



INC of IAH Indian National Chapter International Association of Hydrogeologists



Newsletter

VOLUME 10 ISSUE 01 Jan, 2023

Engage. Inspire. Thrive.

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Edited, designed and
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Treasurer, INC-IAH

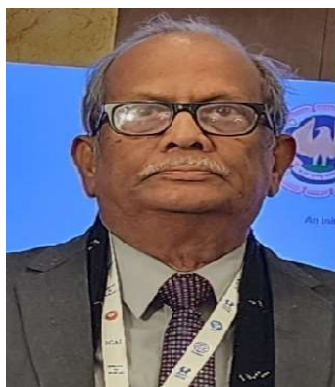


INC of IAH

HQ. c/c Central Ground
Water Board, Bhujal Bhawan,
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www.inciah.org



President's Message

Prof. A. K. Sinha

President, INC of IAH

Vice-Chancellor,
Chhatrapati Shivaji University, Navi Mumbai
Member, Governing Council, IUAC, GOI, New Delhi
and Founder Groundwater Community Forum
E: groundwater2008@gmail.com

Dear Colleagues & Friends

Now another issue of INC-IAH e-newsletter is in your inbox with all good wishes and greetings for excellent days ahead for the readers and subscribers of this newsletter in general and to INC-IAH as an organization in particular.

Last three months have been very hectic but rewarding too. With the very active support of our members particularly of governing council members a national seminar on “Recent approaches in Groundwater Development & Management in Semi/Arid region of India with a focus on Rajasthan” was organized at Jaipur on 24th Dec in partnership with at Rajasthan Institute of Engineering and Technology, Jaipur and State Groundwater Department, Govt of Rajasthan and further, a very significant Special session of INC IAH for the first time was also organized under the aegis of 108th Indian Science Congress at Nagpur during 3rd to 7th Jan 2023. Yes the ongoing monthly lecture Sr has to be postponed during these months which would again will get going from this very month onward.

The e-newsletter provides a good platform to share the thoughts, knowledge and information. I once again appeal to all our esteemed members to use this platform to make it more and more vibrant. I also request to our



INC IAH members to act as an INC-IAH ENVOY in their respective areas and in institution of their operations and affiliations which would not only enhance ones' visibility but would also establish the credibility and utility of INC-IAH. As an ENVOY one may interact with local community, School & College Students, Farmers group, young career professional & practitioners and may enrich their knowledge and skill towards better appreciation and management of groundwater. Let me assure to our esteemed members that such valued contributions will not go unnoticed and will be duly recognized and rewarded by the Community and INC-IAH

I wish to bring to your kind attention once again that with your enhanced indulgence INC-IAH may be in a position to support summer/ winter Schools, boot camps, and Hydrogeological weakened, and many more scientific events as activities needed to strengthen young potential hydrogeologists. I on behalf of the Governing Body, would like to profusely thank Dr Ashok Kumar, Executive Editor, e-Newsletter for completing the upcoming issue through untiring dedication and cumbersome work of editing expeditiously and painstakingly.

Thanks, and warm regards to all

(A. K. Sinha)

Secretary's Message



Sh. Amlanjyoti Kar

Secretary, INC of IAH

*Former Regional Director, Eastern Region
Central Ground Water Board, Kolkata,
Ministry of Jal Shakti, Government of India,
E: amlanjkar@gmail.com*

Dear esteemed colleagues, while penning for this column, I avail the opportunity to heartily greet one and all and trust you are in good health and spirit with family members. It gives me immense pleasure to inform you that we are bringing out the first issue of INC-IAH News Letter for this calendar year of 2023. We are putting our best effort to publish the News Letter within the desired time frame. In our previous issues we have published many scientific short papers, notes, important events, talks, on the seminars, symposium and conferences taking place in India and all around the globe.

On 24.12.2022 INC-IAH have successfully organized a National Seminar in liaison with the Rajasthan Institute of Engineering and Technology at Jaipur. Many good papers on arid and semi-arid regions of India with special reference to Rajasthan were submitted and presented in the Seminar.

In the middle of January'23 we have announced the submission of nomination for giving away the INC-IAH award-2022. The submission of nomination will be closed on 20.02.2023. I appeal to all the members to nominate self for various categories as also to enthuse the non-members especially for submitting the nomination for the Life Time achievement award.

INC-IAH have announced the date of Annual General Meeting on 26.02.2023. I am making an earnest request to all the esteemed members of IAH as per the enrolment in the year 2022 to renew their membership, so that all can join in the forthcoming general body meeting to render their wise views and guidance for better management of our beloved Association.

Under the leadership of Prof. A. K. Sinha, President, INC-IAH members have made a vibrant presence in the Indian Science Congress held at Nagpur during 3rd -7th January ,2023, where many esteemed members like Dr. S. C. Singh, Dr. Ajoy Kadam, EC member besides Prof A. K. Sinha presented their key note speech and respective papers.

National Aquifer mapping and management has been the flagship programme of the Ministry of Jalshakti and its apex groundwater organization CGWB has undertaken the program all over the country and its first phase of programme in 1:50,000 scale is going to be ended by 2023. The MoJS is further planning to undertake the second phase of NAQUIM in the special areas like on the Spring studies in the Hills and mountains. Besides, to continue the food security of our country amidst the extreme water scarcity in the



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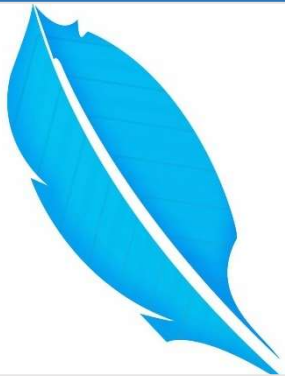
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West, South, Central and the North-western parts of India, the PMKSY(GW) scheme has been envisaged especially in the eastern and North Eastern States. In order to showcase the success of NAQUIM and PMKSY(GW) to the stakeholders especially to the respective State and UT Governments, CGWB has been organizing Workshops all over the country. In this regard the maiden one day workshop on Success stories of implementation of NAQUIM and PMKSY(GW) in the North Eastern States, West Bengal, Sikkim and A&N Islands was organized by the CGWB, Guwahati at Guwahati on 24.1.2023 where [Sh. Ashok Singhal](#), Hon'ble Minister, Irrigation, Govt. of Assam, [S. Abbasi](#), Addl. Chief Secretary Irrigation Govt. of Assam, [Sh. Subodh Yadab](#), Joint Secretary, Ministry of Jalshakti, Govt. of India, [Dr. P. Nandakumaran](#), Former Chairman, CGWB, [Sh. Anand K. Agarwal](#), Member, CGWB and IAH, [Dr. S. S. Singh](#) and [Dr.D.J. Khound](#), Scientist, CGWB both esteemed members INC-IAH, and [Sh. Amlanjyoti Kar](#), Secretary, INC-IAH have deliberated in the Workshop. [Sh. S. C. Kapil](#), Regional Director, CGWB, Guwahati was the organizing Secretary and [Dr. A. Gayen](#), Regional Director, CGWB, Kolkata and esteemed member, INC-IAH was also present and offered the vote of thanks. Many new findings, the key issues and their solutions were discussed in the Workshop.

