

Water is a complex and often misunderstood subject, and waterbodies are usually undervalued as mere pool or reservoirs of Water, whereas they are God's gift to all the terrestrial life forms. These bodies of water uniquely converge soil, water, and air, enabling them to naturally decontaminate water, recharge and enrich groundwater, mitigate air pollution, conserve biodiversity, maintain & manage ambient temperature in the vicinity and act as a blue carbon sink, through their native aqua ecology – all as a part of ecosystem services. However, this capacity is dependent on the health and vitality of the waterbody.

Ecological rejuvenation of waterbodies is vital for sustainable & holistic natural resource management, for climate change mitigation, combating global warming, promoting biodiversity, carbon sequestration, and biodiversity conservation.

This article explores an In-Situ waterbody rejuvenation project by WSAFE Sustainability Services that was implemented at Hassanpur Village in Murthal, district Sonipat, of Haryana state, showcasing substantial improvements in water quality and positive impacts on behavioural changes as well as community engagement. The project was funded through WaterAid and was implemented using our Nature Based Solution.

CHARACTERIZATIONS OF SOME SELECTED CLAY TYPES FOR COST EFFECTIVE WASTEWATER TREATMENTS

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KEYWORDS: Water pollution, Water treatment, Clay, Adsorption, Absorption, Filtration

ABSTRACT

Water pollution is a significant issue affecting water consumption, including drinking. Factors contributing to water pollution include industrial waste, improper garbage disposal, waste accumulation, and natural phenomena. Water treatment is essential for managing water and maintaining environmental standards. Physical, chemical, and biological methods are used, but chemical reagents and complex systems are common. Recent research has focused on cost-effective earth materials, offering advantages such as affordability, ease of use, health benefits, and abundance. This study analyzed the characteristics of selected naturalmaterials for wastewater treatment, specifically through processes like adsorption, absorption, and filtration. Several earth materials abundant in Sri Lanka, including three different types of clays were chosen for evaluation. The research revealed that all clays contain over 75% iron as major clay minerals, with some exhibiting finer particles for increased porosity and permeability. These raw materials can be used to manufacture wastewater treatment systems for the removal of suspended and dissolved solids, heavy metals, pathogens, oils, and toxic compounds. Their unique chemical compositions make them suitable for catalytic and advanced chemical purposes.

WASTEWATER MANAGEMENT – RECYCLE, REUSE AND CIRCULAR ECONOMY

Circular Economy (CE) is a concept that encourages sustainable material and energy management by minimising waste, the amount of waste produced and its potential for re-use as a secondary material.The main reasons for implementing a circular economy are limited raw material availability, the economy's reliance on raw material imports (high prices, market volatility, and uncertain political situations in certain countries), and the economy's decreasing competitiveness in global economies.

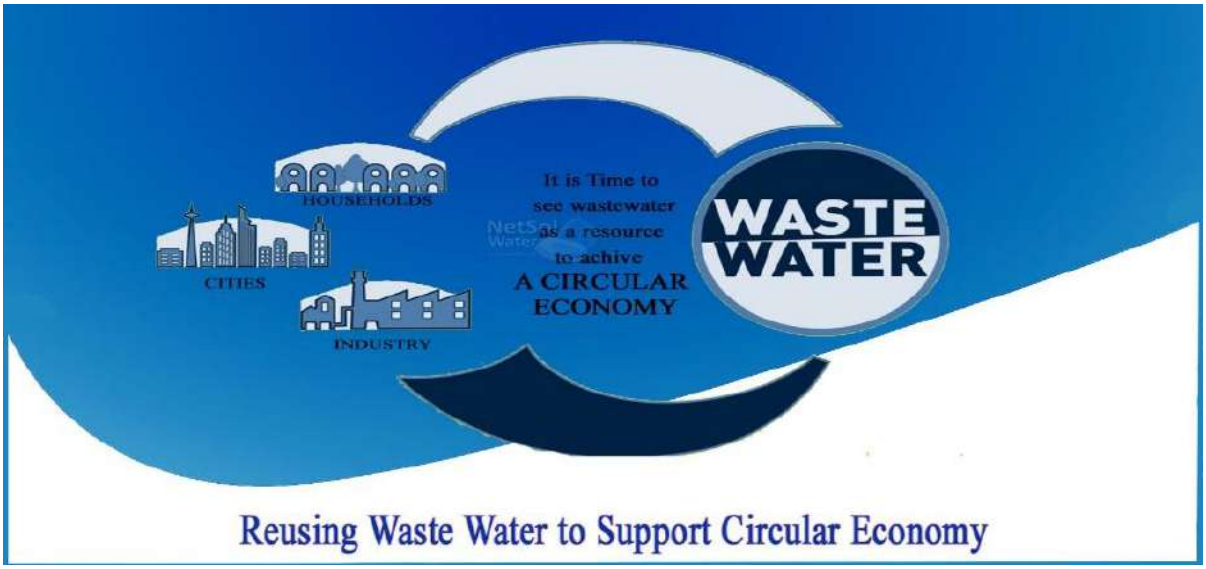
A circular economy model in wastewater management emphasises the shift from viewing wastewater as a nuisance to be disposed of to a valuable resource that, when managed judiciously, can play a pivotal role in fostering sustainable development.
The reuse of treated **wastewater** from **WWTPs** for agriculture and land irrigation, industrial purposes, toilet flushing, and groundwater replenishment is a key component of the current strategy aimed at releasing freshwater for domestic use, improving the effluent quality of WWTPs, and, as a result, improving the quality of river waters used for drinking water abstraction.

Wastewater Management for Circular Economy:
This can be summed-up in a single sentence “Treat, Recycle and Reuse wastewater at source”.
Carrying wastewater from one place to another to treat in a centralized unit need:

1. Infrastructure for sewage conveyance from one palace to annother
2. Huge funds at one go to execute centralizsed projects,
3. Large amount of electrical power and
4. Significant execution time.

Instead, if we treat the wastewater in “Decentralized” units with small capacities and reuse it at source like what is done at a SBM (Swachh Bharat Mission) public toilet at Sangamner.

The unit working can be seen at https://youtu.be/7qJPt-z4U6Q



A Case Study as an example:
A small “FBTec®” unit is installed at a SBM public toilet at Sangamner to treat, recycle and reuse wastewater from the toilet. Lets see how it impacted to support the circular economy.

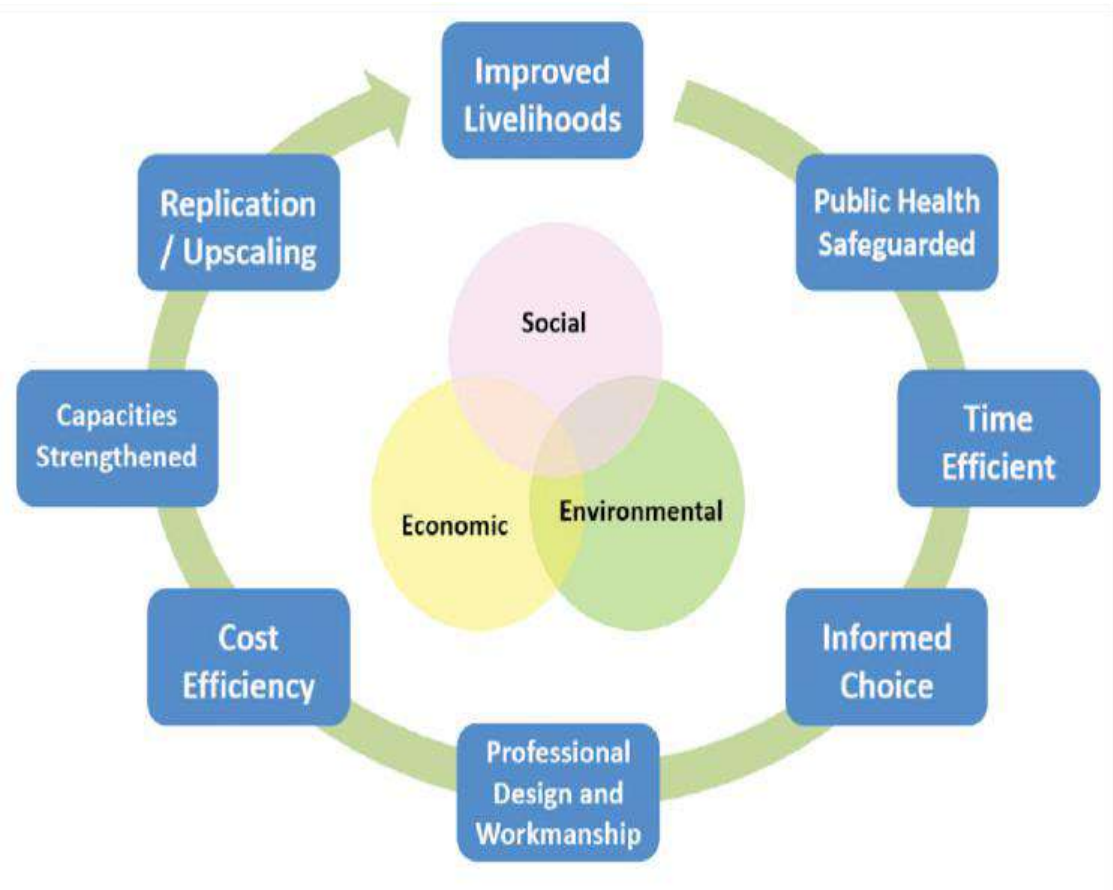
1. Conditions before “FBTec®” installation leading to problems:


The pubic toilet was using freshwater for toilet flush which was getting into the nearby open areas leading to foul smell and mosquito breeding. Moreover, as the toilet would run out of water after just half a day, people would not use it adding to the problems.

2. The solution:

The local government body installed a 20 KLD “FBTec®” unit at the SBM toilet and treated the wastewater from the toilet which was recycled and reused for the same toilet flushing.

3. Net Impact as a circular economy:



1. Wastewater generated was treated and reused at source which stopped getting drained on the open fields nearby and cleanliness of the area was maintained.
2. Foul smell and mosquito breeding stopped.
3. As the waste-water was reused for toilet flushing, fresh water saving for that much amount increased.
4. Avoided the fresh water contamination thereby saving the water-body.
5. “FBTec®” installation helped in creating the job of an operator.

RESOURCE RECOVERY FROM CONSTRUCTED WETLAND: OPTIMIZATION OF BIOGAS GENERATION POTENTIAL OF *CANNA INDICA*

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KEYWORDS
Anaerobic Digestion, Biogas, Constructed Wetlands, Canna Indica, Resource Recovery

ABSTRACT:
Constructed wetlands are an effective wastewater treatment technique that uses natural processes involving vegetation, soil, and microbial communities to remove pollutants. The post-treatment disposal of harvested wetland plants presents an environmental problem. This study investigates the potential of producing biogas from harvested wetland plants (*Canna indica* with 27.4 C/N ratio and 12.38% of TS%) by anaerobic co-digestion with sewage sludge. The biogas yield was optimized by evaluating various mixing ratios (50:50, 70:30, 80:20, 90:10, 100:0, 0:100) of *Canna indica* and sewage sludge with inoculum to substrate ratio (ISR) of 1. The 90:10 (Canna indica: sewage sludge) mixture with 4.14% of TS%, 49% of VS removal and C/N ratio of 15.42 demonstrated the highest biogas production of 724 mL/gVS, which was 76 % and 4% higher than mono-digestions, i.e., sludge: 172 mL/gVS and CI: 695 mL/gVS. respectively. There were significant reductions in both volatile solids (49%) and total solids (38%), suggesting effective anaerobic digestion. The 90:10 mixture effectively degraded organic matter with 33% reduction in soluble chemical oxygen demand and 52.5% reduction in total chemical oxygen demand. The stability of anaerobic digestion was facilitated by the levels of alkalinity and volatile fatty acids. The volatile fatty acid/alkalinity ratio was 0.25-0.4 under steady state conditions. It shows that the process was more stable. The pH values were observed within the optimal range of 7.0-7.5 throughout the batch study ensuring favorable conditions for methanogenesis. The mixed of nitrogen rich sludge and carbon rich *Canna indica* provided optimum nutrient balance, microbial synergy, and medium buffering and resulting in enhanced biogas production and VS removal. The findings of this research indicate the feasibility of combining constructed wetlands and anaerobic co-digestion for sustainable biogas production, contributing to renewable energy generation and resource recovery from wastewater treatment system.

SELENIUM REMEDIATION FROM AQUEOUS SOLUTION USING INDUSTRIAL WASTE: A SUSTAINABLE APPROACH

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KEYWORDS
Selenium, Adsorption, Dolochar, Iron Tailing, Iron Slag

ABSTRACT: (9 pt)
Selenium contamination is a growing concern worldwide due to its adverse impact on humans and the ecosystem. These pollutants can cause serious health hazards, such as cancer, neurotoxicity, and cardiovascular problems, even at trace doses. Iron-based compounds are becoming increasingly popular among adsorbents because of their remarkable adsorption characteristics and diverse nature. This paper investigated the potential characteristics of waste generated from iron industries for selenium removal from aqueous solutions. The morphological and chemical characteristics were determined by SEM, EDX, XRD, BET, pHzpc, BET, and FTIR. The pHzpc of dolochar (D), iron tailing (IT), and iron slag (IS) are 10.4, 6.5, and 10.7, respectively. The FTIR analysis indicated the presence of different functional groups, such as alcoholic, amide, alkane, and carboxyl groups, which assist in adsorption. The heterogeneity of the adsorbent was observed in XRD analysis. A comparative study on selenium removal efficiency was conducted using a batch study at predetermined parameters. The experiment demonstrated that ~30%, ~91%, and ~93% of the selenium were removed from the aqueous solution by IS, D, and IT, respectively. Iron tailing showed better potential for selenium removal from aqueous solutions than others. Though the surface area of dolochar was higher than others, the presence of iron helped in better adsorption. Thus, the study suggested that iron tailings can be used as a low-cost iron-based adsorbent for selenium removal from different industrial wastewater.

Utilizing Of Surface Modified Coal Fly Ash for the Remediation of Acid Mine Drainage Water: A Sustainable and Efficient Alternative

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KEYWORDS
Acid mine drainage, Industrial byproduct, Sulfate, XRD, SEM-EDX

ABSTRACT:

Acid mine drainage (AMD), generated during coal mining activity, is characterized by its low pH and high levels of metals and sulfates, poses a severe threat when discharged into aquatic ecosystems. Traditional methods employ commercial alkalis like lime, caustic soda, and limestone to elevate the pH of AMD water, enabling the precipitation of metals and the formation of gypsum ($CaSO_4.2H_2O$). This study explores the feasibility of utilizing coal fly ash (CFA) for the synthesis of Zeolite X, as a low adsorbent for removing pollutants from synthetic and coal mine sump water. The morphology and chemical composition were comprehensively analyzed using XRD and SEM-EDX techniques before and after the adsorption study. The mine water sample was collected from the sumps of coal mine in Odisha, and synthetic water was prepared in the laboratory scale. The surface morphology of Zeolite shows regularly shaped, angular, and porous structures, according to SEM analysis. The porous structure increases surface area and reactivity, making it useful for AMD treatment. Both raw CFA and Zeolite XRD patterns showed amorphous and crystalline phases due to presence of compounds of silicates and aluminates. Zeolite emerges as a promising and cost-effective alternative for treating AMD, addressing the dual challenges of metal removal and acid neutralization. The maximum sulfate removal efficiency was found to be between 60 to 70 percent. The calcium and sodium content facilitates sulfate precipitation and neutralization reactions, making it a valuable option for mitigating the environmental impact of AMD discharges. This research contributes to the sustainable management of AMD while utilizing an industrial byproduct, presenting a solution for both the mining and thermal power plant and environmental conservation efforts.
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COMPREHENSIVE CHARACTERIZATION OF VARIABLY PROCESSED SEWAGE SLUDGE AND INDUSTRIAL TEXTILE SLUDGE TO CLASSIFY ITS SUITABILITY FOR SAFE DISPOSAL

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KEYWORDS
Sewage Sludge, Characterisation, Textile sludge, Treatment, Solidification

ABSTRACT

Comprehensive characterization of variably processed sewage sludge and industrial textile sludge to classify its suitability for safe disposal

Part A. In India, sludge from STPs is usually disposed on land as manure or dumped in open areas. Hence, for effective sludge management in India and to understand the fate of sludge on land application, the comprehensive characterization of dewatered or treated sludge in terms of pathogens, vectors, and heavy metals is desired.
For the study purpose, sixty-two dewatered sludge samples were collected from forty STPs based on various treatment processes and were examined for physical-chemical parameters and microbiological parameters. The findings revealed that most of the dewatered sludge samples have a range of pH (6.5-7.5), conductivity (<4 ds/cm), total organic carbon (>12%), TN (>0.8%), TP (>0.4%), and C:N ratios (<20) within the threshold range of the Indian Standard (Fertilizer Control Order (FCO) 2009). Moreover, the heavy metals concentrations meet USEPA Class B sludge quality criteria but failed to meet the limiting concentrations of heavy metals and pathogens specified by USEPA Class A sludge and FCO-2009 standards. Almost, the pH, conductivity, TOC, TN, TP, TK and C/N values complying 90, 100, 98, 100, 100, 52 and 100%, respectively, with FCO 2009 standard. Similarly, heavy metals were complying with FCO 2009 guidelines in a percentage of As (90%), Cd (71%), Cr (60%), Cu (95%), Pb (87%), Hg (44%), Ni (84%) and Zn (69%). Overall, all dewatered sludges already satisfy the US EPA Class B criteria. Hence, it is further suggested that various techniques such as composting, natural/thermal/ greenhouse drying, chemical stabilization, long term storage, blending with local soil need to be evaluated under Indian conditions to achieve USEPA class A or FCO parameters.

Part B. This study attempted towards characterisation and finding an environment friendly and cost –effective solution for management of chemical sludge. The chemical sludge samples were collected from various Common Effluent Treatment Plants (CETPs) and subjected to characterization studies. The characterization studies revealed that sludge was alkaline in nature with high electrical conductivity values. The total dry solids in the sludge were varying from 33.35 % to 94.60 % and volatile solids were 34.30 % to 48.37 % of the total solids. The values of Total Organic Carbon (TOC) were also varying to a large extent ranging from 1.23 % to 17.82 %. The concentrations of heavy metals Cr, Cu, Ni, Zn, Cd, Co and Pb in the raw dried sludge as well as leachate were found to be less than the prescribed limits.
Solidification/Stabilization (S/S) of chemical sludge was carried out using binder systems i.e. Ordinary Portland Cement (OPC) so that it can be utilized in the construction material. Evaluation of solidified samples was carried out in terms of physical engineering properties and chemical properties in terms of leachability of heavy metals. The results indicate that chemical sludge has a potential to be used as construction material for different kinds of applications.

NATURE BASED STP 'JALSHUDHI' – AN INITIATIVE OF THE ART OF LIVING SOCIAL PROJECTS

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KEYWORDS
JalShudhi, Nature Based STP, Biofilter, Phytoremediation, Microorganisms

ABSTRACT

As urban population increases, the challenge of managing increased volumes of sewage becomes ever more pressing. This is particularly true in burgeoning cities where rapid growth has outpaced the development of adequate infrastructure. Conventional wastewater management systems are not only expensive but also pose environmental risks and produce significant amounts of sludge. In light of these issues, there is an increasing shift towards exploring more sustainable and cost-effective solutions. Moreover, among the alternatives, biological treatment processes are gaining favour. At the Art of Living Social Projects, nature based sewage treatment plant 'JalShudhi' is used for waste water treatment. It leverages on the natural processes involving filter media, plants, microorganisms and bioenzymes to detoxify wastewater. This biological system is praised not only for its efficiency in purifying water but also for its negligible environmental footprint. This approach is natural and eco-friendly, less power consuming, aesthetically pleasing, without need for skilled manpower, with low operation and maintenance cost, is sustainable and without the problem of sludge disposal.The principle is that the waste water moves through the filter medium likes stones of different gradation, plants with phytoremediation potential and the microorganisms. The approach is customised for water treatment depending on the feasibility, the treatment of stream, pond and lake being different from that of a domestic sewage treatment plant. Canna plants are mostly chosen for growing on the biofilters as it thrives on sewage deriving its nutrients, is aesthetically pleasing, moisture loving, has good biomass and is with an ability to remove certain harmful chemicals and heavy metals. Other plants with phytoremediation potential like Vetiver, Calla Lily, Heliconia, Colocasia, Umbrella grass etc are also used. Need based use of earthworms to improve aeration of the media, reduce compaction and decrease the rate of clogging of biofilters. Microorganisms play a significant role as their enzymes are chiefly involved in the breakdown of organic materials in wastewater. They are the engineers governing major ecological processes. Need based dousing of bioenzymes into the treatment system has also improved the water quality. Both treated and untreated waters were tested for key parameters like pH, TSS, BOD, COD, Ammoniacal Nitrogen, Total Nitrogen and Faecal coliform bacteria. Presently, the treated water meets all the standards for release into the water body and for use in landscape and in toilet flush.

RADHAKUNJ LAKE- A CASE STUDY OF NATURE BASED SOLUTION TO MITIGATE WATER POLLUTION

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KEYWORDS
Water pollution, Nature Based Solutions, Multipronged approach, Phytoremediation, Microorganisms

ABSTRACT

Water being one of the most important of natural resources, is being polluted at an alarming rate. Water plays a crucial role not only for domestic use but also for agriculture and industry. Drainage from residential layouts, industrial effluents, livestock and agricultural runoff has mainly contributed to the pollution of water bodies. Radhakunj Lake situated in the Art of Living International centre faced severe pollution issues leading to the loss of aquatic life. Also, the resulting stench made it unbearable for the numerous people visiting the campus. The lake was polluted because of the multiple drains being let out from residential areas and small scale industries upstream. The Biochemical Oxygen Demand (BOD) and the Chemical Oxygen Demand (COD) levels of water was high; and dissolved oxygen (DO) content low. To mitigate pollution in the lake and upstream; Nature Based Solutions (NBS) using a multi pronged approach was tried. These included construction of boulder checks, phytoremediation (use of plant), phycoremediation (use of algae), bioremediation (use of sewage degrading microorganisms); each targeting different aspects of pollution mitigation. Boulder checks composed of loose boulders were strategically placed so as to remove the debris and to increase filtration of water. Phytoremediation using plants remove, detoxify or immobilize contaminants from the environment. In the lake and upstream, the natural vegetation with phytoremediation potential was documented. Hyperaccumulators like Canna and Vetiver were planted in the riparian zone. The sewage degrading microorganisms were introduced in special structures called biobridges and water made to pass through it. Micronutrients were sprayed in the lake so as to enhance the growth of diatom algae. Aeration was provided using a fountain in the lake. Sampling stations were set up along the stream and in the lake to monitor water quality parameters such as pH, BOD, COD, and DO levels. Results indicated significant improvements post-intervention, with notable reductions in BOD and COD levels, indicating a decrease in organic pollutants. Moreover, the DO levels showed an increase, indicating better conditions for aquatic life. The implementation of these interventions led to a substantial improvement in water quality, with the lake transitioning from a polluted state to a thriving ecosystem. The combination of boulder checks, plant-based remediation, microbial action, an enhanced growth of algae and aeration system at the lake proved effective in mitigating pollution and restoring the health of the water body. This research underscores the importance of adopting sustainable and holistic strategies to combat environmental degradation and protect fragile ecosystems from the adverse effects of pollution.

Integration of TADOX® Technology to achieve ZLD & Net Zero in Textile Wastewater treatment: Case Study from Namami Gange Programme

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ABSTRACT

Textile & Dyeing Wastewater Treatment faces the most challenging issue of removal of colour and dissolved organics, which in turn impacts the biological treatment making it shock prone and leading to inadequate treatment with discharge of coloured effluent in the rivers. This also impacts downstream tertiary treatment and makes ZLD highly resource and energy intensive and hence unsustainable, unaffordable, unacceptable and non-compliant. It is in this pursuit, The Energy and Resources Institute (TERI), New Delhi, has developed a novel technology called TERI Advanced Oxidation Technology (TADOX®), which involves UV-TiO_2 Photocatalysis as an Advanced Oxidation Process (AOP), which removes colour and dissolved organics from the effluent and help curb point source pollution. Central to this study is the Pilot demonstration of TADOX® Technology at the scale of 20 KLD (20,000 Liters per day) in a Textile Common Effluent Treatment Plant (CETP) in Rooma Industrial Area, Kanpur, UP. This project was funded by the National Mission for Clean Ganga (NMCG), Ministry of Jal Shakti (MoJS), Govt. of India. The standalone TADOX® Technology plant treated raw effluent from the equalisation tank at a capacity of 20 KLD and showed exceptional operational resilience and adaptability for over seven months of continuous operation (Feb-Sept 2023). Notably, the system made significant reductions in key pollutants such as TSS by 97.8%, Oil and Grease by 92.3%, COD by 94.5%, BOD by 96.5%, and colour intensity by 98.2%. Further, this project contributed to a National Mission demonstrating groundbreaking advancement in R&D of an indigenous technology taken from a lab to a field scale pilot. This project showcased a first-of-its-kind initiative globally of the successful demonstration of Advanced Oxidation Photocatalysis (AOP) based technology like TADOX® at 20 KLD capacity in a Textile CETP. Life Cycle Assessment (LCA) of the Pilot run results showed 32.11% reduction in GHG emissions. With TADOX® OPEX reduces by 40% than the conventional treatment. If Solar-PV is further integrated with TADOX®, then OPEX is expected to be reduced further by 40% and also Net Zero Targets would be achieved.

HIGHLIGHTS

- Direct TADOX® treatment for textile wastewater achieved 99% decolorization, 94.5% COD and 96.5% BOD reduction.
- TADOX® integration reduces GHG emissions by 32.11% compared to conventional ZLD systems.
- TADOX® integration will help achieve ZLD with CAPEX lowered by 50% and OPEX by 40%.
- Energy consumption reduced by 30%, and further integration of renewables with TADOX may lead to achieving Net Zero Target in wastewater treatment.
- Achieving ZLD and Net Zero Targets together now possible with TADOX® integration in existing wastewater treatment plant.

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KEYWORDS

Textile wastewater, Advanced Oxidation Processes (AOPs), Life Cycle Assessment (LCA), Environmental sustainability, Zero Liquid Discharge (ZLD).

COMMUNITY-DRIVEN GREYWATER MANAGEMENT FOR SUSTAINABLE REUSE: A CIRCULAR ECONOMY APPROACH BY DHAN FOUNDATION

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KEYWORDS
Greywater Management, Community-Driven, Nature-Based Systems, Decentralized Solutions, Sustainable Reuse

ABSTRACT:
DHAN Foundation, a professional NGO operating across 16 states in India, is dedicated to alleviating poverty for nearly 5 million vulnerable individuals by establishing strong community institutions. With a track of revitalizing over 6,000 surface water bodies for irrigation and drinking, DHAN Foundation has recently added its focus to community-driven greywater management. Greywater, which excludes human excreta, represents a substantial opportunity for sustainable reuse in agriculture and urban water systems. This paper presents DHAN Foundation's innovative approaches to greywater management through community-driven and technically advanced pilot projects. In Kathiayanoor, Madurai, constructed wetlands were implemented to treat greywater, leading to a significant increase in dissolved oxygen (DO) levels and improved water quality. Similarly, in Gariamma Cheruvu, Visakhapatnam, leach pit models addressed minor greywater inflows effectively, demonstrating a practical decentralized solution. At the household level, the Foundation promotes leach pit construction among rural households, enhancing water conservation and minimizing the dependency on freshwater resources. A key case study discussed is the restoration project at Saravana Poigai, where the DHAN employed nature-based systems and community engagement to improve water quality. The approach in Kathiayanoor highlighted the effectiveness of nature-based systems, with notable improvements in pH, free ammonia, and biological oxygen demand (BOD), showcasing the system's capability to manage organic loads and support fish rearing. In Gariamma Cheruvu, the leach pit's success in handling minor greywater inflows underscores the potential of localized solutions in urban environments. In saravana Poigai towards organic solutions like Saced groves.

This paper emphasizes that enabling local communities is crucial for addressing social and technical challenges. Grassroots involvement ensures sustainable solutions, as evidenced by the successful implementation of Sharamadhan events and community-driven actions. The integration of traditional wisdom with modern techniques fosters a holistic approach to water management, proving that decentralization and community participation are key to achieving sustainable environmental goals. DHAN Foundation's vision of transforming cities into models of sustainable water reuse through greywater management reflects a commitment to creating a replicable, circular economy that benefits both urban and rural areas.

HARNESSING BAMBOO FOR WATER PURIFICATION AND WASTEWATER TREATMENT: A SUSTAINABLE APPROACH

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KEYWORDS

Bamboo, charcoal, activated charcoal, heavy metal, synthetic dyes, pollutants, wastewater treatment, water purification

ABSTRACT

Bamboo is a promising alternative to traditional wastewater treatment due to its unique properties. Its fibrous structure and high porosity make it ideal for natural filtration systems. Bamboo also exhibits remarkable capabilities in phytoremediation, which helps absorb and neutralise pollutants. Its rapid growth in diverse climates supports sustainable forestry practices and provides economic opportunities for communities. Bamboo's natural filtration properties can be utilised in wastewater treatment, particularly in constructed wetlands, biofilters, and activated carbon. These wetlands create a conducive environment for microbial activity, resulting in cleaner effluent. Bamboo-derived biochar/ activated carbon adsorbs contaminants and effectively removes water pollutants (organic impurities, agrochemicals, heavy metals, and toxins). It is also used for potable water purification.

WC-7

APPLICATION OF COMPARATIVE INDICATORS FOR PERFORMANCE EVALUATION AND BENCHMARKING OF IRRIGATION PROJECTS IN MADHYA PRADESH

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Abstract

The performance evaluation and benchmarking of the irrigation projects are important management tools to improve water use efficiency and financial viability along with the adoption of best management practices and the environmental sustainability of the irrigated agricultural system. It is important to evaluate the performance of the irrigation projects on a continuous basis to identify bottlenecks, constraints, managerial laps and other grey areas in the system and to provide direction for improvement in water resources development and management strategies to reap its full benefits on a long-term basis. The Madhya Pradesh state has achieved a significant rise in irrigation and agricultural production in recent times. The same pace of sustainable development in the waters sector will be a key factor to meet the increasing future water demands in the state. This can be achieved through the benchmarking of irrigation projects and formulation of strategies based on the performance evaluation of irrigation schemes in the specified geographical unit, agro-climatic zone, river basin, state, etc. In the present study, the performance of the Kotwal-Pillowa complex irrigation project located in Madhya Pradesh has been evaluated using comparative indicators suggested by the International Water Management Institute (IWMI).

The performance evaluation analysis was carried out for the Rabi seasons in 2005-06, 2009-10, 2013-14, and 2015-16. Mustered wheat and gramme were the principal crops grown in the Kotwal-Pillowa command during these rabi seasons. The average yield in the command area was observed increased significantly from 1.21 ton/ha in 2005-06 to 1.79 ton/ha in 2015-16. It was observed that the output per unit cropped area was 13523 Rs/ha in the year 2005-05 and it was increased up to 45220 Rs/ha in the year 2013-14. The output per unit command area was seen increased from 28425 Rs/ha in the year 2013-14 to 51272 Rs/ha in the year 2015-16. Though the year 2015 was a dry year, output per unit of irrigation supply was better i.e. 6.53 Rs/m^3, this was because of a high gross return due to adaptation of proper water management practices and crop selection. The relative water supply index and the relative irrigation supply were seen improved with time and were found better in the year 2015-16. The water delivery capacity index analysis indicated that the dam's infrastructure is capable of delivering water to meet peak water demand. Thus, it could be concluded that the performance of Kotwal-Pillowa irrigation project has been improved significantly in terms of its agricultural, water use based performance in the recent period especially after 2013-14, which is due to additional water supply from Gandhi Sagar dam on Chambal River, increased cropped area and adoption managerial practices. The performance evaluation has found to be a very simple method as comparative indicators are very easy to calculate by using field data and useful for formulation of benchmarking criteria to assess the progress of irrigation projects against strategic goals and to formulate strategies to improve system operations.

Key Words: *Performance evaluation; comparative indicators; SGVP; relative water supply; relative irrigation supply; water delivery capacity.*

DATA-DRIVEN OPTIMIZATION OF PUMPED STORAGE SYSTEMS WITH ORANGE: ENHANCING EFFICIENCY AND RELIABILITY

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Abstract: This paper provides a comprehensive examination of the use of Orange, a versatile data mining and machine learning software, in optimizing the efficiency and reliability of Pumped Storage Systems (PSS). The authors discuss the importance of PSS in energy storage and grid stability, and highlight the limitations of traditional efficiency measurement techniques. The paper appraises the current state of the art in PSS optimization, including the application of machine learning algorithms and data-driven approaches. The authors also explore the potential of Orange in enhancing the efficiency and reliability of PSS, and discuss its capabilities in data preprocessing, visualization, and modelling.

Keywords: hydroelectric power plant, energy storage system, machine learning integration, mathematical models, data mining tool.

A COMPREHENSIVE INGRESS PROTECTION TEST FACILITY AT CW&PRS FOR LARGE SIZED HYDRO-METEOROLOGICAL INSTRUMENTS

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Abstract: India is a growing economy and recent development in water sector is enormous. Lots of agencies are installing various instruments such as Automatic Weather Stations, Water level Sensors, Flow Sensors, Data Loggers, Telemetry, Control Panels, Enclosures, etc. These instruments will have to experience various environmental stresses during their expected life in field condition. To sustain the different environmental conditions, these instruments have to be tested for Ingress Protection (IP XX) rating prior to the field installation. The preferred IP rating for any instrument depends on the exposure to solids or liquids that the instrument is expected to receive during operation. To ensure the reliability of any particular instrument, the IP rating needs to be selected such that the instrument can withstand the expected worst-case exposure. CW&PRS has developed a comprehensive IP testing facility under National Hydrology Project, which can test the whole range of IP11 to IP 69K. This paper discusses IP standards, code and practice pertaining to Hydro-meteorological Instruments. The uniqueness of testing facilities developed at CW&PRS to perform for large sized sample test has been discussed in detail.

Keywords: Ingress Protection rating, Hydro-meteorological instruments, IP test on large sized sample, reliability, Electrical Environmental test facility.

PROACTIVE MANAGEMENT OF DAM INFRASTRUCTURE: ENHANCING WIRE ROPE INTEGRITY THROUGH ADVANCED MAGNETIC TESTING TECHNIQUES

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KEYWORDS

Wire rope integrity, Magnetic testing, Non-destructive testing (NDT), Proactive management, Condition assessment

ABSTRACT:

Ensuring the integrity of wire ropes in dam infrastructure is critical for maintaining operational safety and reliability. Wire ropes are essential for the functioning of gates, hoists, and other mechanical systems within dams. Traditional inspection methods often fail to detect internal defects early, posing significant risks of unexpected failures. This paper explores the use of advanced magnetic testing techniques, specifically Magnetic Flux Leakage (MFL) as non-destructive testing (NDT) method to enhance the proactive management of wire ropes in dam infrastructure. Magnetic testing offers significant advantages over traditional inspection methods. MFL magnetizes the wire rope and detects disturbances in the magnetic field caused by defects such as broken wires and corrosion. This technique enables early detection of both internal and external defects, facilitating timely maintenance and preventing catastrophic failures. Implementing magnetic testing as part of a regular inspection regimen enhances safety by ensuring consistent wire rope integrity. This proactive approach leads to substantial cost savings by preventing emergency repairs and reducing unplanned downtime. Additionally, continuous monitoring and maintenance based on magnetic testing data can optimize the investment in the critical components. This paper discusses practical steps for integrating magnetic testing into dam infrastructure management, including establishing routine inspection schedules, analysing test data, and training personnel in magnetic testing techniques. It also emphasizes the importance of complementing magnetic testing with other NDT methods for a comprehensive assessment of wire rope integrity. In conclusion, the advanced magnetic testing technique provides a robust, reliable solution for enhancing the proactive management of wire ropes in dam infrastructure, supporting safer and more efficient dam operations.

GROUNDWATER OCCURRENCE: AQUIFER DISPOSITION AND IRRIGATION WATER QUALITY ASSESSMENT IN BARAK

Valley,Assam,North East India.

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Abstract: Barak Valley lies in the Southern part of Assam. Majority of the population living in Barak Valley are dependent on agriculture for their livelihood. During the year 2021-2023 around 3586 numbers of shallow tube wells were drilled in the region under PMKSY HKKP scheme by the Irrigation department of Assam creating an irrigation potential of 9648 Ha. Due to the absence of continuous granular zones in the region, 549 shallow tube wells are reported non functional. From the 2D aquifer disposition section, it is evident that thick clay layer overlies the shallow aquifer in the region with the top soil being sandy clay/ clayey sand. A thin granular zone of limited extension is present in the aquifer within 30-50mbgl. As a result, the shallow aquifer upto 30-50mbgl is of moderate yield. The deeper aquifer upto 300mbgl has alternate Tertiary sandstone and shale layer. The deeper aquifer in certain part of Barak valley has better yield for irrigation than the shallow aquifer. The irrigation water quality is also studied using many irrigation indices like TDS, Salinity hazard, Na%, SAR, RSC, MH and KI for both the unconfined and confined aquifer. Based on the irrigation indices, it is evident that the groundwater quality of unconfined aquifer is more suitable for irrigation than the confined aquifer.

Key words: **Barak Valley, Irrigation indices, Groundwater quality, Aquifer disposition, North East India**

CHALLENGES OF RESERVOIR SEDIMENTATION AND MEETING THE CONFLICTING DEMANDS

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KEYWORDS
sedimentation, groundwater, MI Census, irrigated area, water management

ABSTRACT
Ensuring the sustainability of water sources and meeting the conflicting demands are two major challenges in effective water management. According to the National Compendium of Reservoir Sedimentation, the average annual loss in live storage capacity of reservoirs is 0.73%, which works out to be 1.8 billion cubic meter (BCM) across the country. Though there are about 5400 dams to serve irrigation purpose, about 70% of the dams are in just 3 States. It is also important to note that the contribution of these states to the agriculture GVA does not commensurate with the number of dams in those states. The reduced efficacy of surface water utilisation has a direct bearing on groundwater abstraction, which in turn leads to rise in energy consumption as well. As per the 6th Minor Irrigation (MI) Census the number of deep tube wells has increased by 43% at national level, while that of the dug wells is decreased by 5.8%, as compared to the 5th MI Census data. But Kerala shows a trend reversal where the number of groundwater-based schemes is decreased, and the number of surface water schemes is increased. The gross irrigated area in Kerala also shows an upward trend, as per the statistics published by the Reserve Bank of India (RBI). Further, 2.12 million households are provided with new functional household tap connection (FHTC) in the last 5 years, with a service level of 100 litres per person per day. This implies that the efforts to improving effectiveness of water management and increasing water use efficiency are yielding the desired results at ground level in Kerala.

WC-8

EVALUATION OF HANDWASHING STATIONS IN ODISHA SCHOOLS

Qualitative assessment of results in four schools in Odisha, India after more than one year since implementation.

Abstract

This study investigates the impact of portable handwashing stations on promoting consistent handwashing habits among school children, aiming to reduce absenteeism due to illness. Drawing on data from four schools in Odisha, India, equipped with such stations, the research highlights the importance of strategically locating and maintaining handwashing facilities, as well as fostering behavior mimicking through positive role modeling by student leaders. Results indicate that convenient placement within classrooms significantly increases handwashing compliance, while consistent maintenance ensures sustained hygiene practices. These findings underscore the need for multifaceted approaches in promoting handwashing habits in schools, with implications for public health interventions targeting improved hygiene and reduced absenteeism among children.

Advancements in Microbial Fuel Cells for Wastewater Treatment: A Comprehensive Review

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Keywords:
Microbial Fuel Cells (MFCs), Wastewater Treatment, Bio-electrochemical Mechanism, Power Density Optimization, Membrane Technology

Abstract:
Microbial Fuel Cells (MFCs) have emerged as promising eco-friendly technologies for wastewater treatment, harnessing the metabolic activities of microorganisms to degrade organic pollutants while simultaneously generating electricity. This review provides a comprehensive analysis of recent developments in MFC technology, focusing on bio-electrochemical mechanisms, electron transfer pathways, and MFC designs such as two-chamber and single-chamber systems.
Key performance indicators such as columbic efficiency, organics, and nutrient removal efficiencies are evaluated alongside discussions on microbial diversity within MFCs, shedding light on the intricate interplay between microbial communities and treatment efficiency. Polarization curves, depicting the relationship between current density and potential, elucidate the polarization losses and the factors influencing power generation in MFCs.
Furthermore, advancements in catholyte formulations, membrane materials, catalysts, and electrode materials are critically evaluated for their impact on MFC performance. The optimization of power output per active surface area of the working electrode is explored, aiming to maximize power density for practical applications.
By synthesizing the aforementioned components, this review offers a holistic understanding of MFCs for wastewater treatment, providing valuable insights for researchers and practitioners alike. It serves as a roadmap for future developments in MFC technology, facilitating the advancement of more efficient and sustainable wastewater treatment solutions.

IMPROVEMENT IN WATER USE EFFICIENCY IN EXISTING WATER INFRASTRUCTURE

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Abstract

Water use efficiency (WUE) is critical in addressing global water scarcity and ensuring sustainable water resources management. The overall efficiency of traditional canal distribution networks in India is approximately 35-50%, primarily due to water losses during distribution and application. The losses may include seepage, leakage, evaporation, and operational inefficiencies. In contrast, Piped Distribution Networks (PDN) with micro irrigation (MI) techniques, such as drip and sprinkler systems, significantly enhance WUE, achieving levels of 80 to 95% and leading to water savings of up to 40% over traditional methods. However, the conventional open canal distribution network with rotational water supply schedules does not support the use of MI in the command area of many projects.

This paper examines successful case studies from various districts in Maharashtra, India, where beneficiaries substantially improved water use efficiency (WUE) through low-cost modifications to existing infrastructure. The findings suggest that integrating modern technology, adopting comprehensive water management policies, and engaging local communities are vital for optimizing water use and securing water for future generations. These systems represent the pinnacle of ideal water distribution and management, embodying principles of sustainability, efficiency, and accessibility. Moreover, these case studies serve as powerful demonstrations of innovative PDN and MI techniques that can be replicated to address water management challenges on a broader scale.

The remarkable features of this scheme show that with the innovative technology adopted, the area of irrigation can be two to three times more than the potential created. By harnessing these methodologies, the irrigation potential of projects can be multiplied many times over the present, significantly enhancing the ability to fulfil the best feature of water distribution systems and water management.

Key Words: Water Use Efficiency (WUE), Sustainable Water Management, Piped Distribution Networks (PDN), Micro Irrigation (MI), Water Management Techniques

Making Irrigation Water Use Efficient

Dr. M.K. Sinha[2]

ABSTRACT

Irrigation is the largest consumer of limited water resources, albeit at a very low water use efficiency. In India, it is estimated that about 70% of water is consumed in Irrigation at a very low efficiency level of about 35-40%, which is nothing but a criminal waste of vital scarce resource such as water. This calls for a paradigm shift in water resources management in the country. National Water Mission set up as part of National Action Plan for Climate Change has envisaged increasing water use efficiency by 20%. Increasing water use efficiency is also contained in the Sustainable Development Goals (Goal 6.4) adopted by the United Nations as Agenda 2030. It is estimated that increasing water use efficiency in Irrigation even modestly by 20% from present level, would release enough water for bringing additional area under irrigation, meeting increased domestic and industrial water demands on urbanisation and industrialisation and also leave some water in the rivers for environmental purposes. The Government of India has set up National Bureau of Water Use Efficiency, which had set up a Task Force to evolve road map for the same. The sectoral group on irrigation of the Task Force has also recommended short term and long term strategies to make irrigation water use efficient including at the farm level. This paper reviews the concept of irrigation efficiency and outlines steps needed to make Irrigation water use efficient including at the farm level, vital for optimum utilization of scarce water resources for development of humanity and civilization as well for mitigation of adverse impacts of climate change.

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DEVELOPMENT OF WEB/MOBILE APPLICATION FOR ENHANCEMENT OF EFFICIENCY IN OPEN CANAL COMMAND

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KEYWORDS
Reservoir operation, mobile application, Water User Association, irrigation management, API

ABSTRACT
For efficient reservoir operation and irrigation planning, a link between water resource managers and farmers/Water User Associations (WUAs) has been felt for a long time. The State Government of Rajasthan enacted the Rajasthan Farmers Participation in Management of Irrigation System Act 2000 & 2002 to empower farmers and WUAs in managing irrigation in reservoir projects. In the study, a web/mobile-based application (KISAN MAITRI) was developed to determine irrigation releases for different water user associations (WUAs) of the Parbati Open Canal Project situated in the Dholpur district of Rajasthan state of India. Through the mobile application, information about crops and areas was collected from farmers. An Excel-based management model considering reservoir level, crop type and areas, soil moisture, climate data, and operation rules has developed. This model is initiated in the backend using forecast climate data, crops, soil, and water availability in the reservoir. The model provides information through mobile application regarding water availability in the reservoir and water in canals, demands and deficits of WUAs, optimized cropping patterns, mandi rates, future climate & rainfall data, and the option to report the incidence of canal breaching in the Parbati Canal Project to make informed decisions on crops, water supplies, and management issues based on scientific inputs. The model modifies the results and guides farmers based on the automatic download of forecast climate data. Based on future climate data downloaded through the API, WR managers can modify the canal releases for optimal water use and farmers can modify water application to the field. The database developed through this application may be used for future planning by elected bodies and the Water Resource Department.

CONVENTIONAL AND SENSOR-BASED METHODS FOR FLOW MEASUREMENTS – TESTING, CALIBRATION AND COMPARATIVE ANALYSIS

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Introduction

Streamflow supplies water for domestic use, irrigation for crops, waste reduction and conveyance, commercial, and industrial use, and energy for hydroelectric power generation, recreation, and commerce transportation. [1]. Assessment on the changes in hydrology can be fully realized with records of streamflow readily available at hand which are also the basic data used for reliable water supply development. In the planning and design of surface-water related projects, streamflow data are highly utilized and is also used after construction fo rmanagement and operation. Overflowing streams can cause considerable damage and even death. Records of flood events logged at gauging stations are used as basis in constructing flood control structures such as bridges, culverts, and flood- control reservoirs, as well as to delineate floodplains and install flood-warning systems.

Over the years, streamflow data collection has been done by point measurements and remote sensing techniques. Direct methods, hydraulic structure methods, and non-contact methods can all be used to quantify it. The approach to use is determined by the stream's properties as well as the application. Even with the continuous improvement and monitoring of streamflow in most advanced countries, majority of the streams in low-income, developing countries remain un gauged. The high cost of gauging tools, the majority of which are imported, is part of the problem.

In countries such as the Philippines, where research financial resources are limited and most river systems are un gauged, the need to develop or select the most accurate, low-cost method for streamflow data gathering is critical. Due to great advances in environmental ICTs, sensor networks have developed innovative features and are gaining popularity in research, environmental monitoring, and management. Advancements in smart technologies have opened a slew of new possibilities for developing and deploying conservation sensor networks. An array of high-quality, low-cost sensing and communication technologies appear to be currently available. However, scientific advancements, particularly electronic components mass manufacturing, have resulted in an explosion of low-cost sensor networks in a variety of applications, posing additional non-technical difficulties. To fully achieve the potential of low-cost ICTs as a tool for developing a more sustainable and resilient future for water sensor network applications, these emerging difficulties need to be recognized and addressed.

To address the technical, institutional and policy issues on hydrologic monitoring, it is important to carry out an extensive review of the various conventional and sensor-based streamflow data acquisition system that can be used for sustainable water resources management and agricultural applications. This allows for improved tailoring of current low-cost water sensor networks. As a result, sensor networks that add value to current systems must evaluate the monitoring environment, scenario, and stakeholders in greater detail. Water sensor network applications will eventually benefit from the full potential of low-cost ICTs. Through an extensive review, the various strengths and limitations of the said data acquisition systems and methods can also be better compared and assessed. Ultimately, the review and ensuing analysis could serve as basis for formulating policy recommendation to address the various issues including not only technical but institutional as well.

This article is an extensive review of literature of methods for streamflow data gathering, both the conventional streamflow data collection methods and the current sensor-based approaches that have been developed for sustainable water resources management and agricultural applications. This study also provides policy recommendations to maximize the potential applicability of the most effective streamflow data collection methods for sustainable water resources management and agricultural applications.

ROLE OF SOLINAS IN REVOLUTIONISING WATER ASSET MANAGEMENT AND HELP MANAGING ASSETS EFFECTIVELY

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KEYWORDS
Water asset management, ENDO90 crawler, ENDO250 crawler,,snakebot,Non intrusive inspection

ABSTRACT
India grapples with significant inefficiencies in water usage due to its aging and deteriorating water infrastructure. Alarmingly, 55-60% of treated water is lost due to leaks, dilapidated networks, and unauthorized connections equating approximately 48 billions of liters wasted daily in reservoirs, pipelines, and water mains, threatening both water security and economic stability resulting in significant revenue losses for water utilities, hindering infrastructure investments. Improving infrastructure efficiency requires reducing pipeline losses by addressing leaks and replacing pipelines with diminished transmission efficiency due to encrustations. Conventional approaches do not adhere to guidelines, which

increases the likelihood of future leaks during mitigation. With increasing concerns over water quality and access, coupled with government initiatives such as "Drink from the Tap" and "24/7 Water Supply," technical interventions are imperative. Indigenous solutions leveraging robotics and digitization for asset condition monitoring can significantly improve water use efficiency in existing infrastructure, ensuring a sustainable water future. Solinas has developed a comprehensive technological solution featuring a robotic inspection tool that collects internal pipeline data, which is then analyzed through data analytics dashboard for condition assessment. This tool harnessing AI and Data analytics allows stakeholders to make data-driven decisions, enhancing asset management efficiency. The remotely operated, tethered robotic vehicle, equipped with cameras and sensors, provides real-time, precise internal pipeline condition data. These products can monitor water pipelines from 50mm to 2000mm in diameter. Example, ENDO90 can inspect pipelines from 90 mm in diameter, while ENDO250 can inspect pipelines from above 250mm.

One of Solinas' recent solutions called "SnakeBot," an innovative robotic inspection tool that delivers real-time visual and acoustic data, facilitating precise identification of leaks, pilferages without needing pipeline dissection. SnakeBot contains a camera and acoustic sensor attached to a pushrod cable and can be inserted into pipelines via existing valves, flanges, or access points in pipelines.SnakeBot can inspect pipelines from 50mm to 200mm by employing hydrochute to harness drag force from fluid velocity for propulsion, enabling inspection distances up to 1 kilometer.

Endobots' impact is abundantly seen in numerous cities in India, such as Coimbatore (SUEZ), Chennai(CMWSSB), Hubli and Tatanagar(JUSCO) helping Government and Private entities manage their existing water assets efficiently. In Coimbatore ,where Solinas has partnered with SUEZ to inspect the water distribution network. Over the 2022-2023 financial year, Endobot led to identification of 190+ defects, sometimes identifying as many as 3-4 defects/day, which were causing disruption of water supply. It also enabled resolving over 240 contamination issues, which would have led to a major health hazard for the population. Faster identification and pinpointing of leakages and other defects allowed SUEZ to save over 1900 manhours. Overall, monetarily, SUEZ was able to save Euro 200K by minimizing excavations and labor requirements needed for defect detection. Most importantly, Endo 90 has helped to save over 6 million liters of water. This also identified the presence of encrustations and evidence of sedimentation which provided crucial inputs for condition assessment of pipeline infrastructure allowing SUEZ to make informed decisions for the maintenance of the water distribution network.

Administrative and Infrastructural Measures for Improving WUE in Existing Open Canal Network of an Irrigation Project

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KEYWORDS
Irrigation Project, Water Use Efficiency, NWM, Canal Network, Water Resources

ABSTRACT:
The global scenarios of climate change due to accumulation of greenhouse gas emitted in the atmosphere affect the industrial and economic growth of many countries. In 2018, German Watch reported that India will become the fifth country in the world to be hit hard by climate change. Recently, KPMG India (2023) reported that India is one of the world's most water-stressed countries, with only 4% of the world's water resources despite having 18% of the world's population. This climate change will impact on several components of hydrological cycle causing a substantial difference between water availability and demand in future. Hence, to bridge the gap between water availability and demand, Water Use Efficiency (WUE) in various sectors of water demand will becomes one of the key issues in the country. Among various water demanding sector, the irrigation sector is the biggest consumer of fresh water as about 80%. But the irrigation water use efficiency is very poor averaging about 36% as per figures released by the Union Government (CWC, 2016).

Therefore, in the present investigation, walk-thru survey of complete irrigation network of selected major and medium irrigation projects in Maharashtra state has been performed to identify the various issues related to poor WUE of these projects. It is observed that the reasons behind the conveyance losses through the distribution network are due to degradation of cross sections of main canal, distributaries, minors and disturbance of canal lining, which unable to carried out the desirable flow. Also, the present condition of various flow controlling and flow

measuring structures has been surveyed to recommend the various administrative and infrastructural measures for enhancing the present level WUE.

Administrative and Infrastructural Measures for Improving WUE in Existing Open Canal Network of an Irrigation Project

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KEYWORDS
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RISK AND NEW APPROACHES TO CLIMATE RESILIENCE

WC-9

WATER ACCOUNTING PLUS (WA+) BASED WATER CONSUMPTION ASSESSMENT FOR THE STATE OF NAGALAND

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Abstract:

For demand-side water management, knowing the water consumption w.r.t different land use classes helps the water manager to undertake appropriate measures to optimize the water use. In this study, WA+ Framework, a python-based tool, has been utilized to assess the total water consumptions, consumption w.r.t different management classes, and beneficial and non-beneficial contribution based on the intended purpose of water use for the state of Nagaland. The state is characterized by its hilly terrain, with mountain ranges and valleys. Also, the basin(s) are transboundary in nature and spread in Indian states like Manipur, Assam and Arunachal Pradesh, and countries like Myanmar (Burma). I view of the data unavailability or scarcity, use of freely available open access data is quite handy, and has been used in the study for assessment of water consumption. Sheet 2 on water consumption revealed that an average water loss of 14.91 BCM (~ 900 mm) is occurring in the form of evapotranspiration from different basins and sub-basins annually in the state. 56% of the evapotranspiration loss was contributed from evaporation; the remaining 44% of loss was due to transpiration. Out of the total evaporation loss, about 44% is due to interception loss, and the remaining is from the soil surface and water bodies. Utilized land use contributes maximum to the evapotranspiration loss, followed by modified land use, managed water use and protected land use. The study also revealed that a considerable chunk of ET (75.88%) is manageable. This implies that this portion of ET, which is a significant loss from the system, has the potential to be managed through scientific measures. Presently, almost 23% of ET loss is being managed through rainfed and irrigated agriculture. 37% of the ET loss is beneficially contributing to the intended purpose. The remaining loss of 63% is non-beneficial, and can be suitably converted to beneficial component by adopting the agronomical and mechanical measures.

Keywords: Evapotranspiration, water consumption, WA+, Nagaland, WALU

RESERVOIR SEDIMENTATION SURVEY-

Satellite based Machine Learning Approach

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Abstract

India has over 5000 reservoirs constructed more than 50 years ago. Evaluating their capacity remains a persistent challenge for the Government of India, crucial for effective utilization planning. Estimating the bathymetry of reservoirs is an important task in water resources management. As the number of lakes is more and work involves more time and manpower it was common idea to augment satellite image analysis superimposed with echo bathymetry to achieve the results in lesser time. The technology proposed in this paper uses Satellite bathymetry and echo bathymetry having hull mounted boat with GPS system. The deliverables of the study would be Elevation Area capacity chart and sedimentation profiling

VARIATION IN ALTITUDE EFFECT ON STABLE ISOTOPES (Δ18O) ACROSS HIMALAYAN REGION

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ABSTRACT

The isotopic signature of river water contains process-based information, from establishing a water budget to understanding contrasting flow regimes at a seasonal scale. Understanding these isotopic variations is crucial for water resource management in the region, as it provides insights into the origins and movement of water through the river basin. This knowledge can help predict water availability and develop strategies for sustainable water use in the face of climatic and environmental changes. This study investigates the variation of stable isotopes in river water along the altitude in Kameng River Basin, Arunachal Pradesh, India. Sample sets totalling 46 samples in an elevation range of 53m to 4002 m, collected in February 2001 & another in March 2021, were analysed for this study. The altitude effect was measured as -0.8‰ /km& -9 ‰ /km in 2021 for $\delta^{18}O$ and δD, respectively, which is slightly less than values of -1‰ /km & -10 ‰ /km as observed in 2001. The observed values deviate from the values of -10 to -40 ‰ /km & -2.3 ‰ /km for δD & $\delta^{18}O$ respectively for the North Western and Central Himalayan region (CGWB 2020). This phenomenon is explained by topographical heterogeneity as one moves from west to east along the Himalayas along with factors of variations in canopy cover, which increases from west to east, and the decreasing distance from the Bay of Bengal, a primary moisture source for precipitation, contribute to these differences. This study demonstrates how isotopes can be used to understand hydrological processes from catchment to regional scale, thus assisting in monitoring of water resources at both spatial and temporal scales.