Our elite members from the academia as also from the Professional arena are constantly publishing remarkable papers in the peer reviewed National and International journals of which most remarkable is the very recent paper by an international group led by Prof Bridget R. Scanlon, University of Texas, Austin, USA has been published in the "Nature Reviews Earth & Environment journal" in 2023. [Prof. Abhijit Mukherjee](#), Department of Geology and Geophysics, IIT. Kharagpur, an esteemed member of INC-IAH has been the important and the lone author from the SE Asia in the International paper titled "Global water resources and the role of groundwater in a resilient water future". We feel proud of him.

I convey my thankfulness to all the members individually who have already renewed their membership and welcome all the new members into the family of INC-IAH. I convey my regards once again to all the esteemed members and hope all goodness for them and their family members in the ensuing time. I convey my thanks to [Dr. Ashok Kumar](#), Treasurer INC-IAH for nicely compiling the current issue of the Newsletter and its intime publication.

(Amlanjyoti Kar)



Editor's Desk

Dr Ashok Kumar

Treasure, INC of IAH

Consultant - Hydrogeologist

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Honorary Secretary, VSED, New Delhi

Former Advisor - Hydrogeologist (Cairn India)

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🌐 <https://wateraquifers.com>

Dear Readers,

It is indeed a great honour to be the Editor of the present edition of INC-IAH e-Newsletter. I am thankful to the members particularly members of the governing council for reposing faith in me by assigning the responsibility.

The PRESENT edition, recount the various activities in which INC-IAH members have been actively involved since the 4th quarter of 2022 until the end of January 2023. It provides an overview of major activities, such as the successful organisation of National Seminar in Jaipur and the organisation of first ever INC-IAH special session at the 108th Indian National Science Congress in Nagpur in 2023. The period also witnessed the successful launching of the e-Journal of Geohydrology of INC-IAH, very competently edited by [Prof Dr. B. S. Chaudhary](#) as the Executive Editor and further the publication of Abstract Volume of Jaipur Seminar by [Shri Sujit Sinha](#) (Organising Secretary) and [Shri R. K. Mishra](#) (Organising Secretary). This newsletter provides links for download.

Recently, INC-IAH has announced Awards in various categories. The detail Award guidelines and Application form may be had from this newsletter as well. Readers may explore in more detail through the link provided in the newsletter. I am also trying to reach to a large audience through this volume of the newsletter for renewal of / enrollment of new membership of the IAH. Please refer to the guidelines provided in the newsletter.

A huge thank you to all the individuals who contributed by writing the wonderful and inspiring articles, without which the present newsletter would have remained incomplete.

This volume contains three articles by well-known researchers, namely [Dr. S. N. Rai](#) (former Chief Scientist, NGRI, Hyderabad), [Shri Satyanarayana Chunduri](#) (former Scientist, CGWB), and [Dr. Anadi Gayen](#) (Regional Director, Eastern Region, CGWB).

Last but not least, I would like to thank INC-IAH President [Prof. A. K. Sinha](#), Vice President [Prof. A. Mukherjee](#), Secretary [Shri Amlanjyoti Kar](#), and Executive Committee members for their everlasting support throughout the creation of this edition.

Before I stop my pen, I sincerely request all members, particularly young hydrogeologists, to come forward and add their contributions to make this quarterly newsletter more informative and readable for a larger audience. This is an open newsletter; members may circulate it to any individual or group for wider publicity. This is the only way to grow and make INC-IAH an impact full Scientific organisation

Ashok Kumar



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“Coming together is a beginning. Keeping together is progress. Working together is success.”

Announcement of INC-IAH Awards – 2022

About the Award

The INC- IAH Award has been instituted by the Indian National Chapter (INC) of International Association of Hydrogeologists (IAH) as an instrument for the promotion, motivation, and recognition of the excellence in the domain of the science of the groundwater and its sustainable management.

The INC-IAH award is an open competitive annual program for the members of INC- IAH. However, non-members may also be considered for the award subject to the compliance of certain conditions as enumerated below.

Award & Sponsorship

The Award for 2022 shall carry a citation and a plaque and the expenditure incurred will be borne by the INC-IAH from its own fund. However, as decided in the Executive committee meeting, no prize money will be paid to the awardees in this year due to non-availability of suitable sponsor fulfilling the MoU guidelines of INC-IAH. However, subsequently if INC-IAH finds promising sponsors, or can raise substantial funds through various fund-raising drives then the cash award will be instituted additionally and the same will be given away in the forthcoming years.

This year there will be four INC-IAH awards in the individual categories which are enumerated below. It is also to mention that if suitable candidates (at least three nos.) in different category could not be found as per the selection criteria, no award will be given away. However, the selection procedure for the Lifetime achievement award will be different from the other awards and it is enumerated in the respective section. The following awards will be given away for the INC-IAH award 2022.

1. Lifetime Achievement Award- One no
2. Groundwater Excellence Award – one no.
3. Young Scientist Award – one no.
4. Best Paper Award – two nos. (one for male and one for female)

Opening date:	Submission of nomination will remain open from today i.e., the 16th January, 2023. The nomination guidelines with form will also be uploaded in the INC-IAH website and emailed to all the bonafide members of the INC-IAH.
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Closing date and time:	11.59 PM on 20th February.
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Enquiries:	In case of any query, please contact the Secretary, INC-IAH at amlanjkar@gmail.com or phone 9540686777
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Guidelines, Categories of Award and Application Form are available on the link given below (Also visit inciah.org)