GIS BASED SOIL LOSS ASSESSMENT USING USLE METHOD: A CASE STUDY OF BINA RIVER BASIN, INDIA

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Keywords: Soil loss, Geographic Information Systems, Rainfall Erosivity, USLE, Bina River Basin

Abstract

Soil erosion leads to sedimentation in reservoirs, reducing their storage capacity by occupying space available for water. This decrease in capacity limits water availability for various uses and impacts flood management. Estimating soil loss and identifying hotspot areas is crucial to combat soil degradation. This study aims to estimate the soil loss rate and identify hotspot areas in the Bina basin of Madhya Pradesh, India, using the USLE model and high-resolution geospatial data. The rainfall erosivity factor was derived from rainfall data, the soil erodibility factor from soil data, the topographic factor from DEM data, and the crop cover factor and conservation practice factor from LULC maps. These parameters were integrated using ArcGIS tools to estimate soil loss rates in the study basin. The average annual soil loss rate was estimated at 2.26 t ha^{-1} $year^{-1}$, with a total annual soil loss of 144,888.45 tons from the basin. The mean annual soil loss rate in the basin varied from 0 to 340 t ha^{-1} $year^{-1}$. Spatial risk categorization was 82.31% slight, 13.36% moderate, 3.64% high, 0.53% very high, 0.13% severe, and 0.02% very severe. The results indicated severe erosion on steep slopes with cultivation, lack of conservation measures, and sparse vegetation cover. This assessment provides vital information for policymakers and planners to devise strategies for the conservation and sustainable use of land and water resources.

Keywords: Soil loss, Geographic Information Systems, Rainfall Erosivity, USLE, Bina River Basin

A COMPARATIVE ASSESSMENT OF GRIDDED RAINFALL DATASETS FOR A BASIN IN THE WESTERN GHATS OF KARNATAKA USING STATION RAINFALL

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KEYWORDS
Gauge-based rainfall, Gridded rainfall datasets, Reanalysis datasets, Satellite rainfall datasets, Western Ghats

ABSTRACT
Accurate rainfall data is critical for hydrological studies, water resource management, and environmental monitoring, especially in regions with complex terrain such as the Western Ghats region of India. Raingauge network in the Western Ghats region, despite being relatively dense over its entirety, offers low coverage as the spatial scale of a study decreases with some small pristine basins in the region consisting of only one raingauge within their boundaries. Moreover, the hilly topography in the region forms a conducive environment for localized orographic precipitation, which may not be captured by raingauges located in coastal plains adjacent to these hills. These limitations of raingauges can be circumvented through the usage of gridded rainfall datasets which may offer a relatively better spatial distribution required for improved analyses and further applications. However, there is a plethora of such readily available open-source datasets with varying degrees of spatio-temporal resolutions and more importantly, accuracy with respect to the actual rainfall occurrences. The gridded rainfall datasets can be categorized as gauge-based rainfall, satellite rainfall and reanalysis products. This study performed a comparative assessment of gridded rainfall datasets for a pristine basin located in the Udupi district of Karnataka state namely, the Sita river basin with a catchment area of about 671 km². The gridded datasets evaluated included CHIRPS, TRMM, SM2RAIN, APHRODITE, PRINCETON, IMDAA and IMD datasets which were compared against raingauge data from 2007 to 2015. Using metrics such as coefficient of determination, Nash-Sutcliffe Efficiency, Mean Absolute Error, Root Mean Square Error and Percentage Bias, the study assessed the accuracy and feasibility of these datasets. Mann-Kendall test was also applied to assess the trends in different time series pertaining to each rainfall dataset for the basin. The findings showcased the high capability of IMD dataset in emulating the observed monthly rainfall. The trends exhibited no consistent patterns in almost all the time series. The results of this study served as a foundation for the selection of dataset best-suited for further applications such as hydrologic modelling, hydro-meteorological predictions and water resource management in the river basin.

ADAPTIVE SAND FILTRATION FOR AN AFFORDABLE AND SUSTAINABLE DRINKING WATER SOLUTION

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Abstract

Having access to safe drinking water is one of the most important needs of a household. Over 2.1 billion people worldwide lack access to safe, clean drinking water, which contributes to a variety of water related diseases. Each year, water-borne illnesses affect over 34 million people in India. Likewise, elevated levels of fluoride and arsenic in groundwater have an impact on over 500 million and 50 million individuals, respectively. Tooth and skeletal fluorosis resulted from fluoride concentrations greater than 4 mg/L. Similarly, arsenic concentrations greater than 0.01 mg/L produce skin pigmentation, skin cancer, and hyperkeratosis.

The majority of these cases come from remote areas and low-income communities where proper water purification procedures are not adopted. The primary causes of the non-adoption of any water purification methods are their lack of affordability and sustainability. In these situations, having a sustainable and reasonably priced method of supplying clean drinking water is crucial. The majority of water filtration systems currently in use are based on reverse osmosis (RO), which has high operating costs because filtration membranes need to be changed frequently and requires electricity to power the pumps. More importantly, the RO filtration process squandered more than half of the water, which is a problem in areas where the water supply is already scarce.

Thus, a technology that can purify water to drinking water standards while operating on passive energy would be essential. Adaptive Sand Filter (ASF), which is based on sand filtration technology, is able to filter out biological, physical, aesthetic, and certain heavy metal contaminants (such as As, F, and Fe) from the drinking water, all without the use of chemicals and membranes. It uses a sand filtration column made of brown angular rock sand, activated charcoal, and nanoclay as the filtration medium. A UV-C post-treatment (wavelength 253.7 nm) is then applied. It provides an all-in-one water purification system which does not require a pump and does not waste water.

This article discusses prospects related to slow sand filter and adaptive sand filter as an affordable and effective means of drinking water in remote areas. The use of an adaptive sand filter with a combination of pre treatment showed significantly higher removal of turbidity (99.7 %), and showed complete removal of coliform bacteria. In addition it shows high removal of inorganic substances; Iron (50 %), Nitrate (31 %), Fluoride (14 %) and TDS (12 %).

SIGNIFICANCE OF HIGH FREQUENCY DATA FROM REAL TIME DATA ACQUISITION SYSTEM IN GROUNDWATER MONITORING

Lubna Kouser, H.P. Jayaprakash, Rahul R Shende, N. Jyothi Kumar

Abstract

The vagaries and scanty rainfall patterns have invoked the major population to directly depend on the groundwater resources for subsistence. The increase in demand of groundwater in drought affected areas has resulted in drying of shallow aquifers followed by desaturation of deeper aquifers, has raised a concern on sustainable management of groundwater resources. To identify and regulate the Groundwater related issues, Central Ground Water Board (CGWB), South Western Region (SWR), Bangalore, monitors the ground water levels manually through monitoring network stations in the state of Karnataka four times a year, viz. January, May, August and November. Further, Real Time Data Acquisition System (RTDAS) has been adopted by CGWB in 394 piezometers of Karnataka state under National Hydrology Project (NHP) for acquisition of high frequency Groundwater level data at an efficient rate of every six hours. The Real time data acquisition system through Digital Water Level Recorder (DWLR) with Telemetry system is very essentials in the exigencies like Covid 19 pandemic and other natural disaster during which the manual measurements of groundwater levels in Karnataka state could not be made resulting void in information records. In this paper, the importance of high frequency Groundwater monitoring data through DWLR with telemetry system is discussed with data retrieval, validation and data analysis to understand the short term behaviour of Groundwater. Analysis of data from January to March 2024 indicates that the groundwater levels fluctuated between 12.73 meters and 12.95 meters below

ground level. The study revealed, over a period of nearly 41 days, indicates the possibility of continuous inflow, possibly from upstream sources or rainfall.These fluctuations are subtle, reflecting a relatively stable aquifer system, yet they demonstrate the balance between recharge and extraction rates. The wells representing the short term behavior or aquifer response are observed through data representing constant recharge and discharge rates. The studies also discuss about the challenges involved in maintaining the RTDAS stations in the field. The studies guided that, the optimization in number of RTDAS Groundwater monitoring stations are helpful in sustainable management of Groundwater resources for implementing the beneficial schemes.

Key words: RTDAS, DWLR, Telemetry systems, Groundwater monitoring

WATER SCARCITY AND WAY FORWARD WITH GIS SYSTEM

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KEYWORDS
Water Security, GIS system, Geospatial strategies, AI & ML, Decision support

ABSTRACT

Geographic information about the water system is a crucial element for the protection of public health and property, for economic well-being and environment, and for effective water resource management. Water challenges are multifaceted in nature and have complex ties with environmental, economic, and social systems. There is a pressing necessity to consolidate science and technology for visualizing, analyzing, and reporting the tangible and intangible intersections of the water resource as a system. The geographic approach is the way of thinking and problem-solving, that integrates intersections of water system and organizes water resources information in the crucial context of location.

GIS based solutions have intrinsic capabilities to recognize water scarcity problems from geographic information and uncover trustworthy resolutions. Morden GIS has moved beyond mapping and facilitates complex tasks of spatial modelling, situational scrutiny and predictive analysis. With advancement in GIS system, it empowers water system analysis using artificial intelligence and machine learning tools. It enhances situational awareness of integrated water systems. It assists water resource departments to strategize, plan and execute interventions on water governance and management. Customised thematic solutions on GIS based platforms identify gaps, recognize risks, derive areas of interventions and render decision support to execute tasks. Solutions help to align organization processes with overall strategies of water resources projects. Water resource sector in India has adopted geographic approach to reveal patterns and trends; model scenarios and solutions; and implement water resource missions.

COMPUTATIONS OF RATING CURVES OF THE RIVER YAMUNA AT JUDDO (D/S OF VYASI DAM) AND THE RIVER ALAKNANDA AT GAUCHAR USING

Acoustic Doppler Current Profiler (ADCP)

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ABSTRACT

Development of the stage-discharge curve at a location in a river is an important part of the processing of streamflow data. In this paper, an attempt is made to develop a stage-discharge curve at the gauging site to develop two rating curves using least square fitting approach, one on river Yamuna at Juddo in Katapatthar and another on the river Alaknanda at Gauchar under National Hydrology Project (NHP), utilizing Acoustic Doppler Current Profiler (ADCP) as a pilot project.

Values of discharges obtained directly by ADCP and those calculated by multiplying the values of corresponding area and velocity were compared. Discharges with variations more than 2% were discarded and all the required corrections were applied. A common smooth curve was developed with maximum value of coefficient of determination.

Keywords: *Stage-discharge curves, Acoustic Doppler Current Profiler (ADCP), Least square fitting approach.*

TOPOGRAPHICAL AND HYDROGRAPHICAL SURVEY OF BRAHMAPUTRA RIVER USING DGPS, ECHOTRAC, AND LIDAR DRONE FOR HYDRODYNAMIC MODELLING

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KEYWORDS

Brahmaputra, Topographical Survey, LiDAR, Bathymetric Survey, Hydrodynamic Modelling.

ABSTRACT

The Brahmaputra River, one of Asia's major transboundary rivers, traverses Tibet, India, and Bangladesh. This study targets a comprehensive topographical and hydrographical survey of a 25 km segment of the Brahmaputra River, specifically from 15 km upstream to 10 km downstream of the Kaliabhomora Bridge near Tezpur, Assam. By integrating diverse data sources, the study aims to develop a robust model for flood risk assessment and evaluating future water structure construction prospects. The objectives include utilizing DGPS and Lidar drone technology for detailed mapping of the Brahmaputra River, employing echo sounders to gather precise riverbed data, developing accurate hydrodynamic models using HEC-RAS 2D to simulate various hydrological scenarios, and providing critical insights for flood management and future construction projects. The methodology involved a DGPS survey to map high and low bank lines, spot levels, and cross structures using Real-Time Kinematic (RTK) techniques over a 25 km stretch, and a Lidar drone survey to capture high-resolution elevation data detailing existing bridge piers and vegetation cover. Additionally, a hydrographical survey using Echotrac echo sounders interfaced with Hypack software was conducted for detailed riverbed mapping. The data from DGPS, Lidar, and Echotrac was integrated to create a comprehensive topographical and bathymetric map of the survey area. Data processing was done using Hypack and other geospatial software to ensure accuracy and consistency. A 2D hydrodynamic model was built in HEC-RAS, incorporating Digital Elevation Model (DEM) data and river bathymetry, with simulations run under

different flow conditions and validated against historical flood events. The analysis of simulation results provided insights into flow dynamics, flood extents, and the impact of river structures on flow behavior. The integrated survey data offered a detailed understanding of the Brahmaputra River's topography and bathymetry. The model demonstrated its capability to accurately predict water flow patterns and flood inundation areas, successfully replicating historical flood events. Key findings include the identification of multiple river channels, sandbars, and elevation profiles of riverbanks, bridges, and surrounding floodplains, insights into the impact of river structures on flow behavior, and predictions of the effects of potential future developments in the river. The combined use of DGPS, Echotrac, and Lidar drone technologies has proven highly effective in surveying the Brahmaputra River. The high-resolution data obtained is vital for developing accurate hydrodynamic models, essential for infrastructure planning, flood management, and riverine ecosystem conservation. This study underscores the importance of advanced modeling techniques and reliable data integration in managing complex river systems and offers a comprehensive approach that can be applied to other major river systems worldwide.

INVESTIGATING PERCEPTIONS OF FLOOD RESILIENCE: METHODOLOGICAL INSIGHTS AND IMPLICATIONS FOR INDIA

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ABSTRACT

Floods significantly impact human lives, the economy, infrastructure, and agriculture worldwide, with these effects being particularly pronounced in a flood-prone, agro-based economy like India. Rapid urbanization and climate change have exacerbated the risks associated with flood disasters. Traditionally, flood control approaches have focused on resistance strategies. However, given the uncertainty and escalating risks, quantification of 'flood resilience' has become crucial in flood disaster management. This is highlighted in the Intergovernmental Panel on Climate Change (IPCC)'s latest Assessment Cycle (AR 6). Defined as the ability to withstand and recover from flood events, flood resilience is an evolving concept with limited studies addressing its quantification and mapping. The absence of a standardized method for measuring flood resilience globally further complicates these efforts. This study provides a comprehensive understanding of flood resilience by examining various global case studies, perceptions, and methodologies. Despite a global emphasis on building sustainable, flood-resilient communities, a significant gap exists in studies assessing flood resilience in India. This research underscores the necessity of mapping and measuring flood resilience at regional and national scales within India. Our findings discuss the importance of integrating resilience mapping modules into publicly and commercially available flood management tools in addition to flood risk mapping modules. Such efforts are essential to enhance the flood resilience of Indian cities and the nation, addressing a critical gap in current flood resilience studies and providing a foundation for future empirical research, practical applications, and guidance for policymakers.

Keywords: Flood Hazard, Flood Modelling, Flood Resilience of India, Methodological Insights, System Performance.

PAPER TITLE

Climate Change's Unfolding Impact on Himalayan Agriculture and Hydropower

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KEYWORDS
Climate change, Himalayan basin, hydropower, agriculture, streamflow, resilience

ABSTRACT: (9 pt)

Himalayas are commonly known as the Third Pole and water tower of Asia because they have the highest concentration of snow and glaciers outside the two poles. The snow and ice covered mountains provide melt water to Asia's mighty river basins and make them perennial. This region is rich in glaciers that experience a winter accumulation period, where snow and ice are collected and an ablation period during the warm season, which is the melting time These perennial rivers provide not only water to densely populated regions of the world but also ensure food and energy security. These rivers also have significant potential for hydropower generation. In total the Hindu Kush Himalayan (HKH) region has around 500GW of hydropower potential.

However, the recent investigations in the region suggest that most of the Himalayan glaciers are retreating because of the impact of the changing climate. This glacier retreat in turn would impact the streamflow which would have socio-economic impact on the region by affecting agriculture, livelihood and well-being of the people. Several studies suggest that glacier retreat would initially lead to an increase in melt-water contribution to the stream flow followed by decrease in the contribution leading to low discharge in the rivers. These variations in hydrological regime i.e. reduction in seasonal runoff, reduced snow and exhaustion of glaciers will affect the hydropower projects in the basin. Most of the planned and constructed hydropower projects in the region are 'Run of River' type and they need consistent supply of water for operation which would get compromised due to expected high seasonal variations in discharge of these glaciers fed rivers. It would thus affect the economic efficiency of the power plants. Similarly, increase in temperature and change in snowfall timing would have an impact on the orchards of this region.

This study undertook an assessment of climate change impact on the hydrological regime of the Chenab basin under two climate change scenarios RCP 4.5 and RCP 8.5 using HBV Model. Further these expected hydrological signatures given an indication how the two dependent sectors would get affected and the potential impacts are suggested based on the literature review carried out for the region.

ASSESSMENT OF CLIMATE RESILIENCE AND WATER SECURITY STRATEGIES USING A STAKEHOLDER MAPPING TECHNIQUE IN RAMANATHAPURAM DISTRICT, TAMIL NADU

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KEYWORDS
Climate resilience, Water security, Ramanathapuram, Community Participation, Policy

ABSTRACT:
It is evident that more individuals are putting climate change adaptation plans into practice to guarantee water security. The global water cycle has seen major changes due to climate change, as highlighted in the IPCC's Sixth Assessment Report. In 2019, India ranked as the 7th most affected country by climate change-induced extreme weather events, leading to substantial fatalities and economic losses, with 17 out of 20 people vulnerable to severe hydrological and meteorological disasters.
Ramanathapuram is the most vulnerable district in Tamil Nadu, according to the Climate Change Impacts and Vulnerability Assessment, underscoring the critical need to tackle the issues exclusively in the water resource management. A primary strategy for building resilience in such vulnerable areas connected to the water resources are to reduce water demand through improved efficiency. While existing literature underscores the importance of adaptive strategies in mitigating these impacts but the localized studies focusing specifically on Ramanathapuram district remains sparse.
This research aims to assess the current and future water security and climate change activities in Ramanathapuram by examining policy, practice, and stakeholder participation. It evaluates the effectiveness of government-implemented infrastructure resilience measures and adaptation strategies, explores the role of local communities and stakeholder involvement, and identifies challenges to planning and implementation. The goal is to highlight risks and propose new approaches to enhance climate resilience in the region. Additionally, the study investigates how changes in mean and extreme sea levels create coastal hazards like water quality degradation, erosion, and salinity intrusion, impacting water resource management. It also analyses the interaction between these hazards and socioeconomic factors influencing coastal exposure and vulnerability.
A survey targeting local officials from various departments involved in water management and disaster response is employed, including the Tamil Nadu Water Supply and Drainage Board Department (TWAD), Public Works Department (PWD), Revenue and Disaster Management Department, Rural Development and Panchayat Raj Department, Agriculture Department, Fisheries Department, Block Development Officers, Executive Officers from Town Panchayats, and other pertinent stakeholders. Utilizing KoBo Toolbox, the survey gathers and analyses responses, focusing on infrastructure resilience, adaptation measures, policy effectiveness, and community engagement.
This research recommends, focusing on infrastructure upgrades, community engagement, and sustainable practices. It recommends increasing investment in early warning systems, revising water management policies, and enhancing stakeholder collaboration to improve climate adaptation and resource management.
The research highlights the necessity of a comprehensive strategy that integrates resilient infrastructure, impactful policies, and community ownership to reinforce climate resilience and water security. The resulting regional suggestions are highly valuable for future planning and policy direction, improving Ramanathapuram district's ability to address climate change-related concerns, and guaranteeing the sustainability of water management practices.

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AUTOMATION AND ENERGY EFFICIENCY: TRANSFORMING KERALA'S WATER SUPPLY MANAGEMENT

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KEYWORDS

AI-driven automation, SCADA, Water Management, Energy Management, Sustainable Water Supply

ABSTRACT

The Kerala Water Authority (KWA) serves 34 million residents by providing potable water and managing sewerage across the state. With a daily production capacity of approximately 3500 million litters, KWA oversees a vast 150,000-kilometer distribution network. To enhance operational efficiency, reduce costs, and improve service delivery, KWA is implementing AI-supported automation, SCADA systems, and energy auditing/management studies. This paper discusses KWA's initiatives to modernize its water supply management through these advanced technologies. Objectives include reducing manpower and costs by decreasing reliance on manual labour, improving service levels through increased reliability and efficiency, minimizing service interruptions with optimized performance, and lowering maintenance costs via automated monitoring. KWA has automated several key Water Treatment Plants, providing real-time data on water quantity and quality via their website, notably automating five WTPs under JICA and AMRUT. Of the 2381 motor pump sets, 1365 (57%) are now automated, with critical operational data continuously monitored. SCADA systems have been implemented in key facilities to enhance real-time monitoring and control. Case studies in Alappuzha District and one or two wards of Kollam Corporation demonstrated significant improvements through the automation of rural pump houses, confirmed by cost-benefit and customer satisfaction analyses. Energy management audits on key facilities, including AMRUT Water Treatment Plants and booster stations, recommended replacing inefficient pump sets, correcting power factor and contract demand, installing solar panels, replacing old appliance, and preventing overflow and detecting leaks. The modernization of KWA's water supply system through AI-driven automation, SCADA systems, and energy efficiency measures has significantly improved service delivery, operational efficiency, and cost savings.

EVALUATION OF TIME SERIES-BASED ANFIS MODEL FOR GROUNDWATER QUALITY PREDICTION

Abstract

Predicting groundwater quality is a vital task in ensuring the sustainability of water resources and safeguarding human and environmental health. In this study, we propose the application of an Adaptive Neuro-Fuzzy Inference System (ANFIS) model to forecast groundwater quality using time series data. Groundwater quality parameters are influenced by a complex interplay of various factors, including climatic conditions, anthropogenic activities, and hydrogeological characteristics. The ANFIS model's ability to capture non-linear relationships and its adaptability make it an attractive choice for such a dynamic and intricate problem. This research leverages historical time series data of groundwater quality, encompassing a range of parameters such as pH, EC, $SO42^{-}$, TH, $Ca2^{+}$, $Mg2^{+}$, $HCO3^{-}$ and Fe. The proposed ANFIS model undergoes a comprehensive training process, utilizing input features derived from the time series dataset. By fusing fuzzy logic and neural network concepts, the ANFIS model captures both explicit and implicit relationships within the data, enabling accurate predictions. The study evaluates the performance of the ANFIS model using comparative line graphs, GIS based maps, Root Mean Square Error (RMSE) and Coefficient of Determination (R2), to assess its predictive capabilities. The results demonstrate the ANFIS model's effectiveness in forecasting groundwater quality trends and variations over time.
Keywords: Adaptive Neuro-Fuzzy Inference System, time series data, groundwater quality prediction.

Keywords: *Adaptive Neuro-Fuzzy Inference System, time series data, groundwater quality prediction.*

RECENT ADVANCES IN FOREST HYDROLOGY USING ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING TECHNIQUES

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1. ABSTRACT

Artificial intelligence (AI) and machine learning (ML) are two closely related fields that have seen tremendous growth and impact in recent years. AI refers to the simulation of human intelligence processes by machines, especially computer systems that encompasses a wide range of capabilities, including perception, reasoning, learning, problem-solving, and decision-making. ML is a subset of AI that focuses on the development of algorithms and statistical models that enable computers to learn and improve from experience automatically. Instead of being explicitly programmed to perform a task, ML algorithms are trained on large amounts of data to recognize patterns and make predictions or decisions without human intervention. AI and ML methods find tremendous potential in enhancing the decision support system in forest hydrology management. AI and ML algorithms, like neural networks, decision trees, and support vector machines, are used to develop accurate and efficient hydrological models that simulate water flow, infiltration, evapotranspiration, and other critical hydrological processes within the forested watersheds. The focus of Machine learning in hydrology is to predict accurate streamflow, soil moisture, and other hydrological variables by assimilating real-time data from various sources, such as weather stations, satellites, stream gauges, and remote sensors, into hydrological models. The data assimilation process allows the models to continuously update and improve their predictions based on the latest available information, enhancing their accuracy and reliability for applications such as flood forecasting, water resources management, and climate change impact assessment. AI models can analyse historical streamflow data, weather patterns, soil moisture, and vegetation cover to predict future streamflow. These predictions are essential for water resource planning, flood control, and ecosystem health. This paper reviews the AIML-driven hydrological models that simulate the complex interactions between vegetation, soil, and water that help researchers understand how forest ecosystems respond to climate change, deforestation, and land management practices. Overall, the integration of AI and ML techniques in forest hydrology represents a promising paradigm shift towards more data-driven, predictive, and adaptive approaches for sustainable water resource management and ecosystem stewardship in forest ecosystems.

KEYWORDS: Artificial Intelligence, Artificial Neural network, Machine Learning, Hydrology.

FAMS INTELLIGENCE FOR WATER-CLIMATE-AGRICULTURE-ENERGY SECURITY: A DECISION-MAKING GEOSPATIAL AI PLATFORM

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Theme: Risk and New Approaches to Climate Resilience
Sub-Theme: Utility of Artificial Intelligence and Geospatial Tools for Decision Making

Abstract Synopsis
This abstract provides an overview of a decision-making geospatial AI platform designed to address the interlinked challenges of water, climate, agriculture, and energy security. The platform leverages advanced geospatial analysis and artificial intelligence to facilitate informed decision-making for sustainable resource management. This abstract synopsis summarizes the development and benefits of a decision-making geospatial AI platform that integrates water, climate, agriculture, and energy data to support sustainable resource management. It highlights the platform's methodology, key features, benefits, challenges, and future prospects. Benefits of Developed Decision Support Tools are as follows:

- Integrated Resource Management: Facilitates holistic management of water, climate, agriculture, and energy resources by considering their interdependencies.
- Informed Decision-Making: Enhances the ability of policymakers and stakeholders to make evidence-based decisions for sustainable development.
- Resilience Building: Helps build resilience against climate change impacts by providing actionable insights and adaptive strategies.

The Water-Climate-Agriculture-Energy Security platform represents a significant advancement in the use of geospatial AI for integrated resource management. By providing robust decision support tools, the platform enables stakeholders to navigate the complexities of resource security in the face of climate change, ensuring sustainable development and resilience for future generations.

Keywords: DSS; Geospatial AI; Water Security; Climate Extreme; AI-ML

SUITABLE SITE SELECTION FOR CONSTRUCTION OF WATER HARVESTING STRUCTURES USING GEOSPATIAL TECHNIQUE IN EAST KAMENG DISTRICT OF ARUNACHAL PRADESH

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KEYWORDS
Water Conservation Structures, Site Suitability, Contour Bunds, Staggered Contour Trenches

ABSTRACT:
Effective site selection for water harvesting structures is crucial for sustainable water resource management, particularly in regions vulnerable to water scarcity. North east region of India despite heavy annual received rainfall faces acute water scarcity due to its hilly terrain. Water scarcity in Arunachal Pradesh, despite its abundant natural water resources, remains a pressing issue predominantly due to geographical constraints and uneven distribution of rainfall. The state's mountainous terrain complicates water distribution and infrastructure development, particularly in remote and hilly regions where access to clean water is limited. Climate variability

further exacerbates the problem, with erratic rainfall patterns impacting agricultural productivity and community livelihoods. Inadequate water storage facilities and irrigation systems amplify challenges, affecting both rural communities and urban centers alike. The main goal of this paper is to identify suitable sites for construction of water harvesting structures through the application of geospatial techniques. Geospatial tools such as Geographic Information Systems (GIS), remote sensing, and terrain analysis enable systematic evaluation of various factors influencing site suitability, including topography, land use/land cover, soil characteristics, hydrological parameters, and rainfall patterns. The selected study is East Kameng District of Arunachal Prdaesh). The study area is about 4134 sq. km. The data used are ASTER DEM, LISS-III image and SOI toposheet and soil map. Adopting the IMSD guidelines, the suitable sites were identified in the study area.