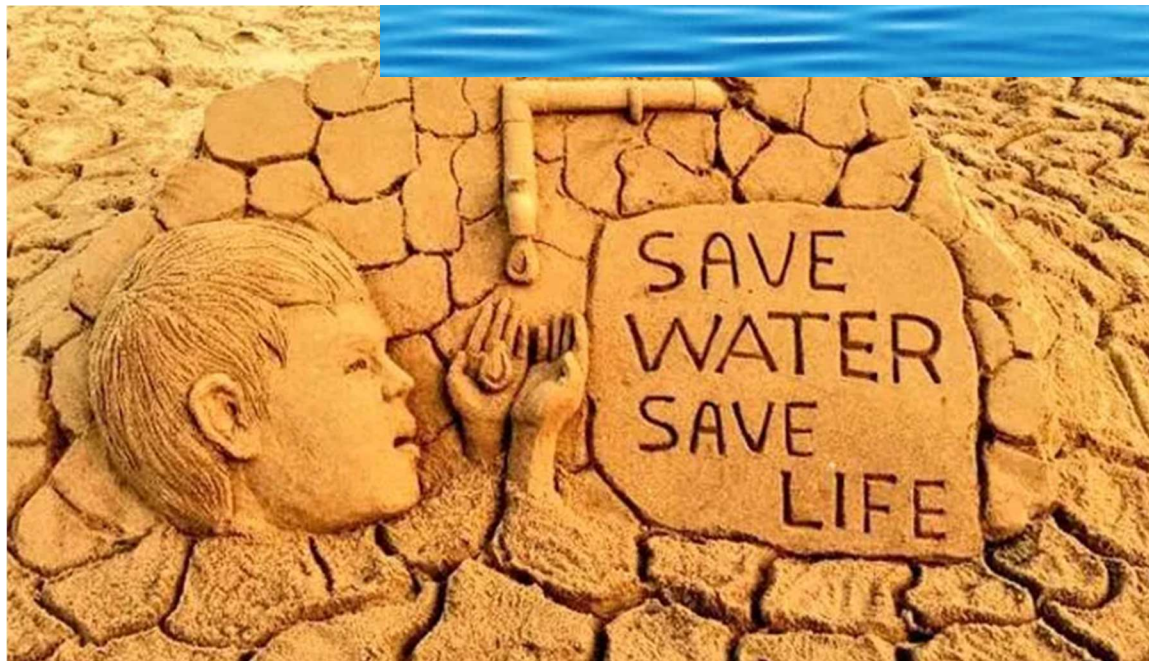
[INC-IAH Award Guidelines & Application form](#)

[Application Form INC-IAH Lifetime Achievement Award](#)

[Application Form INC-IAH Groundwater Excellence Award](#)

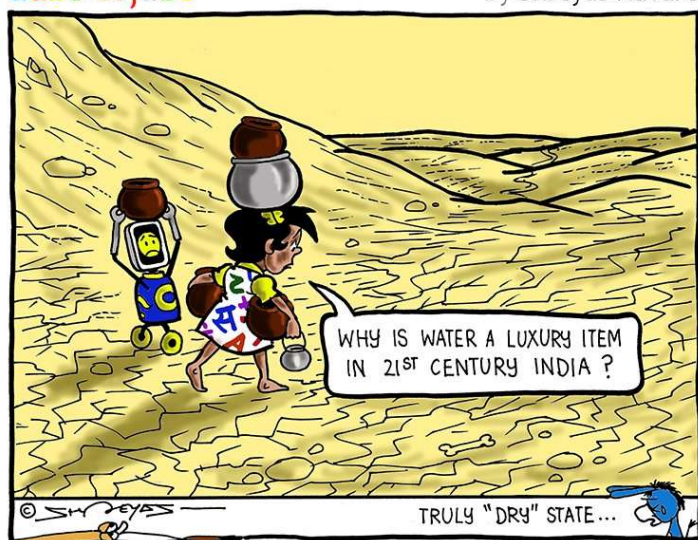
[Application Form INC-IAH Young Scientist Award](#)

[Application Form INC-IAH Best Paper Award](#)



dabs & jabs

by Shreyas Navare



facebook.com/dabsandjabs

जलं ददाति जीवनम्, जलं विना मरणम्॥

पानी बचाओ, जीवन बचाओ।
सारे संसार की प्यास बुझाये, जल के बिना हम जी ना पाये।
जल है जीवन का आधार,
इसे बचा के करो सबका उपकार।
प्रकृति का वरदान है ये अनमोल खजाना,
मिलकर हमे इसकी रक्षा है करना।
जल संरक्षण कर्तव्य है
मेरा, धरती सुंदर बने हमारा।

Groundwater Conservation Tips

10 things you need to know about the water crisis in India (by Arpit Jain and Reshma Anand)

1. India has a serious water problem: The 2030 Water Resources Group estimates that if we continue to consume water as per the current rate, India will have only half the water it needs by 2030—a flashpoint that's only ten years away.
2. Nearly 80 percent of India's freshwater is used in agriculture
3. Over half of India's cultivated land is under water-intensive crops
4. India uses at least twice the amount of water to grow one unit of food versus comparable countries
5. India's farmers rely mainly on tube wells to extract groundwater for their crops
6. Conservative estimates suggest that India has over 30 million borewells today
7. India draws nearly 25 percent of the world's groundwater
8. Sixty percent of India's districts have been declared critical on groundwater
9. India's depleting groundwater reserves also impact our drinking water
10. The country's water crisis has a significant economic cost

<https://idronline.org/10-things-you-need-to-know-about-the-water-crisis-in-india/>

SOFTWARE

Geographical Information Systems

1. **QGIS**: QGIS is a completely open-source GIS tool and can be executed in any operative system. www.qgis.org

2. **SAGA GIS**: It is a GIS platform oriented to spatial analysis. It is a simple but powerful tool for spatial analysis and characterization of basins. www.saga-gis.org

River modeling

3. **HEC-RAS**: This model uses the gradient and topography to evaluate the flow depth, velocities and flooded zones. www.hec.usace.army.mil/software/hecras/

4. **iRIC**: iRIC is a software offers a complete simulation environment of the riverbed <http://i-ric.org/en/>

Hydrologic modeling

5. **HEC-HMS**: HEC-HMS is designed to simulate the hydrologic processes in basins. www.hec.usace.army.mil/software/hechms/

6. **PRMS**: The modeling code PRMS is a modular system of spatially distributed parameters, which represent the physical processes of a basin. www.brr.cr.usgs.gov/projects/SW_MOWS/PRMS.html

7. **SWAT**: It is a tool to evaluate soil and water at a basin scale. www.swat.tamu.edu

Hydrogeological modeling

8. **MODFLOW**: This code performs groundwater modeling based on finite differences developed by the USGS. <http://water.usgs.gov/oq/modflow/>

9. **MT3DMS**: The MT3DMS package is a mass transport model coupled to a flux model in MODFLOW. <http://hydro.geo.ua.edu/mt3d/>

Computational fluid dynamics modeling

10. **OpenFOAM**: Pretty much any physical phenomenon associated to fluid dynamics can be represented with this software. www.openfoam.org

Hydrochemical modelling software

11. **PHREEQC**: It is a computer program is designed to perform a wide variety of aqueous geochemical calculations. <https://www.usgs.gov/software/phreeqc-version-3>



EYE ON IT

Shining new light on ground water measurements

NIWA's LWL6001-S, is putting groundwater levels under the spotlight. The new laser sensor accurately measures groundwater surface levels to sub-millimetre precision. This sensor is ideal for anyone who needs the continuous, reliable data needed to effectively manage groundwater resources.

How does it work?

The LWL6001-S sensor is mounted at the top of a bore casing and connected to the Serial Data Interface (SDI-12) input of a data-logger. The data-logger controls the frequency of the measurements, records the data and, in the case of a Neon logger, sends it to a secure Neon Server where it is archived. Then historical and real-time data can be viewed via any Internet-connected device.

When the data-logger requests a measurement from the sensor, a red laser light pulse is transmitted downward, inside the groundwater bore casing. This light pulse is reflected from a retrievable plastic target disc that floats on the water surface. A separate lens and light sensor detect the reflected light and the 'time-of-flight' of the pulse is used to determine the distance from the reference position at the top of the bore casing down to the target. On site visits, any difference between the reference and sensor may simply be added as an offset to the data-logger.

Groundwater News in Media

Groundwater charges on non-exempted users: How the Punjab policy will work

Those using 300 to 1500 cubic metres per month will pay Rs 4 per cubic metre in the green zone, those in yellow and those orange zones will pay Rs 6 and Rs 8 per cubic metre, respectively.

<https://indianexpress.com/article/explained/groundwater-charges-on-non-exempted-users-heres-how-punjab-policy-will-work-8416418/>

Central Ground Water Board Organises Workshop On 'success Stories of NAQUIM Studies And PMKSY-HKKP-GW scheme in North East and East India'

The North Eastern Region, Guwahati in association with the Eastern Region, Kolkata, Central Ground Water Board (CGWB), Govt of India organized a One Day Workshop today on, 'Success Stories of NAQUIM Studies and PMKSY-HKKP-GW Schemes in North East and East India' in Guwahati, Assam. Shri Subodh Yadav, JS, DoWR, RD & GR presents groundwater scenario of India, National Perspective of NAQUIM and future plans. Shri. A. K. Agarwal, Member (HQ), CGWB, Faridabad discusses scope of utilisation NAQUIM outputs

<https://orissadiary.com/central-ground-water-board-organises-workshop-on-success-stories-of-naquim-studies-and-pmksy-hkkp-gw-schemes-in-north-east-and-east-india/>

Nitrate, uranium, nearly twice the permissible limits, in Gautam Buddha Nagar groundwater

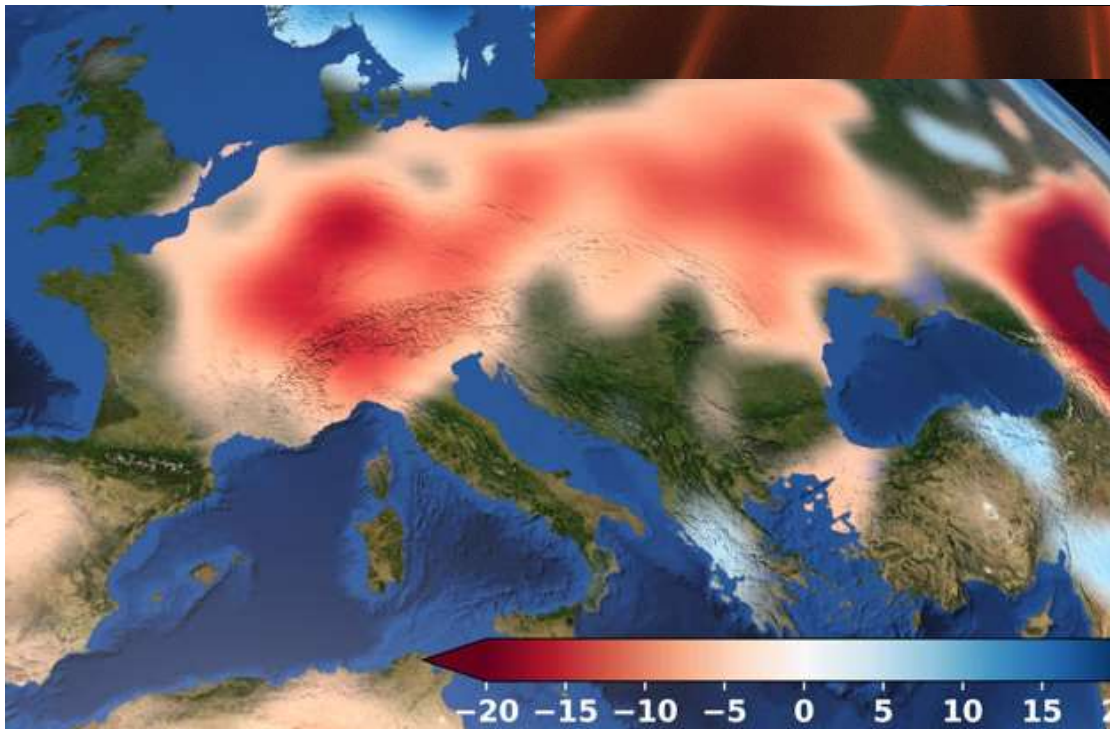
High nitrate and fluoride concentrations, almost twice the permissible limits, have been found in groundwater in different parts of Gautam Buddha Nagar district, rendering it unsuitable for drinking. Along with these heavy metals, uranium was also found to be above permissible limits. These findings are from the central CGWB's groundwater yearbook for Uttar Pradesh 2021-22.

<https://indianexpress.com/article/cities/delhi/nitrate-uranium-in-gautam-buddha-nagar-groundwater-8433027/>

Contaminated groundwater causing chronic ailments in areas on Hindon banks

Residents of nearly 31 villages in Shamli district, located on the banks of the Hindon river, are facing a major health risk. They have been found to be suffering from dreaded diseases like cancer, skin, respiratory and liver-related problems, etc. Following the directions by the National Green Tribunal (NGT), the health department has prepared report. Notably, the tributaries, including Kali, Krishna, etc., are some of the most contaminated rivers that have been causing havoc in the lives of villagers.

<https://www.daijiworld.com/news/newsDisplay?newsID=1044787>



Satellite data shows no rise in groundwater levels across Europe, increasing drought fears

<https://www.msn.com/en-au/news/australia/satellite-data-shows-no-rise-in-groundwater-levels-across-europe-increasing-drought-fears/ar-AA16SJeW>

Drought is impacting Europe on a larger scale than researchers expected, with data from satellites showing no significant rise in groundwater levels. Researchers from Austria's Graz University of Technology have analysed the data from two satellites orbiting Earth. "A few years ago, I would never have imagined that water would be a problem here in Europe, especially in Germany or Austria," researcher Torsten Mayer-Gürr said. "We are actually getting problems with the water supply here. We have to think about this." The two satellites, named Tom and Jerry, orbit the Earth in a polar orbit at an altitude of just under 490 kilometres, with a distance of 200 kilometres between the two. Researchers use satellite gravimetry to observe the world's groundwater resources and document the changes in recent years, the university says. It is part of a bigger project by the European Union to assess groundwater resources and develop sustainable water management plans. Scientists collaborate across specific projects to determine the levels of groundwater. Professor Mayer-Gürr said it was necessary to document the continuing drought and to have continuous satellite missions in space. "The processing and the computational effort here are quite large," he said. "We have a distance measurement every five seconds and thus about half a million measurements per month. "From this we then determine gravity field maps." The finding follows Europe recording its second-warmest year on record, according to the European Union's Copernicus Climate Change Service. The service said temperatures in Europe had increased by more than twice the global average over the past three decades. Last summer was Europe's hottest on record, smashing temperature records in countries including Italy, Spain and Croatia. The heat triggered a widespread drought that initial analysis ranked as Europe's worst in 500 years. The low water levels delayed shipping along Germany's Rhine, while the lack of rain hit hydropower generation and slashed maize and soybean crop yields.