ISOTOPIC FINGERPRINTING OF PRECIPITATION SOURCES, GEOCHEMICAL DISTRIBUTION, AND ASSOCIATED CLIMATE CONTROLS IN TROPICAL RIVER BASINS OF THE WESTERN GHATS, INDIA

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KEYWORDS
Stable isotopes, Strontium isotope, Major ion geochemistry, Rainwater quality, Indian monsoon

ABSTRACT
The environmental sustainability of Earth is largely dependent on monsoonal precipitation. Most studies have focused on the amount and intensity of monsoonal precipitation in the past, modern timescales, and future predictions due to the uncertainty in its occurrence. The humid tropics are highly sensitive to any minor changes in climate as it receives higher monsoonal precipitation. In this study, the sources and distribution variability of precipitation have been investigated in two humid tropical river basins, Swarna and Madisal basins, of the Western Ghats, India. For this, the rainwater samples have been subjected to analysis of stable isotopes of oxygen ($\delta^{18}O$) and hydrogen ($\delta^{2}H$), radiogenic strontium isotope ($^{87}Sr/^{86}Sr$) as well as major ion geochemistry. The major cation and anion compositions of precipitation are in similar order of river water composition. The $\delta^{18}O$, $\delta^{2}H$ and $^{87}Sr/^{86}Sr$ values of precipitation show the dominance of oceanic moisture while the terrestrial moisture contribution is observed from the deuterium excess values in the western part of the Western Ghats. The HYSPLIT trajectory supports moisture origin from the southern part of Arabian Sea closer to the equator during the southwest monsoon and the Bay of Bengal during the winter monsoon. The $\delta^{18}O$ and $\delta^{2}H$ values during the winter monsoon also recorded the cyclonic influence over the region. The long-term isotopic and geochemical database of precipitation are useful in managing the climate uncertainty and anthropogenic impacts on water resources in the Western Ghats and the west coast of India.

REVITALIZING RURAL WATER SECURITY: COMMUNITY-LED INNOVATIONS IN GROUNDWATER SUSTAINABILITY IN MAU MASANIYA VILLAGE IN LINE WITH ATAL BHU JAL YOJANA

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Abstract

Groundwater sustainability in rural areas, particularly in regions characterized by hard rock Granitic terrain, poses significant challenges. Mau Masaniya village, situated in such an environment, struggled with groundwater scarcity despite the presence of a thick fractured overburden exceeding 15 meters. To address this issue, a community-driven initiative led by theJal Saheli team of Parmarth Seva Sansthan, in collaboration with the Atal Bhu Jal Yojana, implemented artificial recharge structures such as check dams, farm ponds, and ponds. These interventions resulted in substantial improvements in groundwater levels. Notably, the construction of eight Gated Check Dams by the Jal Saheli team played a pivotal role in groundwater recharge, contributing over 50% compared to other recharge structures. Additionally, these structures facilitated a recharge of approximately 25 hectare-meters of water along the Kudar River, leading to a significant reduction in groundwater extraction by approximately 42.83 hectare-meters. Byproduct of theses interventions are supporting the sustainability as in 2021, water depths exceeding 5 meters were common, but by 2023, depths decreased to as shallow as 2 meters. Maximum well sustainability was one hour but now it is up to two hours with the speedyrecovery within 12hours, highlighting the enhanced groundwater potential. Moreover, the introduction of recharge structures led to shallower groundwater levels and improved well sustainability. Additionally, increased crop production, particularly wheat production, saw an increase from less than 100 Kuntal to up to 1000 Kuntal. This remarkable enhancement in crop production underscores the effectiveness of the interventions in addressing water scarcity and enhancing community resilience. The study highlights the importance of community-driven approaches and localized interventions in mitigating groundwater challenges, offering valuable insights for similar regions facing water scarcity issues.

Keywords: Groundwater sustainability, Rural areas, Granitic terrain, Community-driven initiatives, Artificial recharge structures.

GROUND WATER SUSTAINABILITY

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APPLYING THE COMPLEX CONCEPT OF GROUNDWATER OVEREXPLOITATION FOR ASSESSING GROUNDWATER OVERDEVELOPMENT PROBLEMS IN INDIA

Abstract

The paper first deals with the definition of aquifer over-exploitation. Then a review of the various definitions and criteria for assessing over-exploitation is presented. Subsequently, the existing methodologies in India for the assessment of groundwater resources are reviewed to examine: the robustness of the criteria used and the scientific accuracy of the methodologies and procedures suggested. Finally, the current estimates of groundwater over-development for India are reviewed from the perspectives of detailed water balance, geology, hydrodynamics, and negative social, economic, ecological and ethical consequences.

The paper argues that there are several conceptual issues involved in the assessment of aquifer over-exploitation. One reason is that over-exploitation is linked to various "undesirable consequences" of groundwater use that are physical, social, economic, ecological, environmental, and ethical in nature. The other reason is that there are differences in the way undesirable consequences are perceived by different stakeholders. The principle of inter-generational equity, used in the concept of sustainability, is one of the goals that are built into the standard definitions of aquifer over-exploitation. But, defining and assessing over-exploitation is both difficult and complex and not amenable to simple formulations. Selected illustrative cases are used to demonstrate how integrating data on complex hydrology, geology, hydro-dynamics, and socio-economic, ecological and ethical aspects of groundwater use with the official statistics could change India's groundwater scenario altogether. The analyses also show why the interpretation of long-term data on water levels needs to factor in the differences in characteristics of the aquifers, which vary from region to region.

Keywords: aquifer overexploitation; ethics of water use, hydromyth, groundwater assessment, recharge estimation, groundwater balance, geology, water level trends, negative consequences

"HIGH-FREQUENCY DATA ANALYSIS: REVOLUTIONIZING GROUNDWATER MANAGEMENT THROUGH THE NATIONAL HYDROLOGY PROJECT-AN OVERVIEW FOR EASTERN INDIA

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Monitoring groundwater tables and piezometric surfaces in Shallow and Deeper ground water abstraction points respectively at a regional scale holds significant importance in hydrogeological research and achieving sustainable development goal. The dynamic level fluctuation is a function of various inflows and outflows from the system. This practice facilitates the analysis of various aspects, including the quantitative and qualitative characteristics of groundwater, assessment of the groundwater budget, evaluation of the long-term impacts of groundwater exploitation, development of groundwater flow models, and the implementation of effective groundwater management and protection measures through groundwater recharge calculations. The National Hydrograph Network Monitoring Station (NHNMS) comprises untapped wells strategically positioned to meet specific objectives. The Central Ground Water Board (CGWB), an apex organization under the Ministry of Jal Shakti, is responsible for assessing these groundwater characteristics nationwide through its annual groundwater monitoring program. Typically, NHNMS monitors groundwater four times a year to observe seasonal variations, and up to twelve times a year for specific studies. These monitoring points include private and government-owned dug wells, tube wells, and piezometers. Given the high costs and time associated with manual monitoring, the National Hydrology Project (NHP) of the Government of India has implemented Digital Water Level Recorders (DWLRs) and Real-Time Data Acquisition Systems (RTDAS) in existing CGWB piezometers to continuously monitor groundwater levels at high frequency. The enormous discrete and continuous data generated focuses on enhancing the breadth, quality, and accessibility of water resource information and

strengthening the capabilities of targeted water resources management institutions in India. This initiative emphasizes the deployment of new sensor technologies, improved data storage, and the implementation of telemetry technologies to establish comprehensive, modern, real-time automated monitoring systems for groundwater regimes. The project aims to fortify the National Water Informatics Centre (NWIC), including the Water Information Management System (WIMS) and Water Resources Information System (WRIS). These advancements benefit central, and state agencies involved in long-term planning and sustainable resource management, benefiting various sectors such as farming, energy, waterways, environment, and agriculture, as well as research institutions, policymakers, NGOs, civil societies, and the private sector.

Keywords: NHP, RTDAS, WIMS, Groundwater, Sustainability

ASSESSMENT OF SEASONAL VARIATION IN DISCHARGE & WATER QUALITY IN SPRINGS OF JAMPUI HILL RANGE, NORTH TRIPURA DISTRICT, TRIPURA.

Dr. R.R. Purohit, Ritu K. Oraon, H.V. Sophia, Rupam Chattaraj

Abstract:
Springs are the primary source of fresh & portable water in the remotest habitations of Jampui Hill Range of the North Tripura. For the first time, spring inventory has been carried out covering an area of 471.86 km^2. The objective of the study was to identify the spring type, their occurrence and distribution and to assess the geochemistry of the spring water. 40 distinct springs were inventoried out of which the discharge of 35 springs were monitored (using volumetric method) and assessed periodically over a period of one year. The spring samples were collected during the pre-monsoon and post-monsoon season and assessed. The initial assessment of periodical discharge of the springs shows that the Jampui Hill springs are seasonal in nature and rainfall dependent. Three types of springs were identified namely, contact, depression and fracture springs. On the basis of discharge, springs have been classified based on Meinzer classification, which falls in between Sixth to Eighth order with a few in the fourth and fifth order. The hydro-chemical study of the spring has shown that quality of the spring water is suitable for drinking and domestic use. Some springs have been abandoned due to siltation and accumulation of debris in the spring chamber for which rejuvenation works can be taken up. Management strategies of the springs have also been touched up on. Anthropogenic intervention likes construction of roads and cutting of mountains have let to the disappearance of springs. The change in landuse patterns from forested land which served as a recharge area for the springs, to the plantation of areca nuts as cash crop in the same area has been a major cause of diminishing spring discharge and some getting dry.
Keyword: Springs, Meinzer, quality, rejuvenation, discharge

High-Resolution Aquifer Mapping Using Advance Heliborne Transient Electromagnetic Survey for Groundwater Assessment and Management at Gram Panchayat Level of Srimadhopur Block, Sikar District, Rajasthan, India.

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KEYWORDS
Heliborne, Transient Electromagnetic, Aquifer information, Aquifer Mapping, Groundwater management

ABSTRACT:
Groundwater is vital for sustaining ecosystems and meeting human requirements; but increased ground water extraction coupled with growing population has necessitated the need for effective management interventions. This paper explores the possibility of advanced tools and techniques for the assessment and, management of groundwater resources. The Heliborne Transient Electromagnetic (HTEM) survey, a cutting-edge geophysical technique, provides high-resolution aquifer information and aid in delineating subsurface geological features without invasive methods. The high-resolution aquifer mapping using HTEM surveys covering an area of approximately 1 lakh sq.km in parts of Rajasthan, Gujarat, and Haryana states in north-west India have already been conducted by Central Ground Water Board (CGWB), Ministry of Jal Shakti, Govt. of India. This state-of- the-art approach with data in high granularity provides deeper insights on aquifer information along flight lines with close spacing. CGWB is currently using this data for deliverables, such as identifying potential groundwater zones, fresh/saline interfaces, and suitable areas for artificial recharge at the Gram Panchayat level using Aarhus Workbench software. This paper focuses on the Gram Panchayat level aquifer information for Srimadhopur block in Sikar district, Rajasthan, covering an area of 575 sq. km. The Srimadhopur block lies in a marginal alluvial formation underlain by rocks of the Delhi Super Group (DSG), including quartzites, phyllites/schists, and impure marbles. Analysis reveals that out of 36 Gram Panchayats comprising 82 villages, limited groundwater is available in marginal alluvium formations in 38 villages, while 34 villages face dry conditions or have some moisture content in alluvium formations. However, HTEM survey data is unavailable for 10 villages, impeding the extraction of deliverables. The analysis recommends various potential sites for ground water drilling and sites for recharge structures such as shafts, injection wells, and shafts with injection wells for artificial recharge to groundwater. This information is very useful for local authorities in the planning of suitable ground water management interventions for sustainable development in the water-stressed areas of Block: Srimadhopur, Sikar district, Rajasthan. Sustainable groundwater management using advance technologies like HTEM, CGWB is trying to ensure the optimum utilization and preservation of this valuable resource for current and future generations.
Type your abstract of not more than **500 words**. For abstract title use Arial 9 point bold, while for abstract text Arial 9 pt regular and justified, both single line spacing. No references, images, charts and tables permitted in the abstract text.
The position and layout of this table (First table in the document and no of columns=1,last two rows for keywords and abstracts and the first row for the paper title) is fixed and must not be altered. This table will be

used programmatically for extracting the paper information as well as the abstract text for print publication. Any tampering with the layout will render the paper unusable.

High-Resolution Aquifer Mapping Using Advance Heliborne Transient Electromagnetic Survey for Groundwater Assessment and Management at Gram Panchayat Level of Srimadhopur Block, Sikar District, Rajasthan, India.

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KEYWORDS

Heliborne, Transient Electromagnetic, Aquifer information, Aquifer Mapping, Groundwater management

ABSTRACT

Groundwater is vital for sustaining ecosystems and meeting human requirements; but increased ground water extraction coupled with growing population has necessitated the need for effective management interventions. This paper explores the possibility of advanced tools and techniques for the assessment and, management of groundwater resources. The Heliborne Transient Electromagnetic (HTEM) survey, a cutting-edge geophysical technique, provides high-resolution aquifer information and aid in delineating subsurface geological features without invasive methods. The high-resolution aquifer mapping using HTEM surveys covering an area of approximately 1 lakh sq.km in parts of Rajasthan, Gujarat, and Haryana states in north-west India have already been conducted by Central Ground Water Board (CGWB), Ministry of Jal Shakti, Govt. of India. This state-of-the-art approach with data in high granularity provides deeper insights on aquifer information along flight lines with close spacing. CGWB is currently using this data for deliverables, such as identifying potential groundwater zones, fresh/saline interfaces, and suitable areas for artificial recharge at the Gram Panchayat level using Aarhus Workbench software. This paper focuses on the Gram Panchayat level aquifer information for Srimadhopur block in Sikar district, Rajasthan, covering an area of 575 sq. km. The Srimadhopur block lies in a marginal alluvial formation underlain by rocks of the Delhi Super Group (DSG), including quartzites, phyllites/schists, and impure marbles. Analysis reveals that out of 36 Gram Panchayats comprising 82 villages, limited groundwater is available in marginal alluvium formations in 38 villages, while 34 villages face dry conditions or have some moisture content in alluvium formations. However, HTEM survey data is unavailable for 10 villages, impeding the extraction of deliverables. The analysis recommends various potential sites for ground water drilling and sites for recharge structures such as shafts, injection wells, and shafts with injection wells for artificial recharge to groundwater. This information is very useful for local authorities in the planning of suitable ground water management interventions for sustainable development in the water-stressed areas of Block: Srimadhopur, Sikar district, Rajasthan. Sustainable groundwater management using advance technologies like HTEM, CGWB is trying to ensure the optimum utilization and preservation of this valuable resource for current and future generations.

UTILIZATION OF LITHOLOGICAL DATA IN GROUNDWATER MODELLING AND RESOURCE MANAGEMENT IN ASSAM

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Keywords: Groundwater modelling, Deep Tube well, Lithological database, Stratigraphic cross-sections, Groundwater resource management.

ABSTRACT

Assam is geologically rich in groundwater, with a low stage of groundwater extraction at just 12.38%. However, some regions near the foothills of Bhutan, Arunachal Pradesh, Meghalaya, and Nagaland have limited groundwater availability. Given the abundance of groundwater in most areas, the Jal Jeevan Mission has designed over 27,000 pipe water supply schemes (PWSS), with 90% of these schemes relying on groundwater sources.

To ensure the sustainability of these extensive schemes, it is crucial to develop a comprehensive lithological database to facilitate groundwater modelling for the state. This modelling can assist in scientific exploration, preventing external contamination, and preparing future recharge plans.

In the present study, we have devised a mechanism to gather real-time data of each exploratory well, such as Deep Tube Wells, directly from the field through a dedicated mobile application. Currently, we have collected approximately 7,000 groundwater exploration data points using this mobile application, which were digitized using Rockworks software. The digitized dataset is instrumental in creating hydrogeological models, including stratigraphic cross-sections, fence diagrams, and 3D solid lithological modelling. These models provide valuable insights into the subsurface geological characteristics, aiding in the comprehensive understanding of groundwater dynamics and facilitating informed decision-making processes in groundwater resource management initiatives.

In the current study, from hydrogeological modelling, we have classified the subsurface lithology into four litho-facies units: clay, sand, silty clay, and silty sand. By analyzing and representing these stratigraphic layers in a cross-sectional format, we gain valuable insights into the vertical arrangement and composition of geological formations. This stratigraphic cross-section aids in understanding the spatial distribution of different sedimentary deposits, their thicknesses, and their lateral variations, contributing significantly to the overall hydrogeological interpretation and groundwater resource assessment efforts.

ROLE OF GEOPHYSICAL SURVEYS IN DELINEATING SPRINGSHED IN DHALAI DISTRICT, TRIPURA

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ABSTRACT

Springs are natural discharge points where groundwater emerges at the earth's surface. This phenomenon occurs under the natural gravitational force, where in water passes through permeable soil and rock layers until it finds an outlet, typically in depressions, cracks, joints, contact or fissures in the terrain. Common in hilly and mountainous regions, springs are vital for local water supplies, supporting both ecological systems and human needs. Most of the springs in the study area are structurally controlled, but their subsurface geometry is poorly understood. Geophysical surveys employing Electrical Resistivity method, have been conducted to delineate the springshed at selected sites near springs in the Dhalai district, Tripura. These studies aim to assess the subsurface geology at specific locations enhancing the understanding and management of water resources by providing detailed insights into subsurface conditions and groundwater flow dynamics. Geologically, the study area is occupied by Quaternary & Upper Tertiary groups of rocks. A total of 21 VES (Vertical Electrical Sounding) have been carried out in the study area using Schlumberger Array to determine the vertical variations in resistivity of subsurface formations. In the study area, there were some constraints like buildings, constructions, hilly terrain etc. resulting in limited space for resistivity surveys in some areas, and the current electrode spread available was between 50 and 1000 m. VES curves recorded are showing 3 to 6 layers of substratum in the area and made inferences of possible sub-surface geology. Based on interpreted results of VES data, the zones of water bearing formation are delineated in different depth ranges as shallow as 2 to 6 m bgl and as deep as 50 to 120 m bgl. The results indicate the potential zones for groundwater development from both shallow and deeper aquifers and in deciphering the type of springs underlying the impermeable zone.

Keywords: Springs, Springshed, Vertical Electrical Sounding (VES), Groundwater

ISOTOPIC ($\Delta^{18}O$) VARIATION OF SHALLOW GROUNDWATER OF INDIA AND UNDERLYING HYDROGEOLOGICAL PROCESSES

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Abstract: This study presents the published as well as new $\delta^{18}O$ of shallow groundwater for India based on seasonal samples collected from ~2100 locations across the country covering all the hydrogeological units present in the country. The isotopic signatures of groundwater are interpreted regarding recharge from the Southwest Monsoon (SWM) and the Northeast Monsoon (NEM) rainfall, allochthonous water transported through preferentially migratory pathways. The important observations and inferences of this study are: The slope of pre-monsoon season groundwater and post-monsoon seasons groundwater are similar and lower than the slope of IMWL (7.8 ± 0.1), the lower slope of groundwater along with decreasing trend of d-excess with $\delta^{18}O$ indicates evaporation is the dominant mechanism for controlling groundwater isotopic composition after precipitation, and this evaporation takes place before recharge. From pre-monsoon to

post-monsoon groundwater showed seasonal variation. Seasonal variation ($\delta^{18}O_{post\text{-}mon}$ - $\delta^{18}O_{pre\text{-}mon}$) in the isotopic composition of groundwater is compared with the isotopic composition of rainfall available from the literature . The seasonal variation in $\delta^{18}O$ shows that during the post-monsoon season, groundwater in half of the geographical area shows depletion compared to the pre-monsoon season, which indicates the groundwater recharge by SWM rainfall, while one fourth of the geographical area shows isotopic enrichment during the post-monsoon season compared to pre-monsoon groundwater which suggests the local, isotopically depleted recharge source during the pre-monsoon season. The remaining geographical area shows no variation, suggesting non-occurrence of the seasonal recharge or slow recharge taking place over a longer period beyond the seasonal time gap of about 6 months. This study provides baseline isotopic data.

Keywords: Stable isotopes, Groundwater recharge, Spatial variation

BHUJAL APP: REVOLUTIONIZING GROUND WATER MONITORING

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KEYWORDS
Groundwater Monitoring, Bhujal App, IoT device, Aquifer Management, Water Conservation

ABSTRACT

Groundwater monitoring across India faces significant challenges due to difficulties in accessing borewell sites, opening borewell caps, and using conventional tools like sounders and Digital Water Level Recorders. These obstacles lead to prolonged data collection times and increased burdens on measurement teams. Additionally, the lack of user-friendly tools for assessing borewell water availability results in unsustainable groundwater use and mismanagement. Waterlabs' Bhujal Innovations offer patented solutions with the Bhujal App and IoT device, which utilize sonar technology to measure groundwater levels without the need for sensors or opening borewells. These tools provide accurate measurements within a minute, are validated by reputable institutions, and have been recognized for their innovative approach. The Bhujal App enables efficient groundwater monitoring, capturing geolocation data for easy map preparation and ensuring data integrity through automated processes. It supports real-time monitoring via cloud data capture and is cost-effective, scalable, and easy to use. The Bhujal App is actively employed by organizations such as the Central Ground Water Board, WaterAid, and Humana People to People, among others. It aids in water conservation efforts and enhances groundwater management practices amidst growing water scarcity due to climate change. The app's non-invasive, resonance-based monitoring method saves time, energy, and financial resources, making it a valuable tool in regions with prevalent borewell use and limited piezometer networks. In conclusion, the Bhujal application revolutionizes groundwater measurement, offering user-friendly, accurate, and efficient solutions to the longstanding challenges in groundwater monitoring in India.

INVESTIGATION OF GROUNDWATER RESIDENCE TIMES AND RECHARGE SOURCES IN SOUTH-WEST PUNJAB, INDIA

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Abstract

Investigating areas of water recharging the groundwater system is essential for improved water resources planning. Age dating of groundwater along with a knowledge of the water isotopic composition can help to understand groundwater flow regimes and residence time in an aquifer. Using these tools can identify where shallow aquifers are vulnerable to changes in land use which can impact on water quality. In this study, aquifers in south-west Punjab, which has a high degree of agricultural land use, were investigated. Multiple tracers were used to determine the residence times and recharge patterns of aquifer systems for the first time in 34 piezometers developed at 10 sites. The piezometers were constructed at a range of depths, from 5m to 31m. Groundwater age distributions reveal groundwater residence times of around 50 years. The isotope data suggests the vertical and lateral interactions among the aquifers and indicate a direct link with the canal/river system and precipitation. Relatively young groundwater age suggests enhanced rapid recharge after precipitation. The findings of this study will be valuable for policy makers, water managers and stakeholders to obtain relevant hydrogeological information for improved aquifer resource planning.

Keywords: Groundwater, age dating, recharge sources, resource management, Punjab

PREDICTION OF MONTHLY RAINFALL BASED ON MACHINE LEARNING TECHNIQUES IN PUSHKAR CITY, RAJASTHAN, INDIA

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KEYWORDS
RF, M5Rules, M5P, Hybrid model, & Rainfall Prediction

ABSTRACT:
stainable groundwater development, flood estimation, drought assessment, streamflow estimation, and reser
ration. The main objective of the present study is to develop a suitable rainfall model for estimating monthly rair

ıe Pushkar City, Rajasthan. The various combinations of input variable were utilized based on monthly rainfall d
ging technique for the development of models. The rainfall data set collected from the water resources departm
Rajasthan, covers the period from 1986 to 2016. In the present study, random forest (RF) and hybrid (M5Rul
P) techniques were applied to predict monthly rainfall. The results obtained by RF and hybrid models were compa
ı observed rainfall and predicted model based on statistical indices such as Nash Sutcliffe Efficiency (NS
'relation Coefficient (CC), Willmott's Index (WI), Root Mean Square Error (RMSE), and Normalized Root Me
ıare Error (nRMSE). The results show that the performance of the RF model (NSE = 0.410, CC = 0.641, WI = 0.9
SE = 60.663 mm, & nRMSE = 1.480) with 10 input variables is found to be superior in comparison to the hyl
del in estimating monthly rainfall for Pushkar city.

ABSTRACTION IDENTIFIABILITY THROUGH REGULARIZATION OF GROUNDWATER MODELS IN A DATA-SCARCE AREA EXEMPLIFIED BY THE AYAD RIVER BASIN

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Introduction

The groundwater system of Ayad River Basin, Rajasthan, India, is overexploited and the water demand is steadily increasing. Estimates of the water balance components are associated with large uncertainty, which complicates sustainable water management of the area. This specifically concerns groundwater abstraction, which in the study has been estimated through indirect methods. The hydrogeological data availability of the Ayad River Basin is relatively low. The water level has only been recorded twice a year, and surface water discharge measurements are not available. Further, the spatial distribution of hydraulic properties is not characterized. Intuitively, the available data will therefore likely only support a simpler groundwater model with lower data requirements.

The overall hypothesis we seek to address is whether the groundwater abstraction rate can be determined from a highly parameterized model in a data-scarce area. Indirect methods for estimation of groundwater abstraction can be applied based on e.g. water demand (Salem et al. 2017), closure term in water balance (Ruud et al. 2004) or water consumption (Pérez et al. 2019). Highly parameterized models offer an alternative solution, where the groundwater abstraction estimates can be estimated by calibrating against historical measurements of hydraulic head. In this study, we test different parameterization and regularization strategies and evaluate the reliability of the estimated groundwater abstraction estimates.

THEME:-CHALLENGES IN SUSTAINABLE MANAGEMENT OF GROUND WATER

PAPER TOPIC:-

"CHALLENGES FOR GUJARAT'S GROUND WATER RESOURCES"

A CASE STUDY OF SALINITY INGRESS IN COASTAL REGION OF SAURASHTRA.

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Keywords
Ground Water Management, Salinity Ingress, HLC-I & II, Salinity Control, Spreading Channels,

ABSTRACT

The Prosperity of mankind is always governed by the environment. With the progress of civilization mankind tried to utilize the surface and ground water resources where and when available. Exploitation of ground water by adopting esoteric method is carried where necessity is felt and resources compromised.

CHALLENGES FOR GUJARAT'S GROUND WATER:-

The state of Gujarat is having various issues regarding ground water, which includes Salinity ingress also. Salinity affects approximately 20% of irrigated land worldwide. Controlling salinity and reclaiming saline land is an urgent priority in order to increase productivity of existing land, make better use of irrigation and demonstrate that new irrigation areas can be managed in a sustainable manner. Salinity Ingress in the coast of Saurashtra has created many problems in the vicinity of the coastal area, particularly for the irrigation land, ground water quality, surface water including drinking water etc. The problem of salinity ingress has aggravated over the years due to heavy withdrawal and non scientific exploitation of ground water. All these ultimately affected the ground water availability and above this the intrusion of saline water in the coastal region of Saurashtra of Gujarat State and thus ruined the life of people economically in a very great extent, Migration of people started at last.

MAIN CAUSES OF SALINITY INGRESS IN SAURASHTRA REGION:-

Geological formation, No perennial river, Scarce and uneven rainfall, Large scale pumping of ground water by farmers in the Coastal Region, Imbalance between water recharge and water withdrawal, Unawareness/ carelessness in usage of precious water, all these led to Salinity ingress in Coastal belt. The Government of Gujarat formed two HIGH LEVEL COMMITTEES in the year '76 and '78 respectively to investigate the problem of salinity ingress and to give suggestions for its remedial measures. Solutions suggested by them were construction of Tidal Regulators, Bandharas, Check dams, Spreading channels, a forestation and some management techniques which include regulation of lifting of underground water and change of crop pattern and coastal land Reclamation bunds. As per the suggestions given by the committees,various infrastructure development plan had taken place and construction of suggested projecte were carried out by the Government of Gujarat in last about 44 years & as such benefits have been obtained, which includes, increase in irrigation potential for land and the increase in the quantity of benefited areas of cultivable land and many other benefits were noticed. The efforts made by the Government of Gujarat have changed the scenario of rural people, who were suffering from the problem of salinity for a long time. Now they witnessed the development. The future is bright in the coming years. Jai-Hind.