EYE ON IT

Automated groundwater monitoring

World's first automated, real-time groundwater monitoring sensor system

Developed by CSIRO, SENSEI is the world's first automated, real-time monitoring and reporting system that operates in remote and extreme conditions, including low pH conditions (acid) and groundwater pressures of at least 20 bar (i.e., to depths of around 200 metres below ground level). The end-to-end sensor, hardware and software solution features robust, solid-state electrochemical sensors for measuring multiple chemical properties in embedded aqueous applications. The small, proprietary button-sized sensors include a novel reference electrode, and measure oxidation-reduction potential and pH. Third party conductivity, pressure, depth and temperature sensors have also been integrated into the product. The systems are currently hard-wired for data and power transfer between the local surface communication gateway and sensor pack. Data from the gateway can be transmitted to an online server using wireless options. Measurements can be taken and transmitted as often as every few seconds, and sent to an online data server. This data can be viewed securely and live from anywhere in the world via a dashboard that makes it easy to interpret and make quick decisions.

INC-IAH National Seminar “Recent Approaches in Groundwater Development and Management in Arid/Semi-Arid Region of India with a focus on Rajasthan” 24th Dec. 2022, Jaipur

INC-IAH NATIONAL SEMINAR

In Association with Rajasthan Institute of Engineering and Technology, Jaipur

ON 24th DECEMBER 2022



VENUE:

Rajasthan Institute of Engineering and Technology, Jaipur, Ajmer road, Bhankrota

CONTACT US

 inciah.org, www.rietjaipur.ac.in
 inciahseminarjpr@gmail.com
 9887060845, 9540686777,
9818174707, 9829047260, 9868843860



About Seminar



The objective of this national seminar is to deliberate and suggest concrete steps towards the development of practical policy and management options to govern groundwater management in arid to semiarid region in order to protect vulnerable and valuable groundwater resources from over-exploitation and contamination, and to sustain groundwater resources for drinking, health, agriculture and other economic activities.

ABOUT INC-IAH

INC of IAH is the Indian chapter of the International Association of Hydrogeologists (iah.org). It has been registered under the Haryana Registration and Regulation of Societies Act, 2012 (Haryana Act No. 1 of 2012) with registration number HR-019-2016-02281 dated August 18th, 2016 and its registered office address is at o/o Central Ground Water Board, Bhujal Bhawan, CGO Complex Rd, Faridabad, Haryana 121001. The International Association of Hydrogeologists (IAH/AIH) is a scientific and educational charitable organisation for scientists, engineers, water managers and other professionals working in the fields of groundwater resource planning, management, and protection. Founded in 1956, it has grown to a world-wide membership of more than 4000 individuals.

ABOUT RIET

Rajasthan Institute of Engineering and Technology (RIET) – a premiere “A” graded, NBA accredited (2012-2015) Engineering And Management Institute, was established in the year 2000 through the approvals and affiliations of AICTE, New Delhi and Rajasthan Technical University, Kota. Courses offered B.Tech, M.Tech, MCA, MBA, Ph.D. in multiple streams.

ABOUT GWD

The Ground Water Department started as an independent department in the year 1956 with an objective of monitoring, exploration and management of ground water resources in the state. The Department is nodal department in the state for all kind of ground water related activities eg ground water resource evaluation, survey and investigation, drilling of deep tube wells, ground water quality monitoring, gw source development, technical assistance for artificial recharge structures, rain water harvesting structures etc. The Department is multidisciplinary in nature and has Mechanical Engineers, Civil Engineers, Hydrogeologists, Geophysicists, Chemists, Hydrometeorologists and skilled Technical staff



Gallery views of participants INC-IAH in National Seminar on Recent Approaches in Groundwater Development and Management in Arid/Semi-Arid Region of India with a focus on Rajasthan on 24th Dec. 2022, Jaipur

INC-IAH National Seminar, 24th Dec. 2022, Jaipur

Patron

Prof. Anoop Singh Poonia,
(Chairman, Rajasthan Institute of Engineering and Technology, Jaipur)

Prof. A. K. Sinha,
(President, INC-IAH, Vice Chancellor, CSMU, Navi-Mumbai)

Shri Suraj Bhan Singh
(Chief Engineer, GWD, Gov. of Raj, Jodhpur)

Convenor

Shri Amlanjyoti Kar,
(Secretary, INC-IAH, Former RD, CGWB)

Shri R. K. Mishra
(Suptd. Engr, GWD, Gov. of Raj, Jaipur)

Prof. (Dr.) Saroj Hiranwal
(Principal, Rajasthan Institute of Engineering and Technology, Jaipur)

Dr. Ashok Kumar
(Treasurer, INC-IAH, Consultant-GW Modelling, Former Advisor, Cairn, India)

Organizing Secretary

Shri Sujit Kr Sinha,
(Team leader, TSA, Atal Bhujal Yojana, Former Scientist, CGWB, EC Member, INC-IAH)

Dr. Komal
(Assistant Prof. Applied Science, RIET, Jaipur)

Ms. Shalini Tiwari
(Assistant prof. CSE Department, RIET, Jaipur)

IMPORTANT DATES

Abstract Submission - 30th Nov 2022,
Full paper Submission - 10th Dec 2022

Advisory committee

Prof. N. J. Pawar, (Vice Chancellor, D. Y. Patil University, Pune)
Dr. Sushil Gupta (Former Chairman, CGWB, Govt. OF INDIA, New Delhi)
Dr. R. C. Jain, (Former Chairman, CGWB, Govt. OF INDIA, New Delhi)
Prof. M. K. Jha, (Chair Professor, Department of Agriculture & Food Engg., IIT, Kharagpur)
Prof. Sudhir Kumar (Professor-HAG, Department of Civil Engg., MNIT, Jaipur)
Dr. A. Mukherjee (Vice-President INC-IAH, MRIU, Faridabad)
Dr. S.N. Rai (Former Scientist-G, NGRI, Hyderabad)
Shri Anand K. Agarwal (Member, CGWB, Govt. OF INDIA, New Delhi)
Prof. B.S. Chaudhary (Department of Geophysics, Kurukshetra University, Haryana)
Prof. Shashank Shekhar (Deptt. of Geology, Delhi University)
Prof. Saumitra Mukherjee (SES, JNU, New Delhi)
Er. Gunjan Saxena (Chairman, Institutions of Engineers India, Rajasthan State Centre, Jaipur)