GROUNDWATER SUSTAINABILITY CHALLENGES FOR HARD-ROCK AQUIFERS IN THE HIGHLY IRRIGATED SEMI-ARID REGION OF TELANGANA

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Abstracts:
Agriculture consumes approximately 70% of the global freshwater supply. Extensive agricultural practices have led to water resource depletion in many parts of the world, posing a serious threat to water sustainability. In Telangana, around 85% of the irrigation water comes from hard-rock aquifers, which have limited storage capacity and are highly dependent on monsoon rainfall for replenishment. This study aims to explore the water-food-economy nexus in the context of Telangana state in India. This work reveals that paddy cultivation is the predominant irrigated crop in Telangana, with the majority of irrigation water being sourced from groundwater. Over the past three decades, the area irrigated with groundwater has nearly tripled, leading to the overexploitation of aquifer systems in several areas. Although the agricultural sector employs approximately half of the labor force, it only contributes around 16% to the Gross State Domestic Product (GSDP) and is at risk of decline due to water shortages. Therefore, the sustainable management of groundwater is crucial not only for water and food security but also for the livelihoods of half of the labor force and their dependents in the region. This study emphasizes the intricate relationship between these factors and advocates for urgent action to ensure the sustainability of water resources in the face of climate change. Promoting the cultivation of water-efficient crops, prioritizing rain-fed agriculture in the context of climate resilience, and implementing water regulation and rainwater harvesting measures are essential steps toward establishing water security in the region.

Keywords: Telangana, Hard Rock Aquifers, Source Sustainability, Groundwater Irrigation, Water-food-economy nexus

GROUNDWATER SUSTAINABILITY CHALLENGES IN HARD-ROCK AQUIFERS IN THE HIGHLY IRRIGATED SEMI-ARID REGION OF TELANGANA

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Keywords: Telangana, Hard Rock Aquifers, Source Sustainability, Groundwater Irrigation, Water-food-economy nexus

ADVANCING REAL-TIME AND COST-EFFECTIVE GROUNDWATER QUALITY MONITORING USING MACHINE LEARNING-BASED PREDICTIVE MODELS: A CASE STUDY IN RAJASTHAN, INDIA

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Keywords: Artificial Neural Network, Groundwater Quality, Nitrate, Aquifer, Quality Monitoring.

ABSTRACT

Groundwater quality monitoring is a critical component of groundwater management worldwide. In India, numerous agencies undertake continuous and repetitive assessments of aquifer quality. However, the challenges inherent in analytical chemistry and the establishment and upkeep of accredited laboratories often impede effective groundwater quality monitoring, especially in many developing nations. Nonetheless, recent advancements in Artificial Intelligence (AI), specifically machine learning using Deep Neural Network (DNN) algorithms, offer a promising avenue to address these challenges.

In this study, an ANN model has been developed to predict groundwater quality based on easily measurable parameters such as Electrical Conductivity, pH, and temperature. The model was specifically trained on existing groundwater quality data from a shallow aquifer to forecast nitrate contamination levels in Rajasthan. Evaluation of the model against established statistical benchmarks revealed that the prediction error (or 'Loss') fell within an acceptable range.

With adequate computational resources and scaling, the neural network could be further trained to predict the concentrations of other cations and anions in groundwater. This capability has the potential to revolutionize groundwater quality monitoring, providing a fast, cost-effective, and real-time approach to monitoring groundwater quality.

WC-12

HEALTH RISK ASSESSMENT OF ELEVATED FLUORIDE IN GROUNDWATER AND ITS SUITABILITY FOR DRINKING PURPOSES BASED ON WATER QUALITY INDEX IN TONK DISTRICT, RAJASTHAN, INDIA

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ABSTRACT

The Fluoride, F^- contamination in drinking groundwater is a significant human health risk in all over the India. Moreover, high fluoride pollution in drinking water causes a variety of disorders, including dental, skeletal and neurological, fluorosis. The aim of this research was to evaluate the health risk of elevated fluoride in groundwater and its suitability assessment for drinking purposes. The total of (n = 178) groundwater samples were collected from entire Tonk District, Rajasthan. The results show a mean pH value of 8.23 slightly alkaline, TDS of 1300 mg/L, EC of 2000 µs/cm. The mean values of CO_3^{2-}, HCO^{3-}, SO_4^{2-}, NO_3^- and Cl^- were 39, 388, 120, 49.12 and 333 mg/L, respectively. The mean values of TH, Ca^{2+}, Mg^{2+}, Na^+ and K^+ were 288, 33, 51, 332 and 7.04 mg/L, respectively. The F^- concentration in the groundwater varies between 0.16 and 5.5, with a mean value of 1.61 mg/L, and 80 samples out of 178 about 45% were beyond the BIS recommended limit of 1.5 mg/L. The hydrochemical analysis results indicated that among the groundwater samples of the study area, 40% of groundwater samples belong to Na^+-Cl^-, 38% samples were $NaHCO_3$ type and 22% were mixed $CaNaHCO_3$ type. biotite, muscovite, garnet, amphibole and fluorite are the major minerals enriching fluoride in groundwater. The non-carcinogenic health risk assessment results of the F^- concentrations shows the range of $ADD_{ingestion}$ for children, females, and males in the Tonk district, and their mean values were observed to be 0.0848, 0.0747, and 0.0624, respectively. Mean values of $HQ_{ingestions}$ were 1.414, 1.229, and 1.040 for children, females, and males, respectively. The greatest health risk of fluoride intake was observed in children with highest maximum and average values of $ADD_{ingestion}$ and $HQ_{ingestion}$. The water quality index (WQI) analyses show that out of 178 ground water samples 42% of the samples belong to the poor-quality category, 34% were of good quality, and 6.3% of the samples of the study area belong to the excellent category and 4.7% of samples are not suitable for drinking purpose.

Keywords: Groundwater, Fluoride; Geochemical modeling; Health risk assessment; ingestion

WATER QUALITY AND SUSTAINABLE DEVELOPMENT: A VISION FOR 2030 AND BEYOND

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KEYWORDS
Water Quality index, Drinking water, Irrigation water, water pollution, rivers

ABSTRACT

The availability of fresh water is one of the most critical resources for humanity. With the profound declaration that 'Water is life, its significance cannot be overstated. Water serves as the cornerstone for the biological functions of all living organisms, including humans, plants, and animals, with no viable alternative known. Its unique attributes distinguish Earth among celestial bodies, lending it the distinctive blue hue we recognize. Furthermore, water's distinct physical and chemical properties make it indispensable for numerous industrial processes, hydroelectric power generation,

transportation, and food production. The economic, social, and cultural well-being of societies hinges significantly on the accessibility and quality of fresh and clean water supplies. Moreover, the vitality of most ecosystems directly relies on the availability of fresh water resources. Notably, nations endowed with ample fresh water resources often enjoy economic advantages over less fortunate counterparts. However, many developing countries face challenges due to the scarcity of such resources. In essence, water stands as a linchpin for sustainable development, embodying the true essence of sustainability.

The Water Quality Vision for 2030 presents a forward-looking and comprehensive strategy aimed at ensuring the sustainability of water resources, a critical component for nurturing life and preserving ecosystems. This vision is holistic, addressing multiple facets of water quality monitoring and management to tackle current and future challenges effectively. It outlines a plan for meticulous monitoring of various pollutants, including micro-plastics, pharmaceuticals, agricultural chemicals, metal speciation, and toxicity levels, which are essential for maintaining the health of our water bodies.

In an effort to increase public engagement and ensure transparency, the strategy includes the creation of a River / ground Water Quality Index and the installation of real-time data monitoring systems in accessible locations. The deployment of mobile water testing laboratories is another innovative approach to bring water quality testing closer to communities, facilitating immediate action when necessary. Recognizing the significance of rigorous and standardized testing, the vision advocates for the accreditation of water quality laboratories and an expansion in the number of monitoring sites. This expansion is crucial to comprehensively address and manage the diverse sources of pollution effectively.

Furthermore, it identifies emerging concerns such as the effects of urbanization, the use of agricultural chemicals, residues from pharmaceuticals, and the pervasive issue of plastic pollution. These factors demand continuous research and the development of proactive management strategies to protect water quality and the health of aquatic ecosystems. By adopting this integrated approach, all stakeholders, including policymakers, businesses, communities, and individuals, are encouraged to collaborate in fostering a sustainable and resilient water future. This collective effort is vital for ensuring the well-being of our planet and the prosperity of future generations.

ASSESSMENT OF AQUACULTURE IMPACT ON SHALLOW GROUNDWATER IN THE GODAVARI DELTA, ANDHRA PRADESH

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KEYWORDS

Groundwater, Salinity, Aquaculture, Shallow Wells, Godavari Delta

ABSTRACT

The groundwater salinity in the Godavari delta, Andhra Pradesh has been evaluated, and found that the average salinity (EC) in shallow and piezometer wells has increased from 1664 to 2428 µS/cm and 2515 to 3606 µS/cm from the years 2005 to 2019 respectively. The mapping of surface water bodies (for May) has been carried out using the Normalized Difference Water Index (NDWI) of the years 2005, 2009, 2014, and 2019 in the Godavari delta. The percentage of water bodies in the delta has increased from 13.6 to 21.17 from the year 2005 to 2019. It is further found that the percentage of water bodies increased in the upland delta zone during the 15 years (2005-2019) is 1.60% while in the coastal zone is 5.97%. According to the land use/land cover (LU/LC) maps, the highest area of 48% and 42% is occupied by agriculture in the years 2005 and 2019 respectively. This decrease of 6% was caused mainly by the increase of water bodies (from 7.95 to11.78%) which are aqua ponds during the 15 years. During this period, the highest water bodies increased in five coastal mandals of Western (Bhimavaram, Mogalture and Narasapuram) and Central (Sakhinetipally and Uppalaguptam) deltas. The analysis of rainfall indicated that there is no impact of rainfall on increased water bodies. A decreased trend of groundwater levels is observed in the Sakhinetipally, Mogalturu, and Bhimavaram mandals where groundwater salinity increased which indicates brackish water aquaculture is being practiced using shallow groundwater. Freshwater aquaculture using canal water is dominant in the Narasapuram mandal for the increased water table and groundwater salinity. The rise of groundwater table and salinity in the Uppalaguptham mandal may be due to the creek water/backwater utility for aquaculture. Further five salinity zones (Zone I to Zone V) have been identified in the Godavari delta using hydrogeochemistry to identify the salinity sources of each zone. Out of the five salinity zones, the groundwater salinity in shallow wells is more when compared to piezometer wells in the Zone II (slightly brackish) and Zone III (brackish) and this is mainly due to the impact of aquaculture activities on shallow wells in the Godavari delta.

IMPENDING ISSUES OF SALINE GROUNDWATER IN THE AQUIFERS OF NAVALGUND TALUK OF DHARWAD DISTRICT, KARNATAKA

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Abstract

Navalgund Taluk, situated in the Malaprabha River basin, is characterized by its gentle, undulating terrain typical of the eastern maidan region. This area is primarily drained by several major nallas, including Bennihalla, Hirehalla, Tuprihalla, Handiganhalla, Gundiganhalla, and Yarnahalla. Agriculture stands as the predominant occupation, facilitated by the fertile black cotton soil (BCS) that varies in thickness from 1.0 to 5.0 meters. Irrigation in Navalgund is primarily sustained through a combination of canals, tanks, wells, and tube wells. A significant portion of the land, about 109.90 square kilometers, is irrigated by a 29 km canal network stemming from the Malaprabha irrigation project. Additionally, 35 open wells and 214 bore wells, along with other minor sources, provide irrigation to another 34.49 square kilometers. The region's major aquifer is composed of Granitic Gneiss, which supports groundwater in both unconfined and semi-confined conditions. Exploratory bore wells, drilled to depths ranging from 53 meters below ground level (mbgl) to 200 mbgl, tap into the semi-confined aquifer. The weathered zone of the aquifer extends from 5 mbgl to 20 mbgl, while deeper fractured formations are found between 28 and 200 mbgl, yielding water at rates between 0.07 and 3.10 liters per second (lps). Despite the abundance of groundwater, its quality is a significant concern due to high salinity levels. Total Dissolved Solids (TDS) in the groundwater can reach up to 6,036 mg/l, with an average of 1,627.18 mg/l. Electrical Conductivity (EC) values are also alarmingly high, peaking at 11,000 µS/cm at 25°C, particularly in Gummagol village. However, the unconfined aquifer in the eastern part of Navalgund displays relatively lower EC values, indicating fresher water quality. Moreover, geophysical surveys particularly Electrical Resistivity Surveys, have recorded values between 20-62 Ohm.m, suggesting the presence of fresh groundwater. These findings were corroborated by the drilling of exploratory bore wells in Naiknur and Tadhal Villages. Gibb's data plot for pre-monsoon water samples indicates that a significant proportion of these samples reflect the influence of silicate weathering on the groundwater chemistry. Overall, Navalgund Taluk's agricultural prosperity is heavily dependent on its irrigation infrastructure and groundwater resources. The region's black cotton soil supports extensive farming, while the Malaprabha irrigation project, along with numerous wells, ensures water availability for crops. However, the salinity issue in groundwater remains a major challenge, necessitating ongoing monitoring and potential interventions to manage and improve water quality. The exploration and utilization of fresh groundwater pockets, as indicated by geophysical surveys, could provide a viable solution to this problem. Additionally, understanding the geological factors, such as silicate weathering, that affect groundwater chemistry is crucial for developing strategies to mitigate the salinity and enhance the sustainability of water resources in Navalgund Taluk.

Keywords: groundwater, aquifer, salinity, irrigation, geophysical

GROUNDWATER QUALITY SCENARIO IN THE COASTAL TRACT OF CANDOLIM, CALANGUTE AND ANJUNA VILLAGES IN BARDEZ TALUK OF NORTH GOA DISTRICT, GOA STATE

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Goa has a significant coastal length which is the home to many beautiful and famous beaches in the world. Over the past five decades, Goa has undergone a profound metamorphosis into a premier tourist hub, witnessing an exponential surge in coastal development characterized by a proliferation of resorts, residences, dining establishments, and entertainment venues. This burgeoning influx of multilateral investments, coupled with the mushrooming of new industries and heightened rural-urban mobility, has catalyzed a transformative paradigm in the region's socioeconomic landscape, accentuated by escalating tourism and attendant infrastructural undertakings. However, this unprecedented growth trajectory has engendered significant stress on the coastal ecosystem, particularly on the fragile groundwater

reservoirs. Past empirical inquiries have spotlighted the vulnerability of coastal aquifers to seawater intrusion, a consequence of intensified groundwater extraction and potential sea level rise. To elucidate the dynamic interplay between anthropogenic pressures and hydrogeological dynamics, the Central Groundwater Board, under the aegis of the Ministry of Jal Shakti, Government of India, embarked on a comprehensive study during the year 2022-23, focusing on the groundwater quality within the precincts of Candolim, Calangute, and Anjuna villages situated in the Bardez taluk of North Goa district. The study terrain, characterized by schist and laterite formations, experiences an average annual rainfall of 2982 mm. Thirty monitoring wells were strategically deployed, and groundwater samples were meticulously collected from the phreatic aquifer across distinct temporal intervals of September (rainy season), November, 2022 (post monsoon) and January (regression period) and in March 2023 (dry season). A discernible degradation in groundwater quality, primarily manifesting in elevated nitrate concentrations, was notably observed during the post-monsoon period, proximal to Calangute beach, where nitrate levels soared up to 98.05 mg/l. It is speculated that this occurrence is closely associated with increased tourist visits and the simultaneous rise in organic waste disposal. Electrical conductivity (EC) values within the study area generally ranged within 750 mS/cm at 25°C, with sporadic spikes observed, notably reaching a maximum of 1600 mS/cm in the vicinity of the Calangute creek, indicative of minor incursions of saline water along the coastal fringe, in locales such as Baga and Anjuna. The Hydro chemical analyses, depicted in Gibbs plots, revealed a distinct seasonal pattern. Pre-monsoon periods were marked by dominance of rock-derived elements, whereas post-monsoon phases showed a growing influence of seawater, indicating the impact of tidal fluctuations. Therefore, the results of this study highlight the interaction between seasonal changes and human activities in shaping the groundwater system. This emphasizes the urgent need of real-time surveillance, monitoring for careful resource management strategies to protect the ecological balance and groundwater quality in the coastal areas of Goa.

Keywords: Coastal, groundwater, tourism, anthropogenic, ecological

INTEGRATED WATERSHED MANAGEMENT FOR SUSTAINABLE DEVELOPMENT: A CASE STUDY OF KADVANCHI VILLAGE IN JALANA DISTRICT, INDIA

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KEYWORDS
Watershed management, Groundwater recharge, Agricultural productivity, Water conservation, Sustainable development

ABSTRACT
The Kadvanchi Watershed Development initiative in Jalana District represents a significant effort in addressing water scarcity through integrated watershed management practices. This study examines the implementation of various water conservation and management techniques within the Kadvanchi watershed, focusing on their impact on water availability, agricultural productivity, and local livelihoods. Key interventions include the construction of check dams, contour trenches, and percolation tanks designed to enhance groundwater recharge and mitigate the adverse effects of irregular rainfall and droughts. Our research highlights the geophysical and climatic characteristics of the region, which necessitate tailored watershed management strategies. By analyzing pre- and post-implementation data, we demonstrate the substantial improvements in groundwater levels, crop yields, and the socio-economic conditions of the local population. The success of the Kadvanchi Watershed Development project underscores its potential as a replicable model for other drought-prone areas in Maharashtra and beyond. This paper contributes to the broader discourse on sustainable water resource management and offers practical insights for policymakers, practitioners, and researchers engaged in combating water scarcity and promoting agricultural sustainability.

IDENTIFYING PRODUCTIVE WELL SITES IN HARD ROCK TERRAINS USING GEOPHYSICAL TECHNIQUES: A CASE STUDY FROM SONBHADRA DISTRICT, UTTAR PRADESH

Abstract:

The growth of population in the country leads to a rise in demand of groundwater. While obtaining water through wells is relatively straightforward in alluvial areas, it is more challenging in hard rock terrains where groundwater is not uniformly available. Therefore, to cater for the growing population in hardrock regions, it is important to locate the productive sites using integrated techniques. This study aims to pinpoint productive site for a well to be drilled in Hard rock Terrain of Babhani and Myorpur Blocks of Sonbhadra district, Uttar Pradesh, using integrated geophysical techniques such as Gradient Profiling (GP) and Vertical Electrical Sounding (VES). Initially, three GP were carried out covering 200 metres length each to locate the low resistivity zones for VES using the ABEM Terrameter LS instrument. The acquired GP data is interpreted and the variation of resistivity 'low' and 'high' observed on gradient profile. The resistive 'low' zones on gradient profiles are selected for VES to know vertical variation of resistivity of the subsurface. Five VES has been conducted and acquired data is interpreted using IX1D software. Interpretation reveals various subsurface layer such as surface layers followed by upper fills, dry weathered zone, potential fractured zone with water saturation and massive granite basement. To further confirm the presence of fracture zone non-conventional techniques of VES interpretation factor analysis were also used. Based on factor analysis, one out of 5 VES indicate the presence of fracture at depth of 15 mbgl to 20 mbgl. This site is recommended for drilling and on drilling it is found that fracture zone is present between 13.55 mbgl to 19.65 mbgl with 1.5 inch of groundwater discharge on 90-degree V notch. Thus, this method effectively pinpoints productive well sites in water-scarce hard rock terrains.

Key words: VES, Gradient Profile, Factor Analysis, Sonbhadra District.

GROUNDWATER RECHARGE THROUGH DESILTING IN MAUDA, MAHARASHTRA

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KEYWORDS
Mauda River, Maharashtra, Desilting, Groundwater recharge, Crop Productivity.

ABSTRACT: GROUNDWATER RECHARGE THROUGH DESILTING IN MAUDA, MAHARASHTRA

Mauda, is a town and a tehsil in the Ramtek subdivision of the Nagpur district in Vidarbha region of Maharashtra, India. Mauda is water stressed tehsil. Due to restrictions on water supplied from Government of Maharashtra (GOM) through Chaurai dam (in Madhya Pradesh), villages in the tehsil of Mauda have been facing water crisis. Due to this situation, The Art of Living team decided to initiate a water conservation project there. The collaborative efforts by NTPC Limited, Mauda and The Art of Living for resolving the water scarcity and drought conditions of Mauda Tehsil has resulted in drastically shifting the tehsil to water secure and water surplus region. In Mauda, the project began in 2017 and the area stretched over 70 sq km. Over 150 villages were involved in the project, 29 micro watersheds were identified & treated, 29,000 Hectares of area got benefitted and 40,000 people rejoiced the benefits of this initiative. Ponds & Nalas (Natural Water Streams) were created to hold rain water. Desilting of the river beds, ponds, and Nalas was done by following the 80:20 Rule. During the cleaning of the water body desilting is done in such a way that once the water body is carrying water, the water is slowed down and stored. Desilting is done using 80:20 rule, in which 80 meters of the river bed is desilted, and 20 meters of the river bed is kept as it is. This created a series of small water storage ponds which enhance groundwater recharge. Third-party Impact Assessment was done by GIST to evaluate the benefits generated by the watershed program for the local communities in Mauda tehsil, Maharashtra. The efforts were recognized by many government and private organizations. The Water sustainability award 2021-22 was presented to NTPC limited, Mauda and The Art of Living for its Excellence in Participatory Water Management by facilitating the participation of communities in water management towards the achievement of Sustainable Development Goal on clean water and sanitation. Award was presented by UNDP, Water Resources, The Energy and Resources Institute, New Delhi and TERI. So far, we have desilted 2,67,44,950 CBM, 1238 KM of area in 18 districts of Maharashtra. VVKI has recently signed an MOU with Government of Maharashtra to work jointly to address the water scarcity issues under the Project "Jalyukt Shivar Abhiyan 2.0", for desilting of existing water streams in 24 districts and 86 Tehsils of Maharashtra. This paper presents a comprehensive analysis of a groundwater recharge initiative in Mauda, Maharashtra, undertaken by NTPC Limited, The Art of Living, and local stakeholders. This study evaluates the methods used, the impacts observed, and the outcomes achieved, highlighting the significant improvements in water availability and agricultural productivity.

WATER GOVERNANCE AND FINANCING

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FINANCING: AN EMERGING NEED FOR INDIAN AGING WATER INFRASTRUCTURE

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Abstract:
Water is fundamental to all life on Earth. Throughout history, the prosperity, well-being, and sustainability of life and economies have largely depended on water availability. Today, water remains crucial to the social and economic development of every nation. There is an urgent need to explicitly recognize water's role as a connector across all economic activities, including energy generation, transport, food production, sanitation, public health, and disease reduction. Furthermore, Goal six of the Sustainable Development Goals (SDGs) directly addresses water, while achieving most of the other sixteen SDGs also depends on water availability. Dams are critical national infrastructures that provide water security and support economic prosperity. These assets face significant challenges due to aging and evolving hazards. The most urgent issues include rehabilitating aging infrastructure, securing funds for capital improvements, and ensuring the long-term sustainability of these assets to deliver the expected benefits with minimal risks. In this context, a lifecycle management approach ensures not only the infrastructure's integrity but also emphasizes structured institutional governance and the necessary technical expertise to address various safety concerns. Addressing issues in isolation may overlook or negate efforts to mitigate other problems. A comprehensive lifecycle perspective encompassing assets, personnel, and ecological systems is indispensable. Additionally, a consistent, risk-informed decision-making framework is essential.
Aged dam structures incur rapidly rising maintenance needs and costs while their effectiveness declines, posing potential threats to life, the economy, and the environment. This paper provides an overview of the current state of financing for the large-scale rehabilitation of aging Indian dams, focusing on data from the externally funded Dam Rehabilitation and Improvement Project (DRIP) Phase-I. The paper examines the financing aspects, an emerging need for existing hydro infrastructures (especially dams and reservoirs), the national perspective on current financing, and the way forward. Financial protection of these assets involves having plans and funding in place for their rehabilitation and reconstruction over time. This includes regular budgetary mechanisms for day-to-day operation and maintenance costs and an operational framework for catastrophe insurance programs for public assets, drawing on global experiences. This paper targets dam owners, operators, regulators, governments, and their partners responsible for planning, developing, and maintaining water infrastructures, emphasizing the adaptation to an effective financing mechanism.
Key Words: Water security, Infrastructure rehabilitation, Sustainable financing, Dam Safety, Economic prosperity

Regulatory Frameworks and Policy Implications for Promoting Sustainable Water Governance and Water Finance in Bharat@2047: Fostering Industry 6.0 and Economic 4.0

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Abstract

In order to achieve the objectives of Industry 6.0 and Economic 4.0, Bharat (India) recognises the importance of sustainable water governance and innovative water financing methods under the Bharat@2047 project. This paper presents an overview of the regulatory frameworks and policy implications required to enable effective water management and finance methods that promote industrial expansion, economic development, and environmental sustainability in the next twenty years.Efficient water management necessitates a unified regulatory strategy that covers water entitlements, distribution mechanisms, and detailed quality criteria. Policies should provide incentives for the use of intelligent water management technology, such as monitoring systems enabled by the Internet of Things (IoT), improved water treatment solutions, and platforms that utilise data to inform decision-making. These technologies will

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have a crucial impact on improving the efficiency of water usage, minimising waste, and guaranteeing the sustainable exploitation of water resources. Water financing methods are crucial for facilitating these technical developments and infrastructural enhancements. Novel financial structures, such as public-private partnerships, water tariffs determined by use, and green bonds, have the potential to provide the required investment for water projects. Regulatory frameworks should promote private sector involvement and investment by offering explicit rules, risk-sharing systems, and financial incentives. Moreover, the incorporation of water management into wider economic strategies would promote a mutually beneficial connection between sustainable water use and industrial expansion. Implementing policies that encourage water-efficient industrial operations, the establishment of circular water economies, and the use of water reuse and recycling methods would significantly contribute to the attainment of Industry 6.0 targets. This strategy is in line with the ideas of Economic 4.0, which prioritise sustainability, innovation, and inclusion. Public awareness and stakeholder involvement are essential elements of sustainable water governance. Education campaigns and community participation activities can improve adherence to legislation and foster a culture of water conservation. To establish sustainable water governance, assist the transition to Industry 6.0, and stimulate Economic 4.0, Bharat@2047 will require a strong regulatory framework and novel water financing structures. Future study should prioritise the optimisation of these frameworks and the identification of optimal strategies for combining water management with industrial and economic policies. This will ensure that Bharat's growth is both prosperous and sustainable.

Keywords : Bharat , Economic 4.0 , Industry 6 .0 , water governance , Water financing

WATER MANAGEMENT IN INDIA—FROM ANCIENT COMMUNITY-BASED SYSTEMS TO COLONIAL INTERVENTIONS AND MODERN STRATEGIES

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KEYWORDS
Community-driven systems, Colonial hydrology, Ecological awareness, Sustainable practices, Integrated water management

ABSTRACT:
The evolution of water management in India—from ancient community-based systems to colonial interventions and modern strategies—highlights the enduring relevance of traditional knowledge in sustainable resource management. As India navigates current and future water challenges, integrating diverse approaches and learning from historical experiences can pave the way for a more equitable, resilient, and water-secure future. Ancient Indian Community-Based Water Management focused on sustainability and community cooperation through rainwater harvesting, water sharing, and underground water management. However, it was reliant on rainfall patterns and vulnerable to prolonged droughts. British India Water Management focused on centralized control and irrigation for revenue generation through large-scale canals and engineering. However, it neglected traditional systems, leading to social and ecological disruptions. Independent India's Water Management focused on balancing development and sustainability through a multi-pronged approach, including large-scale projects, green revolution initiatives, groundwater extraction technologies, and institutional reforms. Despite its strengths, challenges remain in managing rapid urbanization and industrialization's water demands.

India's water management journey reflects a continuous learning process, and by studying the strengths and weaknesses of each era, a more comprehensive approach can be developed. The importance of traditional knowledge should be revived and modernized for sustainable water use, and large-scale projects should not come at the cost of local needs and traditional practices. Promoting efficient irrigation methods and water-saving technologies is crucial. By embracing innovation and harnessing the wisdom of the past, India can ensure a future where water sustains its communities and ecosystems for generations to come.

ADMINISTRATIVE DIVISIONS
REVENUE DISTRICTS TO RIVER BASIN DISTRICTS

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KEYWORDS
River Basin Districts, Water Governance, Administrative Structure, Convergence of Stakeholders, Reorganisation of Districts

ABSTRACT

Water Governance is essential for management, conservation and equitable allocation of the resource among all the users. Administrative systems form an important aspect of water governance. Presently various stakeholders having different interests on water are interacting with each other in various forms on different forums. Government, being the central policy maker has to provide a common forum for all of them to converge their shared interests. But, different departments of the government handling specific interests of various sectors have their own administrative structure and jurisdictions. This creates coordination delays in policy making and results in poor management of resources. In order to create convergence among all the stakeholders, administrative systems have to be transformed in such a way that all the arms of government have a shared common administrative structure and jurisdiction based on a common underlying factor.

India is a union of states and states are divided into districts which are further divided into sub-divisions, tehsils and villages. Historically, districts were formed based on the land tax administration requirements. A detailed analysis of the basic factors of various human activities shows that water is the common underlying factor for all of them. Watershed boundaries are the appropriate units of governance for division of geographical area into administrative units providing a common jurisdiction for all stakeholders. Present administrative districts have to be reorganised based on the watershed boundaries. At all levels of governance, boundaries have to be realigned with the corresponding natural boundaries of river basins and sub-basins.

The process involves two major aspects - legal mechanism for reorganisation of districts and technical support for processing the spatial data of all the parameters to be considered. States follow different mechanisms for this process. Some take the executive route of issuing Government Orders and some other states have passed specific laws providing a mechanism for altering administrative boundaries. Geographical Information System (GIS) tools provide the processing support for the spatial data. Apart from watershed boundaries, other important factors such as population distribution, forest cover, topography, transport networks and groundwater potential should also be taken into consideration which can also be processed in any GIS platform.

As an illustration, the reorganisation exercise has been done for the state of Tamil Nadu at the level of districts. Tamil Nadu has 38 revenue districts for general administration. However certain departments like health, education, highways and electricity board have their own administrative jurisdictions. This multiplicity of administrative units inherently results in coordination issues in governance. A common uniform structure can be created by reorganising all these units based on river basin boundaries. There are 17 major river basins in Tamil Nadu which can be grouped into 10 Regions. These Regions can be further divided into districts aligning them with the river basin boundaries.

FROM AWARENESS TO ACTION: IMPROVING WASH PRACTICES IN TRIBAL AREAS THROUGH INTERSECTORAL COLLABORATION

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KEYWORDS
Cross-sectoral convergence, WASH and financing, Stakeholders in WASH, Community engagement, Social Behaviour Change

ABSTRACT
USAID NISHTHA in collaboration with local NGO Samarthan implemented a model for Cross-Sectoral Partnerships for sustained healthy hygiene behaviors aimed at enhancing healthy hygiene practices in two tribal districts of Chhattisgarh, India.

Problem Statement:
Tribal communities face significant challenges due to inadequate WASH infrastructure and limited awareness of hygiene practices. Lack of coordination between various government departments exacerbates these issues, highlighting the need to address these gaps to improve health outcomes and prevent hygiene-related diseases.

Methodology:
From September 2021 to January 2023, the project employed a multi-faceted approach to tackle hygiene challenges. Key steps included micro-resource mapping, strategic planning, and resource allocation. SBCC strategies were used to raise awareness and generate demand for WASH services. The project emphasized cross-sectoral partnerships, involving government bodies, self-help groups, and NGOs. Activities included constructing handwashing units and community toilets, forming village-level and water testing committees, and promoting community participation in WASH decision-making processes. The project also leveraged government schemes and financial resources to empower local communities and ensure sustainable hygiene behaviors.

Results:
The project significantly improved hygiene practices and health outcomes in the targeted communities. Over 500 handwashing units were constructed, promoting proper hygiene. Village-level and water testing committees tested over 1,500 water samples for fecal contamination, enhancing community engagement and decision-making. The project secured USD $56,387 in funds, fostering community empowerment and ownership. SBCC strategies sensitized 65,581 community members on healthy hygiene behaviors, increasing knowledge and demand for WASH services, and promoting sustained behavior change. Collaboration among stakeholders facilitated resource pooling and strengthened the interventions' impact and sustainability, demonstrating the effectiveness of cross-sectoral partnerships and community-driven approaches.

CO-CREATION IN COMMUNITY-LED WATER CONSERVATION THROUGH SUSTAINABLE PARTNERSHIP WITH THE STAKEHOLDERS

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Key words
Co-Creation, Institutional partnership, Saturation model, Sustainable development

Water unites community and enables them to converge with the stakeholders at large. DHAN Foundation works in partnership with the state and central government, private philanthropies, CSR institutions, banking and financial institutions, academic and research institutions towards conservation of water commons. The Vayalagam Water Users Associations promoted at village level acts as the base platform to lead the water conservation works along with the community investment. Restoration of traditional water bodies like tanks, ponds, etc are not just seen as a remedial measure. On the other hand, it is envisaged as a noble journey towards sustainable development wherein partnership with various stakeholders gets high priority. It offers the platform for multiple stakeholders to join together and co-create the water conservation models which are highly efficient and effective in shaping the lifestyle of community at grassroots.

DHAN Foundation has gone through a systematic versions of partnership towards water conservation. It commences with the project partnership to address the requirement of a particular locality. Later it gets graduated into the programme partnership wherein a collection of thematic components are addressed. The higher version in this series is the institutional partnership which envisages saturation focus along with co-creation as high priority. The term saturation refers to reaching the entire families in a given context through the mission of water security.

DHAN Foundation has experienced a range of partnership models in water conservation with the stakeholders at multiple levels. One of the prominent models is the public-private-civic partnership experienced at Munger District, Bihar wherein the District Rural Development Agency (DRDA, Munger), ITC Limited and DHAN Foundation have entered into a tripartite agreement to make the MGNREGS more systematic and effective. Within three years of partnership, an amount of Rs.13 Cr investment has been made through MGNREGS ensuring effective implementation strategy. In the similar line, DHAN Foundation has joined hands with Axis Bank Foundation and launched a project named DHANA which is known for its `Basin Saturation' model. The DHANA project is implemented in Pambar river basin by which around 1,45,000 small and marginal farmers are secured with water and livelihoods through the saturation approach.

As a whole, the models experimented and experienced by DHAN Foundation has enabled the community to establish sustainable strategies in water security for small and marginal farmers. As part of co-creation with the partners, the new elements like endowment fund for continued repairs and maintenance of tank structures, establishing collective institutions at grassroots to avail specialized services, construction of farm ponds as loan product, etc are being showcased for the society at large to replicate. Convergence between community and stakeholders makes the mission more vibrant through co-creation.

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TOWARDS EFFECTIVE GOVERNANCE IN IRRIGATION MANAGEMENT FOR ENHANCING PEOPLE'S PARTICIPATION

Chandam Victoria Devi, Uzzal Mani Hazarika, Chandan Bhuyan, Bhaskar Jyoti Buragohain

Abstract:
Water is indispensable for the sustenance of individuals, society and ecosystem. There is no life without water and those to whom it is denied are denied life. This precious resource is regarded by common man as free gift of nature, giving and manage by the globe. However, the increase demand of water, access to clean water, water rights, sector reforms in water management, gender participation, lack of accountability and transparency calls for the need of effective water governance. The decentralization of irrigation management which is considered to be an important component of sector reform in irrigation management requires effective governance. In the irrigation sector, the beneficiaries are participated in management of irrigation water and delivery of the water services. Under the provisions of National Water Policy (2002), Ministry of Jal Shakti, Government of India, necessary legal and institutional changes were made by states for participation of water users in irrigation management such as operation, maintenance and management of water infrastructures, water distribution and collection of water rates. Under the Assam Irrigation Water Users Act,2004, 847 Nos. of Water User Associations were formed for farmers' participation in the management of irrigation system for ensuring efficient and equitable supply and distribution to optimize agricultural productions. The provisions in the Act provided scope for formation of famer's organizations, roles and functions of WUA, power to levy collection of fee, resource of farmer's organization, offences and penalties, settlement of disputes and conflict resolutions. In Assam out of 790300 ha irrigation potential created, only 95020 hectares are covered by WUAs, which is only 12 % over potential created area. To increase peoples' participation, the current irrigation governance in Assam needs to be thoroughly examined. A decreasing trend of the number of farmers, area irrigation and levy collection was found from 2017 to 2023 in the case of Chataichapori lift irrigation project, Assam. This calls for further study of the operation and governance of modern irrigation system. The traditional system of diverting water from perennial streams known as *Dong Bandh* System is practiced by Bodos of Assam who basically reside in adjoining areas of plain and hills regions. It is a community based water management system by using traditional knowledge, which demonstrates the capability of local community to self-organize for water resource management. The aim of this paper is identify irrigation water governance trends, challenges and knowledge gaps that are relevant for making better governance. The case of one minor irrigation project namely, Chataichapori lift irrigation project has been studied and how shortfalls of the irrigation governance can be rectified by learning from the governance system of traditional water management in Assam is suggested.

Key word: Governance, Irrigation, Management, Water, Association

8TH INDIA WATER WEEK 2024

Thematic Focus: "Partnerships and Cooperation for Inclusive Water Development and Management."

17 to 20 September, 2024

Convergent action and community participation in Water Planning and Management

An initiative of the Public Health Engineering Department (JJM), Government of Assam in collaboration with UNICEF Assam.

Background:

The Central Government initiated the support for rural water supply in 1972 through the Accelerated Rural Water Supply Programme (ARWSP). In 2009, this program was relaunched as the National Rural Drinking Water Programme (NRDWP), which aimed to "enable all households to have access to and use safe and adequate drinking water within premises to the extent possible." The target was set to achieve this goal by 2030, aligning with the United Nations' Sustainable Development Goals. The learnings and experiences of NRDWP paved the way for the launch of Jal Jeevan Mission in the year 2019 to provide regular safe drinking water of prescribed quality and adequate quantity to every rural household in India.

The State of Assam has been implementing the Mission in its full spirit and with continued effort has successfully provided Functional Household Tap Connection **(FHTC)** to **57.61 lacs (80.50%)** households. As the state has made significant achievements in providing safe drinking, it has also extensively worked on one of the most critical components of the Jal Jeevan Mission, which is community ownership and participation to ensure the long-term sustainability of the Piped Water Supply Scheme (PWSS). Right from the very inception of the mission, equal focus on community engagement has been made as well to ensure a multi-pronged approach towards the service delivery and sustenance under the mission.

IRRIGATION AND WATER MANAGEMENT THROUGH WATER BUDGET

(A Case Study of Parambur Big Tank Water User Association in Pudukkottai District, Tamilnadu)

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Key words:

Traditional water budgeting, Water Users Association, Pani Pipe Irrigation, Women's participation.

Abstract

Water is prime and precious gift of nature to mankind and millions of other species living on the earth for the survival. Increase in demand on water accelerates towards effective utilization of available water to meet the human needs including food grain production. Each and every step in water conservation, conveyance, equitable distribution, quality and utilization play major role to provide water for all and new innovation and technical knowhow is the need of the hour. At the same time an experience of new approach like water budget and water saving technic for tank irrigation being adopted in Tamil Nadu is to be shared for cross learning and adoption in large scale. This paper is an attempt to share the strategy/ approach adopted by the Parambur Big Tank Water User Association in irrigation water management including traditional water budget, water saving technic and impact realised by the beneficiaries. Parambur Big Tank is one of the rainfed tank located at Parambur village in Pudukottai district which lies in drought-prone area of the Tamil Nadu. Before the commencement of every irrigation session, Water Budget for the village is being prepared traditionally and water being supplied by the Neerkatti of association itself. Although 40% of the rainfall, Parambur Villagers and nearby three villagers are getting benefit growing two crops and fish farming by adopting water saving through measuring of water by pani pipe method. This transformation was happened mainly by adopting the strategy of traditional Water Budget, Pani Pipe method of measuring, Collective decision on area of cultivation, assured supply of water by association and Women participation.

WOMEN LEADERSHIP FOR EFFECTIVE WATER MANAGEMENT AND COMMUNITY RESILIENCE: NATIONAL AND INTERNATIONAL INSIGHTS AND PRACTICE

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KEYWORDS
Women-led initiatives, Community engagement, Sustainable water management, Policy advocacy, Women Leadership

ABSTRACT: (9 pt)
The theme "Beneficiaries Participation in Water Planning and Management" emphasizes the essential role driven by the leadership of women witnessing transformative changes, who are effectively mobilizing community participation worldwide. Poor water management leads to crises, disasters, and a lower quality of life.

This abstract examines the best strategies implemented globally, focusing on women-led initiatives that have successfully engaged communities in water management. Additionally, it highlights the pivotal role in supporting and advancing these initiatives through research review, capacity building, and policy advocacy, thereby contributing to sustainable water management practices.

Across the globe, women are emerging as key leaders in water management, bringing innovative and sustainable solutions to address water challenges by mobilizing their communities. In India, initiatives such as the Self-Employed Women's Association (SEWA), Water User Associations in Maharashtra, Water Self Help Groups' (WSHGs), Jal Saheli (Water Friend), and Jalasathi Initiative exemplify this trend. These efforts are supported by schemes like the National Rural Livelihoods Mission (NRLM), Jal Jeevan Mission (JJM), Jal Shakti Abhiyan (JSA), and Mahila Kisan Sashaktikaran Pariyojana (MKSP).

Similarly, worldwide, women-led initiatives are making significant impacts. In Kenya, the Women in Water and Natural Resources Conservation Project empowers women in water management. Nepal's Women's Water Group in the Middle Hills, Bolivia's Asociación de Mujeres Constructoras de Cochabamba, Uganda's Women-led WASH Programs, Bangladesh's Women in Local Water Governance, and Morocco's Tanmia.ma Women's Water Cooperative are all exemplary initiatives. These efforts are bolstered by schemes such as the Rural Water Supply and Sanitation Project in Nepal, the PROAGUA Program in Bolivia, WaterAid's Women-led WASH Programs in Uganda, and the BRAC WASH Program in Bangladesh.

Community engagement is crucial for sustainable water management, and women-led initiatives have proven especially effective. Successful participatory interventions/strategies addressed with this approach include:

a. Training and Capacity Building: Women-led initiatives enhance local expertise and resilience.
b. Grassroots Activism and Local Management: Engaging communities in grassroots activism ensures sustainable use and conservation of water resources.
c. Economic Empowerment and Entrepreneurship: Initiatives promote economic opportunities linked to water management, fostering sustainable livelihoods.
d. Policy Advocacy and Leadership: Women leaders advocate for inclusive water policies and governance frameworks
e. Inclusive Decision-Making Processes: Initiatives promote diverse voices in water management strategies.
f. Collaborative Water Diplomacy: Facilitating dialogue and cooperation among stakeholders.

These initiatives addressing climate change challenges like water scarcity and environmental degradation promote sustainable practices and community resilience. Women's leadership enhances water management and gender equity, leading to more resilient and equitable solutions, contributing to sustainable development goals.

This review research will consider two women-led initiatives from India and two from international contexts. The goal was to develop a strategic tool for effective grassroots-level implementation, focusing on institutionalization, financial sustainability, support mechanisms, impact assessment, and long-term sustainability.

CAPACITY BUILDING TRAINING AND WATER LITERACY PROGRAMS IN WATER CONSERVATION PROJECTS

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KEYWORDS
Capacity Building Training, Community Mobilization, Water Conservation Projects, Water Literacy Awareness, Water Conservation Projects

ABSTRACT: CAPACITY BUILDING TRAINING AND WATER LITERACY PROGRAMS IN WATER CONSERVATION PROJECTS

Community Participation is an integral part of the river rejuvenation Projects of the Art of Living. We organize Water Literacy Awareness Programs and Community Leadership Training Programs to empower the people to take initiative in developing their own villages. So far, we have mobilized more than 1,50,000 local people in the area of River Rejuvenation programs, through our Community Leadership Training programs and community mobilization workshops in Karnataka, Tamil Nadu, Andhra Pradesh, Maharashtra, and Uttar Pradesh. The local people are trained in such a way that they remain capable of looking after the recharge structures after the exit of the implementing agency. Through Water Literacy programs, stakeholders are made aware of their water consumption patterns, their cropping patterns, ideal farming methods, techniques for water-efficient farming, measurement of rainfall and the devices used for it, measuring evaporation, Water profile, Water profile layout, and Impact Assessment etc. The most important aspect of the Water Literacy program is preparing the Water profile layout for the village. This helps the stakeholders to understand demand-supply dynamics to help them to plan their water utilization. To execute the river rejuvenation programs the most important need identified was to generate awareness about the project among the stakeholders of the Government officials of different departments such as Rural Development and Panchayat Raj, Ministry of Agriculture and farmer's welfare, District Water Management Agency (DMWA), etc. This awareness campaign involves training about the River rejuvenation projects, Methodology, Recharge Structures, Civil Works, Project execution and monitoring, water literacy. Various such awareness campaigns were executed in Karnataka, Tamil Nadu, Andhra Pradesh, Maharashtra, and Uttar Pradesh to thousands of officials. Rural women from the region are encouraged to join the project by involving them in various stages from planning to implementation. This approach to community engagement facilitated social equity, for instance in the Naganadhi River Rejuvenation project in Tamil Nadu, nearly 90% of the ongoing project workers are women. There is a unique way in which Art of Living implements any of the River Rejuvenation projects, which involves the local community participating and owning the project. Where all the stakeholders of the project like farmers, villagers, and Panchayat Samiti are introduced to the project by organizing Water literacy workshops, in which all the activities to be taken up for reviving the river are explained in detail. The relevant stakeholders are trained through Community leadership programs which empower the people to take initiative in developing their own village. Some of the stakeholders then come forward to contribute to the project by donating time, money, or any other resource required. This increases ownership of the project by the community which contributes to the effective implementation and sustainability of the project. This paper analyzes the methodologies, benefits, impacts, and outcomes of these initiatives, highlighting the crucial role of community participation and education in fostering sustainable water management practices.

Augmenting Groundwater Recharge through De-siltation of Traditional Tanks coupled with the Doha model in the Bundelkhand region with Active Community Participation

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KEYWORDS
Tank Restoration, Doha Model structure, Tank Management committee, Groundwater Recharge, Bundelkhand

ABSTRACT:
Ancient communities in the Bundelkhand region built around 8000 traditional water bodies between the 8th and 12th centuries. However, many of these tanks became non-functional due to various reasons such as siltation, encroachments, and blockage of feed channels. This study examines the effects of desilting these tanks and implementing the Doha Model for groundwater recharge, which involves constructing percolation trenches along seasonal streams. Tank Management Committees were formed to involve the local community in the maintenance and operation of these recharge structures. The study collected quantitative and qualitative data to assess the impact on agriculture, livestock, and domestic water use. Restoring the tanks increased their storage capacity, provided irrigation water, and accelerated the recharge of downstream wells. Applying fertile silt from tank de-siltation has significantly improved soil quality for beneficiary farmers. Wheat yield has doubled, and other crops have seen improvements of up to 20 quintals per hectare. Additionally, the total cultivated area has increased by 16.4% during the Kharif season and 17.4% during the Rabi season. The area under irrigation has also grown substantially, with a 28% increase in the Kharif season and a 33% increase in the Rabi season in the tank command. Prior to restoration, most wells would dry up early in the year, but post-revival, they retained water until May.

INVOLVING SOCIETIES FOR URBAN WATER MANAGEMENT IN INDIAN CITIES THROUGH A SOCIAL-ECOLOGICAL APPROACH

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Keywords
Social-ecological approach, urban water management, society, inclusion, India

Abstract

Freshwater sustains life and its scarcity threatens human well-being and health of ecological systems which thereby impacts the society in multiple ways. Humans have become the principal driver of extreme environmental changes (Cosgrove & Loucks, 2015) as water challenges have become complex due to various factors such as urbanization, population growth, politics, economic growth, culture etc. In the past, technological solutions dominated the water management strategies and they were centered primarily on prediction and control method, giving less importance to the demands or actions of society (Pahl-Wostl et al., 2008). The dire circumstances of water challenges today are a result of people's lack of involvement in the management of water resources (Poricha & Dasgupta, 2011). There is dearth of research, on the social dimension of water, where transition management happens when the actions are water conscious ones and society keeps learning from their past experiences. Water supplies' quantity, quality, dependability and affordability affect societies either directly or indirectly. The dynamic relationship between humans and water is prominent for supporting both human well-being and the sustainable management of water resources. To understand this complex relationship an integrated perspective on water issues is required by identifying the social processes in form of norms and values (Höllermann & Evers, 2020). As per Karl Wittfogel's assertion, a multi-disciplinary approach in the field of water management has contributed to the transformation of human society which basically means increase in societal knowledge and understanding (Šulyová et al., 2021). The social-ecological approach to water management offers a promising framework as it analyses the dynamic interrelationships in between the social and ecological systems. For further assessing the roles of social inclusivity, a stakeholder workshop was conducted. Workshops are a preferred mode of citizen engagement and provide a platform for diverse voices to discuss and deliberate on problems as well as challenges faced in their resolution.

In this paper, the citizens understanding of the human-water interactions, perception of water challenges, barriers and the impact of current ways of managing water has been addressed through a stakeholder workshop which was conducted as part of the Water for Change project, inviting the ward councillors of the Bhopal city. A major conclusion that can be drawn from the paper is that the water management regime cannot continue to function with the business-as-usual, siloed and linear conventional approaches to resolve complex water issues. Through a 'citizen-centric approach' the perceptions of citizens regarding water challenges and their aspirations as key actors within the urban water management regime should be analyzed. Therefore, in order to successfully address the sustainable water management, it is imperative to comprehend the social dimension of water management. We cannot see 'the environment' or our 'water systems' as distinct from the people who depend on, utilize, and alter them, notwithstanding the complexity of social systems.

COMMUNITY PARTICIPATION IN TRADITIONAL WATER MANAGEMENT IN ASSAM

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Dr. Sanayanbi Hodam, Assistant professor (WRE), NERIWALM

Abstract

Assam is a land of diverse tradition and culture spreading over vast alluvial plains of mighty Brahmaputra. The river Brahmaputra transcendent the beautiful state from east to west leading to the formation of many fluvial landforms and become the main source of water and life to the people of Assam. According to the Central Water Commission, the Brahmaputra river has the highest water resource potential, however, the water utilization is very less compared to other river basins of India. All the north bank tributaries of Brahmaputra that originates in Himalayas are flashy in nature and cause sever flood during rainy season whereas during dry spells many of these river dries out with critically low discharge. All the communities of Assam have developed certain ways to manage water related problems. This paper is a review of all the traditional water management practices in Assam involving community participation. Some of them that have included in this paper are the Paik System of Ahom, Thengal Kachari's community involvement in digging pits, Kare Okum construction by Mishing tribes, digging Khernai by Dimasa community and dong construction by Bodo community. This paper also gives recommendations for incorporation of technical interventions to improve their effectiveness and sustainability.

CITIZEN SCIENCE FOR WATER MANAGEMENT: COMPREHENSIVE APPROACH TO CONSERVE ECOHYDROLOGY OF AHAR RIVER BASIN

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Keywords: Water quality, Biodiversity, water sustainability, water resource management, Citizen Science, Freshwater Lakes

Abstract

Water quality and public health are threatened by challenges faced by the River-Lake system of Ahar River basin, Udaipur, Rajasthan, India, such as nutrient pollution from leaching in the catchment area, reduced water holding capacity due to incoming silt, and water scarcity during drought periods. Additionally, urbanization around the lake is gradually affecting the shoreline, posing a threat to the water quality and public health. The key factors impacting the water quality of the Ahar River basin lakes include population growth, sewer drainage, irresponsible tourism expansion, overuse of fertilizers in the catchment, plastic waste, and proscribed dumping of medical biohazardous waste. These disturb the overall health of these drinking water supply lakes like Madar, Lakhawali, Govardhan Sagar, Pichola, and Fateh Sagar directly resulting in a threat to public health. The lakes' water spread area covers about ~25 percent of Udaipur city (64 sq km) which could be managed efficiently if the local citizens had contributed to monitoring and data collection. Studies have highlighted the potential for worldwide application of citizen science initiatives, using low-cost simple tools for generating long-term time series data sets, which may also help monitor climate change, generate awareness amongst citizens and contribute to scientific research. A similar initiative was undertaken in Udaipur where the citizen science network from 18 institutions monitored the chemical, biological and physical parameters of surface water bodies near respective institutions and represented the upper, middle, and lower basin of Ahar River as a whole. This was a collaborative research study between partners from India and Denmark using citizen science as a methodological tool. A cohort of 500 citizen scientists was formed through mobilization and awareness generation workshops. Citizen scientists, with assistance from researchers in a co-learning framework, acquired skills to collect water quality data from surface water bodies across the Ahar River basin, map contamination sources, and record flora and fauna species. The data collected shows water bodies lying in the lower basin to be most contaminated due to the mixing of city sewer loadings and industrial effluents draining into natural drains. The water bodies lying in the upper basin were found to be relatively cleaner. These inferences were drawn based on dissolved oxygen that was calculated. There was a presence of aquatic weeds like water hyacinth, Typha, pondweed, Lemna, and alligator weed were present in water bodies indicating biological as well as chemical contamination. Thus this study has proved to be helpful in the comprehensive assessment of the health of surface water bodies in Udaipur as well as in creating scientific literacy and awareness among citizens. This might further be used in water resource management planning, generating awareness to a wider group of audiences, and inducing climate change education in academia.

THE ROLE OF WOMEN IN WATER MANAGEMENT: EMPOWERING AGENTS OF CHANGE

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ABSTRACT

Water management is a critical global challenge, impacting various aspects of human well-being and sustainable development. The active participation of women in water management is essential for achieving equitable and sustainable outcomes. This paper explores the multifaceted roles of women in water management, highlighting their contributions, challenges, and the importance of their inclusion in decision-making processes. It also examines the potential benefits of empowering women in water management. The paper is substantiated by some of the case studies of women's inclusion at various capacities in the engineering projects. By untapping the role of women as agents of change in water management, we can foster inclusive and resilient societies while achieving sustainable development goals.

Keywords: Women, water management, empowerment, participation, gender equality.

WOMEN'S ROLE IN KERALA'S WATER SECTOR ENGINEERING

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KEYWORDS
women empowerment, water diplomacy, Water Sector Engineering, Kerala, Sustainable Development

ABSTRACT

Women empowerment in Kerala's water sector engineering has been under-explored, especially regarding women's leadership roles and the challenges they face. This paper highlights the need to address gender inequality and enhance women's leadership to achieve Sustainable Development Goals (SDGs) amidst challenges like floods and droughts. Equipping women as leaders and designers in water management involves developing their skills to act as water diplomats on both national and global stages. Historical examples showcase the added value women bring as negotiators, emphasizing the importance of a gender-aware water sector. Male colleagues also play a crucial role in encouraging women to rise to higher positions.

In Kerala, women engineers significantly impact dam and canal management, water resource research, and project execution. During the 2018 and 2019 floods, they effectively managed dam operations to mitigate downstream flooding and led post-flood reconstruction efforts, demonstrating their crisis management skills. Women engineers also contribute to interstate water policy discussions, underscoring their importance as leaders and negotiators. Empowering women in Kerala's water sector is essential for addressing gender inequality and achieving sustainable development, making it a model for other regions.