PANELIST/KEY SPEAKER

Dr. D. V. S. Verma (Department of Civil Engg., Kurukshetra University)
Shri S. M. Kanwar (Former Chief engr., GWD, (Govt. of Rajasthan) Jaipur)
Dr. Subhash C. Singh (Former Senior Scientist, CGWB, Govt. OF India, New Delhi)
Shri Pramod Kumar Tripathy (RD, CGWB, Western Region, Jaipur)
Prof. Mahendra Choudhary (HOD Department of Civil Engg., MNIT, Jaipur)
Prof. Mahesh Kumar Jat (Department of Civil Engineering, MNIT, Jaipur)

Registration Process

Participants can register through this link:

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Registration Fee:

- 500/- (For students and research scholar)
- 1000/- (For Faculty, Industrialist)

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Mr. Jay Prakash (Asst. Prof., Department of Civil Engg., RIET, Jaipur)
Mr. Chandan Chandravanshi (RIET, Jaipur)

Thematic Tracks

Track-1:
Innovative Techniques of Groundwater Exploration and Management

Track-2:
Groundwater Recharge, Groundwater Contamination and Treatment Techniques

Track-3:
Groundwater Resources vulnerability, resilience and its sustainability

Track-4:
Groundwater Community Participation, Governance and Regulation for feasible mitigation

Track-5:
Perspective on Groundwater Development & Management in Rajasthan



Inaugural session: INC-IAH National Seminar on Recent Approaches in Groundwater Development and Management in Arid/Semi-Arid Region of India with a focus on Rajasthan on 24th Dec. 2022, Jaipur

(On dais Left to Right: Shri Sujit Sinha, (Organising Secretary) Prof Saroj Hiranwal (Principal, RIET), Prof. B. S. Chaudhary (Kurukshetra University), Shri Suraj Bhan Singh (CE, GWD), Shri Sanjay K. Yadav (Member Board of Director, JMRC), Prof Anoop Singh Poonia (Chairman, RIET), Prof A. K. Sinha (President, INC-IAH), Shri Amlanjyoti Kar (Secretary, INC-IAH), Shri S. M. Kanwar (Former CE, GWD), Shri R. K. Mishra (SE, GWD), Dr Ashok Kumar (Convenor and Treasure, INC-IAH)

Glimpses of INC-IAH National Seminar, 24th Dec. 2022, Jaipur



Inaugural address by **Prof A. K. Sinha**, President, INC-IAH in National Seminar on **Recent Approaches in Groundwater Development and Management in Arid/Semi-Arid Region of India with a focus on Rajasthan** on 24th Dec. 2022, Jaipur
(On dais left to right: Prof Saroj Hiranwal (Principal, RIET), Prof. B. S. Chaudhary (Kurukshetra University), Shri Suraj Bhan Singh (CE, GWD), Shri Sanjay K. Yadav (Member Board of Director, JMRC), Prof Anoop Singh Poonia (Chairman, RIET))



Release of abstract volume during the inaugural session of INC-IAH National Seminar on **Recent Approaches in Groundwater Development and Management in Arid/Semi-Arid Region of India with a focus on Rajasthan** on 24th Dec. 2022, Jaipur
Left to Right: Prof Saroj Hiranwal (Principal, RIET), Prof. B. S. Chaudhary (Kurukshetra University), Shri Suraj Bhan Singh (CE, GWD), Shri S. M. Kanwar (Former CE, GWD), Shri Sanjay K. Yadav (Member Board of Director, JMRC), Prof Anoop Singh Poonia (Chairman, RIET), Prof A. K. Sinha (President, INC-IAH), Shri Amlanjyoti Kar (Secretary, INC-IAH), Shri R. K. Mishra (SE, GWD)

Glimpses of INC-IAH National Seminar, 24th Dec. 2022, Jaipur



Release of e-Journal of Geohydrology of INC-IAH during the inaugural session of INC-IAH National Seminar on **Recent Approaches in Groundwater Development and Management in Arid/Semi-Arid Region of India with a focus on Rajasthan** on 24th Dec. 2022, Jaipur (On dais **Left to Right**: Shri Sujit Sinha (Organizing Secretary), Prof Saroj Hiranwal (Principal, RIET), Prof. B. S. Chaudhary (Kurukshetra University), Shri Suraj Bhan Singh (CE, GWD), Shri S. M. Kanwar (Former CE, GWD), xx (metro Rail), Prof Anoop Singh Poonia (Chairman, RIET), Prof A. K. Sinha (President, INC-IAH), Shri Amlanjyoti Kar (Secretary, INC-IAH), Shri R. K. Mishra (SE, GWD))



Panel Discussion Session: INC-IAH National Seminar on **Recent Approaches in Groundwater Development and Management in Arid/Semi-Arid Region of India with a focus on Rajasthan** on 24th Dec. 2022, Jaipur

Left to Right: Shri Pramod Kumar Tripathi (Regional Director, CGWB, Jaipur), Prof Saroj Hiranwal (Principal, RIET), Shri S. M. Kanwar (Former CE, GWD), Prof A. K. Sinha (President, INC-IAH)

Glimpses of INC-IAH National Seminar, 24th Dec. 2022, Jaipur



INC-IAH National Seminar on **Recent Approaches in Groundwater Development and Management in Arid/Semi-Arid Region of India with a focus on Rajasthan** on 24th Dec. 2022, Jaipur (*Left to Right: Shri Sujit Sinha (Organizing Secretary), Prof. B. S. Chaudhary (Kurukshetra University), Shri Suraj Bhan Singh (CE, GWD), Prof Anoop Singh Poonia (Chairman, RIET), Prof A. K. Sinha (President, INC-IAH), Shri R. K. Mishra (SE, GWD)*)



Technical Session Chaired by Prof Arunanshu Mukherjee (Vice-President, INC-IAH), Co-Chaired by Prof. B. S. Chaudhary (Kurukshetra University) and Rapporteur - Dr Ranjan Sinha (DGM, Vedanta Oil and Gas)



Technical session in progress - Dr Ranjan Sinha (DGM, Vedanta Oil and Gas) presenting paper on Oil field groundwater management in Barmer Oil fields



Group photo of Organising Committee and Other dignitaries of INC-IAH National Seminar on **Recent Approaches in Groundwater Development and Management in Arid/Semi-Arid Region of India with a focus on Rajasthan** on 24th Dec. 2022, Jaipur

INC-IAH National Seminar “Recent Approaches in Groundwater Development and Management in Arid/Semi-Arid Region of India with a focus on Rajasthan”

24th Dec. 2022, Jaipur

List of Papers

	Presenter	Title of Papers
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	Chair: Prof Arunanshu Mukherjee, MIRU, Faridabad	
	Co-Chair: Prof B. S. Chaudhary, Department of Geophysics, Kurukshetra university, Kurukshetra	
SN	Rapporteur: Dr Ranjan Sinha, DGM, Cairn Oil and Gas, Vedanta Ltd.	
1	Shri. Amlanjyoti Kar Secretary, INC-IAH, Former RD, CGWB)	Conservation of Subterranean flow in solving the acute drinking water crisis in Andaman and Nicobar Islands and its wider Applicability: Examples from the Equatorial Islands and Semiarid Purulia district: West Bengal
2	Dr. Subhash C. Singh Former Sr. Scientist, CGWB, Govt of India, New Delhi	Delineation of flowing ground water channel using Electrical Tomography in Limestone Terrain of Bundelkhand, India
3	Ms. Pallabita Ghosh Cairn Oil and Gas, Vedanta Ltd.	Advance scientific monitoring of groundwater: A case study of Western Rajasthan
4	Prof. M. Rai Singhani Ex-director, MNIT Jaipur	Recent Trends in Ground water Development
5	Sushil Kumar Dept of Geophysics, Kurukshetra University, Kurukshetra	Geophysical and hydrological Investigations for Saraswati River paleochannel in Kurukshetra District
6	R K Mishra Suptd. Engr, GWD, Rajasthan	Overview of Groundwater of Rajasthan
Technical Session II		
	Chair: Shri Pramod Kumar Tripathi (Regional Director, CGWB, Jaipur)	
	Co-Chair: Dr Amlanjyoti Kar, Former Director, CGWB, Consultant ADB	
	Rapporteur: Dr Komal, RIET	
7	Shri Ranjan Sinha, DGM (Subsurface), Cairn oil and gas, Vedanta Ltd.	Hydrogeological Study for well design in the largest offshore oilfield of Barmer basin in India
8	Prof. (Dr.) B.S. Chaudhary Department of Geophysics, Kurukshetra university, Kurukshetra	Geospatial technology for Sustainable water Resources Management: Indian Perspective
9	Prof Arunanshu Mukherjee, MRIU, Faridabad	Sustainability of ground water in Barmer, Rajasthan
10	Dr. K.P.Singh, CGWB, Jaipur	High Resolution Aquifer mapping through Heliborne Electromagnetic Surveys in Arid Regions of North Western India
11	Chunduri Satyanarayana Rural electrification corporation, Hyderabad	Source of high Fluoride concentration in groundwater in different rock formations of Rajasthan State
12	Akash Deep, Research Scholar, Kurukshetra University	Monitoring of Spatio-temporal changes in GW Quality and depth through GIS in Kurukshetra District, Haryana
13	Devesh Lawania, RIET Jaipur	Perspective on groundwater development and management in Rajasthan
14	Bhavya Katiwal, RIET Jaipur	Lake Rejuvenation in Peri-urban areas: A case study of Udayapura lake in Bangalore, Karnataka



INC-IAH NATIONAL SEMINAR 2022

**on "Recent approaches in Groundwater Development & Management
in Semi/Arid region of India with a focus on Rajasthan"**

IN ASSOCIATION WITH

**Indian National Chapter of International Association of Hydrogeologists (INC-IAH)
Rajasthan Institute of Engineering & Technology (RIET), Jaipur
Ground Water Department, Govt. of Rajasthan**



**Venue : Rajasthan Institute of Engineering and Technology,
Jaipur Bhankrota**

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108th INDIAN SCIENCE CONGRESS

"INC-IAH Session"

(Indian National Chapter of
International Association of Hydrogeologists)



EARTH SYSTEM SCIENCE SECTION



January 3-7, 2023 at R.T.M. Nagpur University,
Nagpur, Maharashtra

Special Session of INC-IAH in 108th Indian National Science Congress (January 4, 2023, Nagpur)

The 108th Indian Science Congress has scheduled for the first time a special session for INC-IAH on January 4, 2023, at R.T.M. Nagpur University in Nagpur, Maharashtra, India. This special session was under the "Earth System Science Session - II" of the ISC, and the session was held on the second day of congress. The session is chaired by the sectional president, Prof. Atul Kumar Varma, Professor (HAG), Department of Applied Geology, Indian Institute of Technology (IIT) Dhanbad, and co-chaired by Prof. A. K. Sinha, President, INC of IAH, Vice-Chancellor, Chhatrapati Shivaji University, Navi Mumbai. Eleven scientists and researchers from the CGWB and Central and State Universities presented their findings on various aspects of groundwater, including groundwater modeling, groundwater quality assessment, and resource management. The key speaker of this special session was Prof. A. K. Sinha, and the session ended with an address by Prof. Atul Kumar Varma. This is one of INC-IAH's remarkable accomplishments in obtaining approval for the special session and managing the events in such a short period of time.



Special Session of INC-IAH in 108th Indian Science Congress in progress

108th Indian National Science Congress, Nagpur (3rd - 7th Jan 2023)

INC-IAH Special Session on Groundwater (4th Jan 2023)

(Earth System Science Section)
at R.T.M. Nagpur University, Nagpur, Maharashtra, India

List of Participants

Sr. No.	Name of Participant	Organization / Affiliation	Title of Presentation
1	Prof (Dr.) A. K. Sinha	President INC-IAH & Vice-Chancellor, Chhatrapati Shivaji Maharaj University, Navi Mumbai (Maharashtra) 410206	Sustaining Groundwater Resources through Community Empowerment and Ethical practices.
2	Pradeep Kumar Parchure	Member (Retd.), CGWB and Advisor (GW), Anacon Laboratories Pvt. Ltd., Nagpur	Using FloPy for ground water modelling
3	Dr. Subhash Singh	Former Scientist, CGWB. Present-Member Wetland Authority, Govt of MP and Consultant Ataljal, Govt of MP	The Unseen River Saraswati at Prayag is a Myth or Flowing Groundwater
4	D. Venkateshwaran,	Scientist-D (Retd), CGWB	Ground Modelling Studies for Estimation of Canal Seepage in the Command Area of Pench Irrigation Project, Nagpur District, Maharashtra
5	Dr. Umesh Balpande	National Program Management Unit, Atal Bhujal Yojana, New Delhi,	"Atal Bhujal Yojana – An initiative towards Community led Sustainable Groundwater Management"
6	Dr. Shilpi Gupta	Scientist-C, Central Ground Water Authority, New Delhi,	Groundwater quality evaluation using water quality index (WQI), GIS and multivariate statistical technique in National Capital Region, Delhi, India
7	Priti D Raut	Scientist C, Central Ground Water Board, Nagpur, 440001, India	Ground Water Management Studies In Chikhli Block, Buldhana District, Maharashtra
8	Dr. Bhavana Umrikar	Savitribai Phule Pune University, Pune	Monitoring The Spatio-Temporal Changes in Groundwater Resources Of Maharashtra State Using Grace Satellite Data
9	Dr. Ajaykumar Kadam	Kavayitri Bahinabai Chaudhari North Maharashtra University, Jalgaon	Delineation of Groundwater Recharge potential Zones using Integrated Fuzzy-AHP methods: A hydro-spatial modelling-based approach
10	Mr. Bhavesh Patil	Kavayitri Bahinabai Chaudhari North Maharashtra University, Jalgaon	Impact Of Climate Change On Groundwater: An Overview
11	Mr. Amit V Shirke	Savitribai Phule Pune University, Pune	Mapping of Landslide susceptible zones in and around Patan taluka, Satara district, India, using groundwater floatation implication approach
12	Dr. Siddharam. S. Hangaragi	Karnatka geographical Association, Bagakot.	Behavioural changes of groundwater resources in Karnataka state: spatial approach by using geostatistical methods
13	Dr. Y. A. Murkute	Sr Asstt Professor, RTM Nagpur University, Nagpur	Hydrogeochemical characteristics and suitability of groundwater.
14	B. S. Manjare	Asstt Professor, RTM Nagpur University, Nagpur	Groundwater potential zones identification for soil and water