NAGANADHI RIVER REJUVENATION BY WOMEN WORKERS OF TAMIL NADU

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KEYWORDS
Naganadhi River, Groundwater Level, Women Empowerment, MGNREGA, Capacity Building

ABSTRACT: NAGANADHI RIVER REJUVENATION BY WOMEN WORKERS OF TAMIL NADU
Over two decades, the Naganadhi River, which is vital to the Vellore district, dried up. Rainwater failed to reach groundwater and surface water due to runoff from the land. Farmers' livelihoods and agricultural methods suffered as a result of the over exploitation of groundwater and failure of monsoon season. People suffered over a long period due to scarcity of water. The Art of Living therefore initiated the Naganadhi River Rejuvenation project by offering an innovative solution of installing groundwater recharge structures - Boulder checks and Recharge wells across the stream catchments of the river. The entire Naganadhi river rejuvenation project was executed successfully by the women of the villages. The Art of Living equipped the rural women with the capacity building programs and technical trainings to carry out the river rejuvenation project successfully. Following its success, we have been implementing a project to increase water resources in the catchment areas of rivers over 15 districts of Tamil Nadu towards rejuvenating 25 river streams in collaboration with the government and various organizations. The Government of Tamil Nadu has directed all District Collectors to follow the Naganadhi Project model in all remaining districts of Tamil Nadu. The success of Naganadhi revival at Kaniyambadi block, Vellore district ultimately motivated more than 44,000 women working all over Tamil Nadu by completing the construction of 6648 groundwater recharge structures in 1400+ villages. The rejuvenation of Naganadhi is a story of the transformation, determination, and hard work of rural women. Due to their efforts Naganadhi has been flowing continuously for more than 2 years. It was a matter of pride for the women when the Prime Minister Mr. Narendra Modi Ji appreciated for the third time, “the contribution of the work of women workers,” in his talk “Mann Ki Baat” radio program. Considering the urgent need for the augmentation of groundwater resources through effective artificial recharge methods, The Art of Living foundation through Vyakti Vikas Kendra, India (VVKI), and with the help of the Vellore District Administration under the MGNREGA scheme, dedicated efforts towards the rejuvenation of Naganadhi River in Tamil Nadu along with their broader mission of rejuvenating numerous rivers across India, emphasizing sustainable water resource management and conservation. Within the Kaniyambadi union, a total of 207 small Boulder Checks and 354 Recharge Wells were constructed. Additionally, 89 dug wells were selected for water level monitoring. Observations conducted in May and August 2017 revealed a substantial increase in water levels, rising from 1 meter to 8 meters. This transformation underscores the effectiveness of the implemented measures and highlights the success of collaborative endeavors in water resource management and conservation. Notably, this project was executed by rural women who were trained and empowered by the foundation.

UNVEILING ANCIENT ENGINEERING AT DEVAGIRI DAULATABAD FORT, INDIA

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KEYWORDS
Key words: Daulatabad, Water Supply Schemes-Ancient Engineering Techniques, Rainwater Harvesting Water Scarcity in Arid Zone.

ABSTRACT

The Devgiri Daulatabad fort is situated in the southwestern part of India, approximately 400 km from the Arabian Sea coast. It is isolated from the Ajanta hilly range near Ellora caves. Constructed in 1187 AD by Bhillima, the king of the Yadava family, this fort played a vital role in the cultural and economic development of the region during ancient and medieval times. Over the years, it witnessed the rule of various dynasties, including the Yadavas, Allauddin Khilji, Mohammed Tugluq, Bahmanis, Nizamshahi, Mughals, and Asifjahi.

Perched at an altitude of 200 m above mean sea level , the fort is strategically located, providing natural protection against warfare. It served as the capital of Maharashtra during the Yadava period and the imperial capital of India during Mohammed Tugluq era from 1328 to 1341 AD. Additionally, it remained a stronghold of the Mughal Empire, particularly during Aurangazeb presence in Deccan for 25 years. The Mughal king Shah Jahan constructed hill top baradari structure in 1636 AD. The fort and its surrounding suburb had witnessed a population more then one lac in those days . To meet the water needs of the inhabitants, various water supply schemes were implemented by different rulers. This paper explores and unearthed ancient water supply systems, remarkably, age-old engineering techniques, including rainwater harvesting, which have proven to be sustainable and can be replicated for hilly areas in India and around the world to address water scarcity in arid zones. Inside the fort, reservoirs, tanks, pressure relief towers, filtration chambers, and stone and earthen conduits are special features of these schemes. Water is conveyed by gravity, making these schemes economical, maintenance-free, and operational without the need for lifting water at a cost.

WC-15

Traditional Water Resource: Talab

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KEYWORDS
Introduction, Concept, Structure, Function, Utility

ABSTRACT:
Traditional Water Resources are a part of water culture in India. Talab is the oldest way of rain water harvesting. Talabs are constructed and erected in such a way that every drop of rain water is captured. Each part of a Talab, Agor, Agar, Pal, Praveshika, Nesta, Ghat, not only harness each drop of rain water but conserve it also. Each part of a Talab functions in such a way that each one receives, saves and preserves the water captured. It is Rajasthan where rain water is rare commodity yet rarest types of rain water harvesting are in practice creating a water-culture.

THEME:-WATER GOVERNANCE AND FINANCING
SUB-THEME:-HARNESSING TRADITIONAL KNOWELEDGE FOR WATER CONSERVATION
PAPER TOPIC:-"STEP WELLS-ANCIENT ARCHAEOLOGICAL STRUCTURES FOR WATER CONSERVATION IN INDIA"

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Keywords
step wells, water conservation, rejunuvation, liquid assets, jal mandir

ABSTRACT

The source of all water is rain, a most beautiful gift of God. World has developed so many innovative techniques and methods of water conservation, yet not able to conserve every drop of rain water and hence we witnessing floods in some part of the world and at the same time people are facing draught. This is the reality of life in many ways. Perhaps this is why every region in the country has its own traditional water harvesting techniques that reflect the geographical peculiarities and cultural uniqueness of the regions.

Archaeological evidence shows that the practice of water conservation is deep rooted in the science of ancient India. The cities of the Indus Valley Civilization had excellent systems of water harvesting and drainage. The settlement of Dholavira, laid out on a slope between two storm water channels, is a great example of water engineering. There are many ancient methods for water conservation which are forgotten in the pages of history, but now time has come to harness all these in the modern era, where water is scares. Naming few traditional water conservation systems of forgotten history we may found- 1-Step-wells/Jhalara/Bawari, 2-Talab, 3-Ahar Pynes, 4-Panam Keni, 5-Zing, 6-Zab and 7-Eri systems, which were useful in water conservation.

Amongst all these step-wells are being brought back into use to ease water challenges in India. Number of surviving step wells can be found in north Karnataka, Gujarat, Rajasthan, Delhi, M.P. & Maharashtra. Historian and enthusiast people searched out many step wells and gathered complete information. Restoration works started primarily by them and then various State Governments took initiative for rejunuvation of many step wells. In recent history the Birkha-Baoli, at Jodhpur, Rajasthan is good example of harnessing traditional water conservation systems, having the storage capacity of 17.5 million liters of rain water.

Looking to its important in the modern era also the ministry of jal-Shakti Government of India also took initiative for more publicity of such an ancient technology in the field of water conservation and published a wonderful book on step wells-***"khandani khajana-for the liquid assets of India-step wells"***. Now it is our duty and obligation towards our motherland to preserve our "khandani khajana-the liquid assets of India-step wells" and go for water harvesting for environment and livelihood though the forgotten history of so called "Jal-Mandir". One most important chapter in rejunuvation of step wells is the tremendous work done by Rohan Kale from Maharashtra. He and his team searched about 1400 step wells within the Maharashtra state and put the details in geographical map of India.

In my full length paper, I shall be presenting detailed information about various traditional water conservation systems mentioned and the rejunuvation works carried out by various states and organizations along with the work of Rohan Kale of Maharashtra in this field. I Hope that the committee will find my inputs valuable and provide me an opportunity to present the same. Jai-Hind.

NECESSITY OF REVIVAL OF STEP WELLS FOR WATER CONSERVATION IN INDIA

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Abstract

Step wells in Marathwada and several droughts affected parts of Maharashtra were the main source of drinking till a few decades ago. It is noticed that the stepwells built in ancient era are still functioning effectively and they ensure the availability of water during periods of drought. Step Wells that were used to supply drinking water during the Nizam's time have become defunct because people use them to throw trash and other debris. They have become breeding grounds for mosquitoes and harmful creatures. At present on account of tremendous pressure on the land due to over population and the concrete jungles, percolation of rain water into ground has reduced drastically. Therefore, it is essential to restore and rejuvenate such ancient wells as water conservation structures.

Keywords- Stepwells, Barav, Underground S

A HISTORICAL EXPLORATION OF INDIGENOUS WATER MANAGEMENT AND SUSTAINABLE AGRICULTURE THROUGH THE CASE STUDY OF KHAZANA WELL IN INDIA

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KEYWORDS
Water Harvesting, Historical Water Management, Sustainable Agriculture, Indigenous Techniques, Traditional Water Recharging

ABSTRACT:
This paper explores the historical significance of water harvesting in India, focusing on the extraordinary traditions developed by the indigenous communities to address the ephemeral nature of water resources. Recognizing the irregular distribution and erratic patterns of monsoon rainfall, Indians innovatively implemented diverse water harvesting techniques across the country. The systems, lasting for extended periods, aimed to sustain food production and provide protective irrigation. The study explores the unique case of 'Khazana Well', constructed

approximately four hundred and thirty years ago during the Nizamshahi rule in Maharashtra. Unlike conventional wells irrigating small parcels of land, Khazana well emerged as a remarkable example by irrigating 200 hectares, showcasing a historical feat in water management. Despite a gradual reduction in irrigated area over the years, the well's longevity and efficiency stand as a testament to its ingenious construction and water recharging methods. The paper presents an in-depth analysis of the historical context surrounding the construction of Khazana well, shedding light on the surprising techniques employed for well recharging. Additionally, it explores the evolving water management practices associated with this historical landmark. Emphasizing the importance of water purity, the study underscores the traditional focus on collecting rainwater and managing various water sources, including ground and river water. While tracing the decline in irrigated area from 200 hectares to 60 hectares, the paper highlights the need for a comprehensive understanding of the factors contributing to this reduction. The management transition from self-disciplined beneficiaries to state department oversight is discussed, emphasizing the evolving role of governance in maintaining historical water structures. The case of 'Khazana Well' serves as a valuable example for studying and disseminating effective water management strategies. By documenting the historical context, construction methods, and evolving management practices, this paper contributes to the preservation of indigenous knowledge and offers insights for contemporary water sustainability initiatives. In conclusion, 'Khazana Well' stands as a historical marvel in water management, irrigating vast lands for centuries. The study underscores the significance of preserving indigenous water-harvesting techniques for contemporary sustainable practices. Lessons from this historical well offer valuable insights into resilient water management strategies essential for addressing modern-day challenges.
prings, Rivulets, Baolis, Spring-Fed Wells, Stepwell Atlas, H

TRADITIONAL WATER PRESERVING MANAGEMENT WISDOM: A CASE STUDY OF NAHARE AMBARI

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KEYWORDS
Traditional water management, NahareAmbari, indigenous knowledge, community governance, sustainability.

ABSTRACT:
Traditional water management systems have sustained for centuries, relying on indigenous knowledge and practices that harmonize with local ecosystems. Nahare Ambari, an underground conduit water supply and distribution system established nearly 400 years ago in the vicinity of Aurangabad City, Maharashtra State, India, exemplifies such wisdom, demonstrating a holistic approach to water conservation and management. This paper explores the traditional water management practices of Nahare Ambari, examining its historical significance, ecological relevance, and contemporary applicability. Drawing upon ethnographic research, remains of the system, and existing literature, it sheds light on the engineering techniques, systems of rainwater harvesting, and water governance that have enabled Nahare Ambari to thrive in arid environments. By documenting and understanding these traditional practices, this study advocates for their preservation and integration into modern water management strategies, emphasizing the importance of indigenous knowledge in addressing contemporary water challenges.

WATER RELATED DISASTERS AND ITS MANAGEMENT

WC-16

GLACIAL LAKE OUTBURST FLOOD STUDY AND CONTINGENCY PLAN FOR PROJECT IN DHAULIGANGA SUB BASIN, UTTARAKHAND, INDIA

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1.0 ABSTRACT

NHPC Ltd., A Government of India enterprise is operating 20 hydro Power Stations and 10 Hydroelectric Projects which are located in Himalayan region. Glaciers in many parts of the Indian Himalayas are currently thinning and retreating, presumably as a result of the current climate warming.

Glacial lakes often form between the frontal moraine and the retreating glacier or on the surface of the lower section of the glacier. These kinds of lakes are held back (dammed) by unstable moraine complexes, and have a potential to breach their moraine dams. Such breach of moraine dam results in releases of water afflux in very short duration causing floods in downstream areas. This phenomenon, in the Himalayas and elsewhere, has been known as a Glacial Lake Outburst Flood (GLOF) and has the potential for generating extensive destruction in the valley downstream. The impact of such an outburst depends on the physical character of the moraine dam, the lake size and depth and the rapidity of its drainage, and the distance from nearby surroundings. In certain circumstances, a GLOF event can instantaneously release a huge amount of water and debris. This would leave extensive impact on the downstream areas posing a threat to human lives and infrastructure. Understanding threats of GLOF has become necessary for safety of hydropower projects also, as these projects are moving gradually into the High Himalaya due to availability of high head and sufficient discharge in all season throughout the year. Thus, GLOF risk assessment has become an issue of considerable significance that must be dealt with. Assessment of hazard potential from glacial lake outburst flood is of importance for the design of river engineering structure located downstream of hazardous glacial lakes as well as to plan contingency measures to save or minimize the imminent losses by taking proper mitigation measures and early warning to downstream people.

The present paper deals with the characteristics process, geographical distribution, the change in size observed in the glacial lakes present in Dhauliganga Sub basin of Sharda basin over past 25 years where in 280 MW, Dhauliganga Power Station of NHPC limited is located. Also likely impact of potentially hazardous lakes on Dhauliganga dam along with its contingency plan has been assessed.

GOVERNMENT'S INITIATIVES AND POLICIES ON FLOOD MANAGEMENT IN COUNTRY

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ABSTRACT

Devastation by floods is a recurrent annual phenomenon in India. Floods cause considerable damage to life, property – public and private, and disruption to infrastructure, besides causing agony to the people. Flood hazards, when considered in relation to vulnerability and exposure limits, describe the associated flood risk. This article aims to discuss the government initiative and policies on flood management in India at a decadal scale from 1957 to 2023. In the article, some important initiatives taken by government of India to tackle extreme flood events witnessed in those decades that shaped the perspectives, measures, action plans, and policies in the subsequent years are discussed. The review confirms that with the changing patterns of floods due to climate change, associated hazards, and risks over the years, various flood management works in the form of structural and non-structural measures have corroborated the policy reforms. Inspite of these developments, the issues related to the scientific research and study, standardization of data and its availability, climatic variability, urban development, complex population dynamics, and their inter-relationships in the context of flood risk need to be given more emphasis.

Key word: Flood risk, management, constitutional provisions, Policy, Committee, new technology, Artificial Intelligence

CHALLENGES IN MANAGEMENT OF FLOODS

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ABSTRACT

Floods are inevitable forces of nature and although we cannot prevent floods entirely, strategic management of floods safeguards lives, property, and ecosystems against their devastating consequences.

Any management begins with quantification/measurement and flood management is no exception. A robust system of gauging gives an idea of what to expect and enables a mechanism of forecasting floods. Capturing the flows in rivers at peak floods is a challenge in itself requiring the engagement of sophisticated equipment in a challenging environment. Further, when a swollen river overflows the banks, measuring discharge across that cross section adds to the complexity of the task at hand. Depending on the terrain of the catchment, some rivers can be exhibit flash flooding and the rate of rise in water level can be over 2 m/hr. Stage-discharge (SD) relationships could experience more pronounced hysteresis effects in such cases making it challenging to accurately estimate the flow based on water level. Backwater effects near river confluence points make the SD relationship unreliable and necessitate a completely different approach to assess flows.

The data acquired by such measurements at a network of hydro-meteorological observation sites becomes the basis for issuing flood forecasts. The main challenges in flood forecasting are quantitative accuracy, lead time and timely dissemination of information. Variability of travel time from a base station to a forecast station with the quantum of flood also poses a challenge to forecasting. Rainfall-runoff Mathematical models are formulated to provide forecasts with large lead time. However, calibration and validation of such models are a mighty challenge.

Another aspect of challenges in flood management is the resilient investment required to create a robust infrastructure of flood protection works. However, this paper will deal with the challenges faced in measurement and forecasting for management of floods in the Godavari basin and the various efforts put into overcoming these challenges. As a case study, the peak flood during July2022 at Perur and Bhadrachalam with over-the-bank flow is estimated after taking the cross section across the banks till the MWL. Also, during measurement of a high flood at Polavaram, the waves in the river caused the ADCP to jump, resulting in missing sections, to which the GPS correction is applied. During the monsoon period, a comparative study of current meters with ADCPs at Perur and Bhadrachalam and their SD relationships have been carried out to see how much the current meter reading deviates from the ADCP readings. The backwater effect was observed at Konta for a prolonged duration during monsoon 2022 and this paper also presents the methodology adopted to estimate the flow at Konta using the upstream observations along with estimating the contribution from the ungauged catchment. This paper also lists out the various challenges faced in formulation of forecast in the Godavari Basin through the conventional flood forecasting methods and by running the mathematical rainfall-runoff models.

Keywords: Current Meter; Acoustic Doppler Current Profiler; Stage – Discharge Relationship; Rainfall-Runoff Model; Backwater Effect; Ungauged Catchment

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The views expressed in this paper are strictly the personal views of the authors

THEME:-WATER RELATED DISASTERS AND ITS MANAGEMENT

SUB-THEME-CHALLENGES IN MANAGEMENT OF FLOODS & DROUGHTS

PAPER TOPIC:- "CATCH THE RAIN, WHERE IT FALLS, WHEN IT FALLS"-TO COMBAT FLOODS & DROUGHTS

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KEYWORDS
Flash Floods, Cloud burst, Climate Change, Encroachments, Political Will Power

ABSTRACT

As the insatiable needs of our society keep on increasing along with the advancement of science & technology, the entire world has faced abusive & unfair use of natural resources and may be leading towards destruction of natural resources which leads towards climate change in many ways.

We all know that out of all the deadly natural disasters floods are certainly the most unfortunate & pitiful for humankind all over the world. Yet we now get very early warnings of floods, despite that the floods never fail to show their wrath and lead to millions of dollars of losses to land, farms, buildings & industries. Floods are not just a natural disaster, but in reality the response to all the atrocities that man has done to Mother Nature.

The leading causes of floods in India are incessant monsoon rainfall, reduced river channel carrying capacity for high flows, riverbank erosion and the siltation of channel beds, poor natural drainage in flood-prone areas, cloud bursts and several other meteorological factors. Rapid urbanization and changes in the land use pattern have given rise to *urban floods.* All these makes flood management a tedious process.Despite massive investments and continuous flood-control efforts, the socio-economic damages and death toll continue to remain high. The process of flood management becomes very complex due to several socio-hydrological-climate factors along with socio-economic dynamics.

If we look towards major challenges management of floods all over the world, we will found, lack of coordination, un proportionate planning in disaster risk management, lack of awareness among people, communication issues, change in flood prone areas, lack of regularly survey & monitor flood prone areas, emphasizing on widening of rivers & removal of encroachments on the river banks at any cost, interstate water disputes etc. Political will-power can play a pivotal role in minimizing any disaster. India witnessed the divesting floods in Kedarnath in the year-2013 and many metro cities in recent years.

The heavy floods & flash floods in many parts of the world is the best example for what happens if we go against the nature. The "Dam Safety Act-2021", also be helpful to control the floods in India, as it involves many strict laws for proper maintenance of Major dams. To reduce floods & droughts, "Catch The Rain, When It Falls, Where It Falls"**,** tag line of Ministry of Jal-Shakti may be follow vigorously along with the planning and implementation of "Inter Linking of Rivers", but the concept must be accepted by all the states for better India.

EVALUATION OF STRUCTURAL FLOOD RISK REDUCTION MEASURE USING HEC-HMS RAINFALL-RUNOFF MODEL FOR KOYNA DAM IN MAHARASHTRA STATE OF INDIA.

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Abstract

At present floods are the most destructive and recurring natural hazard. Climate change is disrupting the hydrological cycle and altering the usual cycle of rainfall, which frequently results in long-lasting storms with significant rainfall. Construction of Flood Control Dam (FCD) is used worldwide as a sustainable, eco-friendly and effective structural flood control measure. Koyna dam in Maharashtra is a conservation dam, not designed for flood control. Due to Physiographical nature and urbanization of flood prone area, it is difficult to implement the traditional flood mitigation measures in Patan, Karad, Sangli city and its nearby flood prone area on downstream side of Koyna dam. Considering the problem of flood prone area, different approach of implementation of FCD in the watershed area of Koyna dam has been thought off to reduce risk of flooding of flood prone area.

HEC-HMS software is successfully used by various researchers to simulate the Rainfall-Runoff correlation. During the study an event-based HEC-HMS rainfall runoff simulation model is prepared for koyna dam by estimating the input parameters from spatial data. Calibration and validation of model done through statistical evaluation parameters such as R^2, NSE and RSR.

In Koyna watershed area, 30 hypothetical FCD sites were identified. Estimation of design storm with site-specific historical rainfall data by intensity duration frequency (IDF) method is done. Then the effect of implementation of 30 FCD with design storm rainfall flood was evaluated, at the Koyna Dam by creating two inflow scenarios without and with hypothetical FCDs. To quantify the effect of provision of FCD, Flood attenuation ratio (FAR) and flood storage ratio (FSR) were used. Results of HEC-HMS simulation model showed that, for design storm with 30 hypothetical FCD the FAR estimated to be 0.41, means there will be 41% reduction of peak inflow. The FSR value works out to be 0.11, means there will be 11% reduction of flood volume to koyna dam. Thus, provision of FCD, will temporarily retain flood water and will act as a flood absorption capacity of koyna dam without any structural modification to existing dam.

***Key words*:** HEC-HMS, Flood control Dam (FCD), Design storm, IDF, Flood attenuation ratio (FAR), Flood storage ratio. (FSR)

URBAN FLOOD MANAGEMENT IN GREATER HYDERABAD MUNICIPAL CORPORATION ZONE IV

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Abstract *Mitigation of urban floods and waterlogging, majorly in metropolitan cities, has drawn recent attention due to aggravated flooding in cities hindering socio-economic activities and ecology. The complexity of urban floods can be attributed due to rapid urbanization and extreme climatic events. The encroachment of water bodies and drains, unplanned construction, and destruction of natural storm conveyance need to be acknowledged to improve the drainage system to varying climatic conditions. Therefore, this study was carried out to address the inadequacy of the storm drainage network in Zone-IV GHMC (Greater Municipal Hyderabad Corporation), Hyderabad, Telangana. Environmental Protection Agency's (EPA) SWMM (Storm Water Management Model) software has been used to simulate the runoff in integration with the GIS application. Five tipping bucket rain gauges and three automatic water level recorders were installed in the pilot area for collecting the observed data. The model was simulated with different LULC periods from 1973, 1990, 2000, 2005, 2010, 2015, and 2020 and positive correlation between peak discharges, runoff coefficient, runoff depth, and percentage impervious area. The estimated runoff coefficients the above LULC period is 0.869, 0.851, 0.894, 0.903, 0.910, 0.925 and 0.956 of pilot area in GHMC Zone IV. The model simulated the runoff depth flood event for more than 100 years return period on 13 October 2020 and generated the flood inundation map using HEC RAS. Flood inundation depths are well compared with field observation marks. The dataset, the results obtained and the methodology followed in the current study can be used by urban planners to identify the potential flood risk zones and nodes and incorporate them to plan the mitigation and management strategies.*

Keywords: *Depth, Discharge, Flood, Network, Routing and Runoff.*

A NOVEL APPROACH FOR FLASH DROUGHT IDENTIFICATION AND ITS IMPACT ON TERRESTRIAL ECOSYSTEM OVER INDIA

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Abstract: Flash droughts (FDs) have gathered significant attention in the recent past because of their abrupt and rapid emergence, leading to substantial consequences for water sources, ecosystems, and agriculture. The influence of FDs on society can vary depending on numerous factors like their frequency, intensification rate, and mean severity. However, these aspects are not yet well comprehended, particularly concerning India, and remain unclear. In this research, a novel method was developed to quantitatively establish the definition of FD using the Aridity Index (AI). This innovative approach was then applied to analyze the spatiotemporal features, including trends, and the factors that trigger FDs in 25 river basins throughout India from 1981 to 2021. During the study, the hydrometeorological conditions were thoroughly examined, encompassing precipitation anomalies, soil moisture percentiles, vapor pressure deficit, and temperature anomalies at different stages of flash drought. Also, we investigated FD impact on the terrestrial ecosystem. The findings indicate that FDs characterized by rapid intensification are more prevalent in humid regions as opposed to semi-arid and sub-humid regions. Moreover, the study reveals that both temperature and precipitation play crucial roles as primary triggers of FDs across a substantial portion of the research area. In specific regions, such as the Western Ghats and northeast India, the individual influences of precipitation and soil moisture act as triggers for FDs. Furthermore, atmospheric aridity can create conditions that are favorable for the occurrence of FDs. Further, a serious decrease in Water Use Efficiency (WUE) and underlying WUE is also observed over some parts of Southern India and Ganga river basin, which indicates the non-resilient nature of the ecosystem towards flash drought conditions. The findings will provide valuable insights to policymakers, enabling them to develop effective strategies to mitigate the repercussions of FDs on agriculture and water resources in India.

Keywords: Aridity index, Flash drought, Intensification rate, Soil moisture, Triggers.

INTERCOMPARISON OF EXTREME VALUE FAMILY OF DISTRIBUTIONS FOR MODELLING OF ANNUAL MAXIMUM RAINFALL

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KEYWORDS
Correlation Coefficient, Extreme Value Type-1, Generalized Extreme Value, Mean Squared Error, L-Moments, Model Efficiency, Rainfall

ABSTRACT

Design rainfall depth is used as an input to predict the design flood, which forms as a basis for planning and design of civil and hydraulic structures. Design rainfall is the output of frequency analysis that is determined based on the 1-day maximum rainfall data corresponds to each year. This can be achieved by fitting probability distributions to the series of annual 1-day maximum rainfall (AMR). This paper presented a study on intercomparison of extreme value family of distributions (EVD) viz., Extreme Value Type-1 (EV1), Extreme Value Type-2, Generalized Extreme Value (GEV) and Generalized Pareto (GPA) for modelling the AMR of Afzalpur, Aland and Kalaburagi sites wherein the parameters of the distributions were determined by method of moments, maximum likelihood method and method of L-Moments (LMO). The performance of the EVD applied in modelling the AMR was examined through model performance indicators such as correlation coefficient (CC), Nash-Sutcliffe model efficiency (NSE) and root mean squared error (RMSE). The study showed that (i) the average of predicted AMRs by MoM, MLM and LMO of EV1, GEV and GPA are closer to the observed AMRs for Afzalpur, Aland and Kalaburagi; (ii) the difference between the average of observed and predicted AMRs by EV1 and GEV are found as minimum; (iii) there is a good correlation between the observed and predicted AMRs by three methods of EVD and the CC values vary between 0.937 and 0.996; and (iv) The NSE computed by LMO estimators of EVD applied in modelling the AMR vary from 96.4% to 98.7% for Afzalpur, 92.4% to 96.3% for Aland and 90.8% to 99.1% for Kalaburagi. Based on RMSE values, it was found that EV1 (LMO) is better suited distribution for modelling the AMR of Aland whereas GEV (LMO) for Afzalpur and Kalaburagi. The study suggested that the estimated 1-day maximum rainfall by EV1 (LMO) for Aland whereas GEV (LMO) for Afzalpur and Kalaburagi can be considered for the planning and design of water resources projects in the respective sites.

SEDIMENTATION IN POCHARAM RESERVOIR

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Abstract: *Reservoir sedimentation has profound impacts on both flood and drought management, affecting the capacity to store and regulate water. These impacts can exacerbate the severity of floods and droughts, posing significant challenges for water resource management. Sedimentation decreases the storage capacity of reservoirs, limiting their ability to capture and hold floodwaters. This reduction in capacity means that during heavy rainfall events, reservoirs may reach their maximum capacity more quickly, leading to uncontrolled water release downstream and increasing the risk of flooding. Accumulated sediments can obstruct spillways and other outlet structures, reducing their effectiveness in managing high inflows and controlled water release, may further enhance flood risks. Sediment accumulation reduces the effective storage volume of reservoirs, diminishing their ability to store water for use during dry periods. This decreased storage capacity limits the availability of water for irrigation, drinking, and industrial purposes during droughts. Pocharam reservoir is a crucial water resource in Telangana, supporting irrigation, drinking water supply, and biodiversity conservation. However, sedimentation poses a significant challenge, reducing its storage capacity and affecting its overall efficiency. Hence, accurate prediction of sediment distribution becomes very essential for reservoir operation and design life of dams. It is essential not only for planning, design, and operation of reservoirs but also for flood and drought management and mitigate economic losses. Prediction of sediment distribution and corresponding available storage capacity will provide the update on sedimentation which is crucial for sustainable water resources management. The present study aims the evaluation of "Empirical Area Reduction" method by Borland and Miller (1960) to estimate sediment distribution and hence, elevation-capacity for Pocharam reservoir dam, Telangana, India. The computed elevation capacity curve found poorly matched with observed one. Hence, a new method is proposed to compute elevation-capacity curve. The proposed method required input data of deposited sediment volume, elevation-area-capacity curve along with elevation at bed level and full reservoir level. The proposed method to compute elevation-capacity curve found well matched with observed ones and with correlation coefficient of 0.99.*

Keywords: *Dam, EAC curve, Pocharam, Reservoir sedimentation, Sediment distribution.*

MECHANICAL REMEDIATION EQUIPMENT FOR WATER RESOURCE RESTORATION & CLIMATE ADAPTATION STRATEGIES

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ABSTRACT

This paper evaluates the current challenges faced by aquatic ecosystems in India and explores the effectiveness of new-age machines used for water resource restoration. Various types of de-weeding and de-silting equipment available in India are assessed. The paper discusses the challenges in the Indian context, supported by case studies from across the country. A comparative study is conducted between different modes of engagement for de-weeding and de-silting projects involving government agencies and equipment suppliers/contractors, highlighting their pros and cons. The relationship between urban water restoration and its relevance in climate adaptation strategies is examined, along with broader and future possibilities.

Keywords: *Mechanical Remediation Equipment, Flood Mitigation, Water Resource Restoration, Climate adaptation strategies*

A hybrid framework for improving flood management through medium-range streamflow forecasting model

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KEYWORDS
Forecast, LSTM, Streamflow, Medium-range, Flood Management

ABSTRACT
A hybrid framework for improving flood management through medium-range streamflow forecasting model

The growing intensity and frequency of floods, exacerbated by rapid urban development and extreme climatic events, have serious implications for both economies and communities. Effective flood management strategies are essential to mitigate these impacts, including accurate flood forecasting to support early warning systems, informed flood control, and prompt recovery efforts. Developing a dependable streamflow forecasting tool is particularly

challenging because of the complex nature of catchment behaviour, diverse agricultural management, and limited *insitu* dataset. This research evaluates the capabilities of the SWAT-pothole (PSWAT) rainfall-runoff simulation model, combined with bias-corrected Numerical Weather Prediction (NWP) model, i.e., Global Forecasting System (GFS) meteorological data, for real-time streamflow forecasting with lead times of up to 10 days. A Wavelet-based Bidirectional Long Short-Term Memory (WBiLSTM) model is integrated for error correction to improve forecast precision. The study compares the efficacy of the standalone PSWAT model with several data-driven models in the Brahmani-Baitarani River Basin, covering approximately 49,000 km² in eastern India. Findings indicate that the developed PSWAT-WBiLSTM hybrid model delivers the most accurate forecasts, providing reliable predictions up to 8 days in the Brahmani basin and 9 days in the Baitarani basin. This hybrid approach holds significant potential as a medium-range streamflow forecasting model for enhanced flood management.

OVERLAY ANALYSIS FOR ENHANCED FLOOD MAPPING USING REMOTE SENSING DATA

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Keywords: Flood mapping, remote sensing, overlay analysis, Analytical Hierarchy Process.

Abstract

Floods are one of the most catastrophic natural calamities that have huge impacts on life and property. Floods can be represented as flood inundation map, food hazard map, susceptibility map etc. Traditional approaches of flood mapping involve the use of hydraulic/hydrologic models such as HEC-RAS, HEC-HMS etc, MIKE, LISFLOOD etc. These models posses the drawback that they are computationally demanding and require detailed catchment information. This makes these models unsuitable for large scale applications as well as for data scarce regions. To overcome this drawback, in the present study an effective methodology is presented to develop flood maps using remote sensing data. Thematic layers are generated for seven flood conditioning factors. Overlay analysis is performed using ArcGIS to generate the flood maps. The flood maps are then validated using flood reports and social media posts. The results show that the generated results match very well with our analysis. Thus, the presented approach can be used effectively for generating flood maps that relies only on remote sensing data.

TITLE: ASSESSING THE HYDROLOGICAL MODEL'S PERFORMANCE IN SIMULATING FLOOD HYDROGRAPH WITH HIGH-RESOLUTION RAINFALL DATA

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Abstract

Accurate flood prediction is crucial for effective water resource management and disaster preparedness. This study assesses the performance of the HEC-HMS (Hydrologic Engineering Center's Hydrologic Modeling System) in simulating flood hydrographs for the Muthankera catchment, spanning 1260 km2, using high-resolution rainfall data. The model was initially calibrated and validated using daily weather data and observed discharge at the Muthankera gauging station. Evaluation metrics viz. RMSE-observations standard deviation ratio (RSR), percent bias (PBIAS), coefficient of determination (R2), Nash-Sutcliffe efficiency (NSE), and peak percent threshold statistics (PPTS) were included for high flow values, confirming the model's high degree of accuracy in daily flood hydrograph simulation.

The calibrated and validated HEC-HMS model has been applied to gain more precise flood predictions, using 12-hour rainfall events of 08 and 09 August 2018, aiming to capture the catchment's rainfall-runoff responses and, to analyze the Kerala flood 2018 on a finer scale. Initial findings suggest that the HEC-HMS model provides better resolution of hydrograph peaks and timing, offering a clearer picture of how the catchment responds to rainfall events in an hourly time scale. This study highlights the importance of high-resolution data in hydrologic modeling and demonstrates the capability of the HEC-HMS in managing flood risks in the Muthankera catchment. These insights have significant implications for flood forecasting, early warning systems, and water resource management in similar regions.

Keywords: Rainfall-Runoff, HEC-HMS, PPTS, High-Resolution Rainfall, Kerala Flood.

APPLICATION OF SCS-CN METHOD FOR REVERSE FLOOD ROUTING

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KEYWORDS
SCS-CN Method, Muskingum Method, Reverse Flood Routing, Peak Inflow, Time to Peak Inflow

ABSTRACT
The Soil Conservation Service Curve Number (SCS-CN) method is widely recognized for its reliability in estimating direct surface runoff from agricultural watersheds. Over time, this method has evolved, finding its applications in various fields such as water resources management, water balance studies, reservoir operation, irrigation, flood control, flood forecasting, rainwater harvesting, draught assessment, design flood estimation, urban hydrology, infiltration, soil erosion, sediment yield, pollutant transport and so on. Due to its versatility, the SCS-CN method has become a cornerstone in many sophisticated hydrological and ecological models. Despite its extensive use, its applicability for flood routing has not been fully explored. Hence, an SCS-CN based parallel reverse routing approach, analogous to the Muskingum reverse routing method which simplifies the St. Venant equations, was developed and applied to real flood events from diverse river reaches documented in the hydrologic literature. Performance of the proposed SCS-CN based method is compared to the Muskingum method using metrics such as such as Nash-Sutcliffe efficiency and relative error in peak discharge and time to peak. Our findings demonstrate that the SCS-CN method performs comparably to the Muskingum method, effectively simulating the temporal distribution and magnitude of inflows or upstream flood waves. This demonstrates the SCS-CN method's potential as a valuable tool in distributed hydrologic modeling and effective flood prediction and management, highlighting its flexibility and robustness in channel routing applications. The proposed approach leverages the empirical or conceptual simplicity of the SCS-CN method with the dynamic capabilities of routing methods to address the complexities of channel routing.

NEED FOR PROACTIVE DROUGHT MANAGEMENT IN INDIA: TACKLING CLIMATE CHANGE, URBANIZATION, AND POLICY GAPS

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KEYWORDS
drought management, climate change, agricultural vulnerability, urbanization, policy integration

ABSTRACT
India faces recurrent droughts that significantly impact water resources, agriculture, and livelihoods. This paper focuses on the recent challenges in drought management in India, particularly those exacerbated by climate change, rapid urbanization, and policy limitations. Droughts in India are becoming more frequent and severe, driven by climatic shifts and anthropogenic pressures. The traditional reliance on monsoon rainfall, coupled with increasing water demand, has heightened the vulnerability of several regions to drought. Recent droughts have exposed critical gaps in existing management approaches, necessitating a re-evaluation of current practices. Increasing temperatures, heatwaves, and changing precipitation patterns are altering drought dynamics, making prediction

and management more complex. Over-extraction of groundwater and inefficient water use practices have exacerbated water scarcity during drought periods. The dependency on monsoon rains for agriculture leaves the sector highly susceptible to droughts, threatening food security. Rapid urban growth has increased water demand and reduced natural recharge areas; intensifying drought impacts in urban regions. Effective drought management is hindered by fragmented policies and poor coordination among governmental agencies.
Leveraging advanced climate models and incorporating local climate data can significantly enhance the accuracy and lead time of drought predictions, facilitating improved preparedness. Implementing efficient irrigation methods, rainwater harvesting, and sustainable groundwater management practices can alleviate water scarcity. The adoption of drought-resistant crop varieties, crop diversification, and efficient water usage in agriculture can diminish vulnerability. Crafting integrated policies that encourage inter-agency collaboration, community involvement, and long-term planning can bolster the effectiveness of drought management strategies. This paper emphasizes the necessity of proactive and innovative approaches to protect water resources and ensure sustainable development amid escalating drought risks.

URBAN FLOOD AND MITIGATION: A CASE STUDY NAGPUR

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KEYWORDS
Urban City Flood, Nag River, Return Period, NbS, Nagpur

ABSTRACT
Nagpur is one of the cities in Maharashtra that is affected by both urban flooding and escalating urban heat. The expansion of built areas and consequent pressures on the natural resources have significantly increased the frequency of flood events, impacting low-lying areas along Nag River and other major rivers within the city. In September 2023, incessant rainfall resulted in massive damage to property and inconvenience to citizens. Some of the key contributing factors include extreme rainfall, choked drains from solid waste disposal, inadequate drainage infrastructure, construction within flood buffer zones including cross-drainage structures, and the poor condition of prevailing physical infrastructure. Through the study, fluvial flooding impact of Nag River has been evaluated and the analysis showed that area upstream of Ambazari Lake which is starting point of Nag River, is already protected and falls under the no-development zone. Few flood mitigations were investigated including widening of the river which is found to be a challenge considering that on both sides of the riverbank are extensively developed and, in some cases, up to the river edge. Therefore, an alternate option was considered to create detention basins in the upstream of Ambazari lake which is identified as Nature based solution or NbS

WC-17 & 18

FLOOD RISK ASSESSMENT AT AN INDUSTRIAL SITE UNDER CLIMATE CHANGE CONDITION

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Abstract

The wide range of possible estimates of climate change effects namely rainfall intensity and duration are of great interest for hydrological design. The adaptation of climate change effect in the hydrological design of flood protection measures are a major challenge for water resources planners and engineers. The general prediction from climate change research indicates comparatively more vigorous hydrological cycle with increased precipitation and evaporation rates leading to affect the water availability and runoff and thus flooding characteristics. The potential effects on discharge extremes that determine the design of water management regulations and structures are of much concern. On the other hand, with the growing population, the development activities in the floodplain are increasing, resulting into the increased vulnerability to flood hazards. The basic hydrological design parameters for majority of flood protection measures are either the peak flood discharge and/ or maximum flood level. These parameters must be computed with the re-visited hydrological estimates under projected climate change scenario. In this paper a case study is discussed where in the design flood have been estimated using a simple and convenient tool of 'climate change factor' which are based on rigorous analysis of climate change prediction models and other climate studies. Further, these flood estimates are further used for inundation modelling to compute the maximum flood level and flood extent to quantify the impact of climate change.

Key words: design flood estimation, climate change impact, flood risk, safe grade level, flood protection measure

HYDRO-CLIMATOLOGICAL ASSESSMENT OF FLOODS IN KRISHNA RIVER BASIN, MAHARASHTRA

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Theme: Water related Disasters and its Management

Sub-Theme: Risk to Water Infrastructure due to Hydrological Changes in view of Climate Change and it's Management

Abstract Synopsis:

The sequence of heavy rainfall and dam releases, alongside unregulated catchment flows, contributes significantly to downstream flooding. In present study, Krishna River catchment (area of 21,457 km^2) of Maharashtra, India, traverses through the districts of Satara, Sangli, and Kolhapur, taken as for the hydro-climatological assessment. Devastating floods in 2005 and 2006 inflicted substantial damage in Sangli and Kolhapur, leading to widespread submergence. During the intense rainfall and free catchment flows, devastating flooding occurred during 2005 and 2006 at Sangli town. The present study evaluates individual catchment hydrological response along with detailed rainfall and discharge frequency using hydrological modelling approach. The effects of flow releases from dams and natural flow without dams to assess the effect of reservoirs on downstream floods of the region. The Integrated HEC-HMS model was employed to simulate rainfall-runoff and routing processes. Simulations have been validated for the flood events of 2005 and 2006 to comprehensively analyze the hydrological dynamics and assess the impact of reservoirs on downstream flooding within the study area. Developed integrated model has been utilized for both natural flow scenarios and controlled flow scenarios influenced by dam operations.

Keywords: Hydrology; Climate Risk; Hydrodynamic Modelling; Krishna River Basin; Flood

ASSESSMENT OF AQUIFER SETUPS AND EVALUATION OF SALINE INTRUSION IN GROUNDWATER RESOURCES OF BALASORE-CHANDIPUR AREA, ODISHA.

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Abstract

Groundwater is a primary source of water for various needs in the coastal Balasore-Chandipur region of Odisha. However, saline intrusion poses a concern to the sustainability of groundwater resources in the area. This study aims to characterize the aquifer systems and evaluate saline intrusion in groundwater through an integrated hydrogeological and hadrochemical investigation. Exploratory well data was utilized to delineate the aquifer disposition into younger and older alluvium. Water quality was analysed spatially and seasonally for 62 pre-monsoon and 69 post-monsoon samples based on major ions, WQI, isotopic and irrigation water quality indices. Hydrogeochemical plots revealed weathering, cation exchange and halite dissolution as salinization processes. Na/Cl and Cl/HCO3 ratios along with Gibbs plots for identifying for validation of seawater intrusion. Higher salinity was observed post-monsoon and in coastal regions. Isotopic maps indicated southern recharge zones. The study provides insights on aquifer setup and recommends artificial recharge and regulation for saline intrusion control to ensure groundwater sustainability in the area.

Keywords ·Groundwater sustainability-Saline Intrusion ·Hydrogeochemical Plots-Salinization Process, aquifer setup.

CRITICAL ASSESSMENT OF STATUS OF TRACE AND TOXIC METALS IN RIVERS OF INDIA

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Abstract: River water in India is nowadays reported to have presence of trace & toxic metals due to anthropogenic as well as natural resources. To observe the current status of toxic metal content of Indian Rivers, 9795 no. of river water samples from 491 water quality monitoring stations spread over 10 river basins of India were collected during January 2021-December, 2022. These samples were analyzed for Arsenic, Cadmium, Chromium, Copper, Mercury, Nickel, Lead, Iron and Zinc. As there are no specific standards for river water quality, the analysis results are compared with the acceptable limits prescribed by BIS: 10500-2012 as a benchmark only.

The study identifies locations where the concentration of these metals exceeded the acceptable limits. The comprehensive analysis of water samples across numerous stations has revealed concerning levels of various heavy metals, each governed by specific acceptable limits prescribed by BIS (10500:2012). All metals are found to be within the acceptable limits at 270 out of 491 monitored stations while at 221 stations studied, at least one metal was found to be beyond the limit. The results underscore the pervasive nature of metal exceedance, with multiple stations showing elevated concentrations of arsenic, cadmium, chromium, copper, iron, lead, mercury, and nickel. Iron is observed to have highest abundance showing beyond - limit concentrations at maximum number of samples and stations. Nevertheless, it was concluded that Zinc concentrations are found within the acceptable limits as per Bureau of Indian Standards (BIS) and no toxicity of Zinc in the River water is observed during the study period.

Also, the comparison of current data with water quality data published by CWC in 2021(study period: August 2018-December 2020) revealed that the overall percentage of stations which are found to be 'within limit' in terms of all metals analysed has increased from 26.16 % during Aug 2018-Dec 2020 to 54.99 % during the current study period (2021-2022) and the percentage of stations affected with at least one metal, has decreased from 73.84% to 45.01 %. Similarly, percentage of samples which are observed to be safe in terms of all metals increased from 66.11% to 95.49%. This shows a positive trend.

Key words: Water Quality, River Water, Trace & Toxic Metals, River Basins of India, Metal Exceedance

CRITICAL ASSESSMENT OF RIVER WATER QUALITY AND DETERMINING HOT-SPOTS IN INDIAN RIVERS

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KEYWORDS
Environment, Indian River Basin, Hot-Spots, River Water Quality, Drinking Water

ABSTRACT:

The assessment of water quality is an essential measure within environmental monitoring. When water quality is poor, it affects not only the aquatic life but also the surrounding ecosystems. Rivers are unquestionably important parts of the hydrological cycle, mainly because they are fluxes of water and not reservoirs of water. Rivers, along with water, drag off sediments and other suspended materials (biotic and abiotic) that ultimately will reach all the other aquatic environments. The present study based on the data of 13 water quality parameters observed at 772 water quality monitoring stations in 2021 and 776 monitoring stations in 2022. The eight parameters — pH, dissolved oxygen (DO), biochemical oxygen demand (BOD), total coliform bacteria (TC), free ammonia (NH_3-N), electrical conductivity (EC), boron (B), sodium adsorption ratio (SAR) are important for classification based on the uses defined by the Central Pollution Control Board (CPCB). Fluoride (F^-), Chloride (Cl^-), Total Hardness (TH) and Nitrate (NO_3^-) are among the parameters defined by the Bureau of Indian Standards (BIS: 10500:2012) for drinking water. Faecal Coliform (FC) is based on the primary water quality criteria for bathing water listed in the Gazette Notification issued by the Ministry of Environment, Forest and Climate Change (MoEFCC) in 2000. These samples were analysed at 23 water quality laboratories of CWC. The analysis results are compared with the prescribed limits of CPCB's designated best uses, BIS 10500:2012 and MoEFCC standards to find out the hot spot in Indian river.

To observe the current status of Hot-spots in Indian Rivers, 16476 no. of river water samples from 772 water quality monitoring stations spread over major river basins in India were collected during Jan 2021 to Dec 2021 and 23570 no. of river water samples from 776 water quality monitoring stations spread over major river basins in India were collected during Jan 2022 to Dec 2022. These samples were analysed for afore-mentioned 13 parameters. The hotspots have been found in 219 rivers out of 373 rivers studied in 2021.Similarly, the hotspots have been found in 164 rivers out of 368 rivers studied in 2022.

ADVANCING RIVER WATER QUALITY: MODERN STRATEGIES AND TECHNOLOGIES IN CWC

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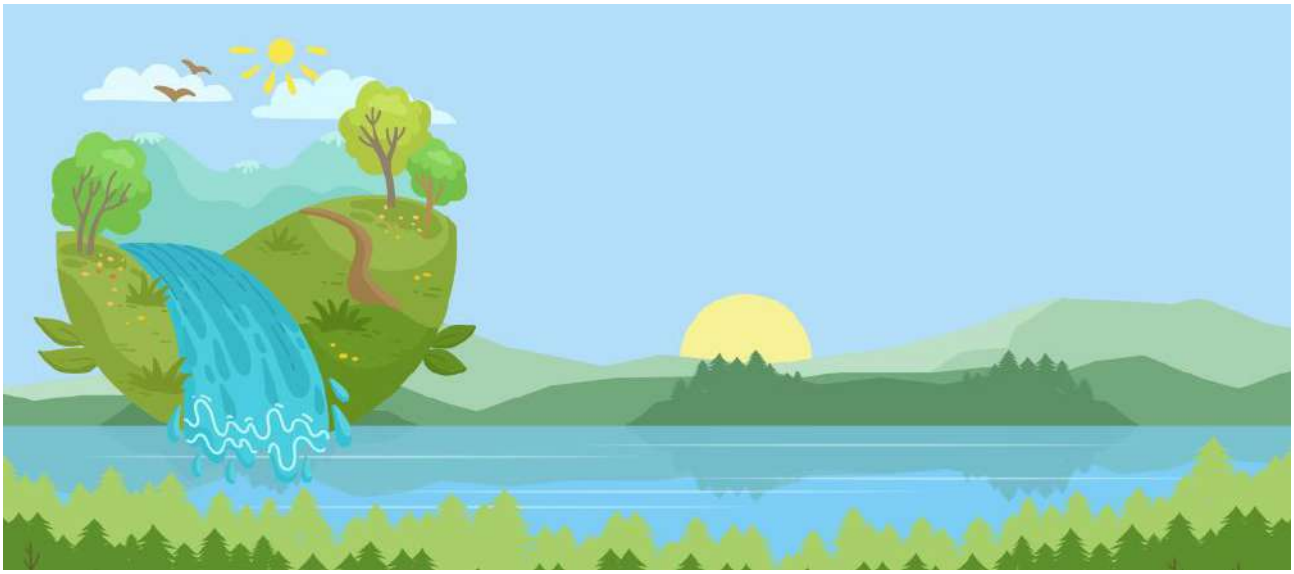
Abstract: Freshwater is a critical resource for sustaining life and supporting sustainable development. Effective management of the world's limited freshwater resources is essential, particularly as both natural and anthropogenic activities lead to the deterioration of water quality in lakes, rivers, oceans, and groundwater. Surface water, being more exposed to atmospheric conditions, is particularly vulnerable to pollution compared to groundwater, making its monitoring a significant concern. With increasing pressures from population growth and industrial activities, effective water quality monitoring has become crucial for resource management. Accurate and long-term data acquisition is necessary to assess water resource conditions, implement effective preservation and remediation strategies, and evaluate program success. This paper explores the modernization of water quality monitoring programs in CWC (Central Water Commission), emphasizing the integration of advanced technologies such as Inductively Coupled Plasma Mass Spectrometry (ICPMS), Gas Chromatography-Mass Spectrometry (GCMS), also real-time monitoring sensors are in pipeline. These advancements are essential for providing reliable, consistent, and actionable information for sustainable water resource management.

Keywords: Sensors, RTWQMS, ICPMS, GCMS, IC, CWC, NMCG.



GEOSPATIAL DECISION SUPPORT SYSTEM FOR INCLUSIVE PLANNING AND UTILIZATION OF THE RESERVOIR WATER INFRASTRUCTURE FOR SUSTAINABLE INLAND FISHERIES PRODUCTION

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ABSTRACT

Reservoirs serve as a major water infrastructure that serves various ecosystem services to the human kind ascertaining nutritional security and livelihoods of the traditional inland fishermen. These resources are referred as 'sleeping giants' as they have extreme untapped fisheries potential amongst the inland water resources. The Department of Fisheries, Ministry of Fisheries, Animal Husbandry & Dairying, Government of India is implementing various reservoir fisheries development schemes through the state fisheries departments under various fisheries development schemes and *Pradhan Mantri Mastya Sampada Yojana* (PMMSY) is the flagship programme that is being implemented during 2020-25. The components of the scheme that supports sustainable utilization of the reservoir infrastructure include enclosure fish culture *i.e.*, cage culture and pen culture, stocking of fish fingerlings of 100 mm size in the reservoirs for enhancing the optimal utilization of the water resources thus scoping the inland fish production. However, there exists wide gap in the availability of robust data of the lentic inland water resources is hindering the opportunity to explore and implement various fisheries development programmes.

With an objective of understanding the water dynamics and develop inclusive water planning modality for enhancing fish production, a study was taken up for the reservoirs viz., Sri Ram Sagar (SRS) (33662 ha), Kaddam (2292 ha) and Swarna (1048 ha) from the Godavari Basin, covering the period 2016-2021, as a case study to demonstrate the use of remote sensed data in fisheries stock enhancement planning. The high spatial resolution satellite data, i.e., Sentinel 2A MSI level 1C which are ortho-corrected imageries with Top of Atmosphere (ToA) reflectance was chosen and the data was accessed and downloaded from the Copernicus Open Access Hub of the European Space Agency. The spatial resolution of the 4 bands considered in the present study, i.e., Red, Green, Blue, and NIR (Near Infra-Red) is 10 m. Resourcesat-2 LISS-III images were acquired from the Bhuvan, an Indian Geo-platform of ISRO, for the year 2016. ArcGIS 10.8 and ERDAS IMAGINE 2015 software were used to process the satellite images and extract the water infrastructure available for fisheries development.

The perennial water spread area suitable for cage culture in the Sri Ram Sagar, Kaddam and Swarna reservoirs estimated through composite water maps ranged 3609.8 ha, 443.94 ha and 93.43 ha and seasonal water spread area suitable for pen culture was 1403.27 ha, 668.71 ha and 167.79 ha respectively. Further, the potential area for enclosure fish culture (both cage and pen culture) in these reservoirs were found to range between 14.89% *i.e.*, 5013.05 ha for Sri Ram Sagar and 48.54% *i.e.*, 1112.65 ha for Kaddam reservoir. Further, a total of 55 cages and 72 cages were installed in the Sri Ram Sagar and Kaddam which were mapped using Google Earth Pro and the results revealed less than 0.1% of the perennial water infrastructure mapped in these reservoirs is under use for cage culture. It was understood that the reservoirs are being under-utilised for fisheries production and study demonstrates scope for developing enclosure fish culture. Furthermore, the data developed with geospatial intervention and the remote sensing approach helps in inclusive water infrastructure planning for enhancing the fish production in India through culture-based fisheries which in turn assures income for the fishermen communities.

The geo-based data utilization and developing maps for water dynamics based on the past rainfall years provides scope for planning fish stock enhancement programmes like fish seed stocking by the fisheries departments. The Telangana Water Resources Information System developed by the ISRO-National Remote Sensing Centre was used by the State Fisheries Department, Government of Telangana for the planning of the available water spread that resulted in optimal stocking of fish seed *i.e,* 500, 1000 and 2000 fish fingerlings/ ha in the studied reservoirs during 2020-23 and the yield from the reservoirs were reported to be 390 kg ha^{-1}, 510 kg ha^{-1} and 524 kg ha^{-1} in Sri Ram Sagar, Kaddam and Swarna respectively. This approach reduces pressure on the costs involved in stocking of fish fingerlings, effective utilization of available water infrastructure for enhancing sustainability. This results indicated that there was an increase in the yield per hectare due to intervention of the geospatial approach which acted as a source for the decision support to stock the fish seed in optimal manner thus ascertaining the livelihoods of the small scale and marginalized inland fishermen depending on the reservoir fishery. The geospatial and remote sensing approach to inclusive water resource planning for the fisheries ascertains the Sustainable Development Goals (SDGs). The Department of Fisheries, Ministry of Fisheries, Animal Husbandry and Dairying, Government of India is fostering the sustainable utilization of water resources for fisheries development ensuring the SDGs *viz*., No Poverty (1), Zero Hunger (2), Clean Water and Sanitation (6), Responsible Consumption and Production (12), Climate Action (13) And Life Below Water (14).

Keywords: Composite water maps, Enclosure fish culture, Geospatial tools, Godavari River, NDWI, Reservoir, Sentinel 2A data, Water infrastructure, SDGs.

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24.	Project Director WTC IARI- Indian Agricultural Research Institute, Pusa Campus, New Delhi – 110012	Member
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36.	Director General National Water Development Agency, New Delhi.	Member
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8th INDIA WATER WEEK-2024

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- **Smt Deepika Sharma**, DD, NDWA, New Delhi
- **Shri Hari Om Varshney**, AE, NDWA, New Delhi
- **Shri Ankit Kumar**, AE. NDWA, New Delhi
- **Shri Krishna Gurjar,** JE, NDWA, New Delhi
- **Shri Dharm Singh Bairwa**, JE, NDWA, New Delhi
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- **Shri Nagesh Mahajan**, Consultant (Technical), IWW Secretariat, New Delhi
- **Shri. R.P Singh**, Consultant
- **Shri Dalip Singh**, Consultant IWW secretariat, New Delhi
- **Shri Danish**, DEO, IWW Secretariat, New Delhi
- **Shri Akash Deep**, DEO, IWW Secretariat, New Delhi

ICID officers Involved in Technical Co-ordinary

- **Shri A B Pandya**, Secretary General, ICID

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