Special Session of INC-IAH in 108th Indian National Science Congress: Keynote address by Prof A K Sinha, President INC-IAH highlighting role of Indian National Chapter of IAH



Special Session of INC-IAH in 108th Indian National Science Congress: Felicitation of Prof Kirtikumar Randive, (RTM Nagpur University) co-chairman of the session by Prof A K Sinha (President INC-IAH) and Shri P.K. Parchure (Former Regional Director, CGWB)



Special Session of INC-IAH INSC: Shri P.K. Parchure (Former Regional Director, CGWB) presenting paper on use FloPy for groundwater modelling



Special Session of INC-IAH in INSC: Dr. Ajaykumar Kadam (EC member, INC-IAH) presenting paper A hydro-spatial modelling-based approach



Special Session of INC-IAH in INSC: Felicitation of Prof. A K Sinha (President, INC-IAH), Co-chair of the session by Dr Ajaykumar Kadam



Special Session of INC-IAH in INSC: Felicitation of Shri Subhash C. Singh (Former Scientist, CGWB) by Prof Kirtikumar Randive



Special Session of INC-IAH in INSC: Felicitation of D. Venkateshwaran (Scientist, CGWB) by Dr Bhavesh Patil



Special Session of INC-IAH in INSC: Felicitation of Prof Samant Co-chair of session by Dr Amit Shirke



Special Session of INC-IAH in INSC: Dr. Amit Shirke presenting paper on topic Landslide Susceptible using groundwater fluctuation implication approach



Special Session of INC-IAH in INSC: Felicitation of Dr. Gaikwad by Shri Subhash C. Singh (Former Scientist, CGWB)

CGWB organises one day workshop on “Success Stories of NAQUIM Studies and PMKSY-HKGP-GW schemes in North-East and East India” in Guwahati, 24th Jan 2023

The North Eastern Region, Guwahati in association with the Eastern Region, Kolkata, Central Ground Water Board (CGWB), Department of Water Resources, River Development & Ganga Rejuvenation, Ministry of Jal Shakti, Govt of India organized a one Day Workshop on, ‘Success Stories of NAQUIM Studies and PMKSY-HKGP-GW Schemes in North East and East India’ in Guwahati, Assam



Speakers and Panelist: On dais left to right [Dr S. V. Vijay Kumar](#) (Scientist-G & Head NIH, Guwahati), [Mr Amlanjyoti Kar](#) (Former RD, CGWB and Secretary, INC-IAH), [Mr. L. Angu](#) (Chief Engineer, WRD, Arunachal Pradesh), [Dr. P. Nandakumaran](#) (Former Chairman, CGWB), [Mr. Sourabh Gupta](#) (RD,RGI, CGWB, Raipur), [Dr. Subhas Chandra](#), Scientist (NGRI), [Dr. Pradip K. Bora](#) (Director, NERIWALAM, MoJS, Govt. of India, Tezpur, Assam), [Mr. Siladitya Sengupta](#) (DDG, GSI, Guwahati)



Panel Discussion Session: [Mr Amlanjyoti Kar](#) (Former RD, CGWB and Secretary, INC-IAH) deliberating on Role of Geology and Hydrology on sustainability of springs in NE States. On dais left to right: [Dr. P. Nandakumaran](#) – Co-Chairman (Former Chairman, CGWB), [Shri Anand K. Agarwal](#) – Session Chairman (Member, CGWB), [Dr. Raja Ram Purohit](#), (Scientist, CGWB, Agartala) and [Dr I. Ray](#) (Scientist, CGWB, Kolkaata)



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Cultural qualities and Heritage viewpoints on water sustainability and future trend

Human history and the evolution of culturally diverse understandings and lifestyles mirror in numerous ways our communications with, need for, and use of water. Because culture is learned, survived, and uttered in wider social relationships, it is a noteworthy dimension in the factors that contour both conflict and harmony in understanding, respecting, using, and managing water. Everything is culturally intermediated, in entire societies. Economic activities; politics; the way we think about and interact with the material environment. And every social group and every actor in society has a cultural engagement with water. Some of this human/water engagement is manifested in the form of water culture: the knowledge, traditional customs, and behaviour that support the development of societies to manage and preserve water resources. The following factors are to be fortified to recognize and cherish the diverse roles played by cultural principles, knowledge, and traditional resource management systems in protecting water quality, regulating access, and ensuring sustainable use of freshwater resources. Further, to identify and address the challenges that local communities confront as large-scale solutions to energy and water scarcity are proposed and executed and to develop and implement the legal framework and social safeguard mechanisms to protect fundamental rights to water, livelihoods, and culturally diverse ways of life. A right understanding of the interrelation of water and cultural perspectives would help in developing insights and thoughts about the implications of water. The study will help to bridge the variety of disciplines, policy, and public perspectives exemplified by case studies and will also facilitate connecting decision-makers with experts such as archaeologists, historians, geographers, ecologists, and landscape architects.

Keywords: Water, history, culture, religion, sustainability

1.0 Introduction

Water has two forms namely celestial and terrestrial (Rig Veda) and both are having the same destination, and that is the vast ocean. Water is the mother of Agni and is, therefore, the producer of fire. Like Rig Vedic prophets, modern science has not solved the mystery about how water came to possess from which the life has manifested. Before the creation of the universe, there was said to be nothing but the bottomless, uninterrupted, and immeasurable water. Water plays a key role in the form of rain to sustain life on earth. Water performs as a source of inspiration for many centuries in most cultures. People have adopted deeply rooted spiritual and religious values and beliefs that bind them and support them in living the way they do, which influence water management. Despite historical water wisdom, many societies are yet to bridge the wise water management. Recently, religious and spiritual leaders are emphasizing protecting the natural resources of mother earth. Parjanya or clouds make happen water downpour (Rig Veda). Parjanya means the clouds causing the downpour of rains. This cloud is called a large pot full of water, which is known as 'driti'. Being great medicine, water helps to protect from diseases and facilitates maintaining the health, strength, long-life, wealth, and immortality of human beings. The world prays for its favours. The world moves with the pure and simple movement of the water. It wash-downs the impurities and also cleanses the inconsistencies in the behaviour of humans. The sustainability of the landscape quality may only be assured by promise of all actors involved like farmers, nature and water managers, recreation entrepreneurs, spatial planners for which a complete economic base is a must for any sustainable future (Vos W. et al, 1999). Locally dishonoured provisioning and regulating facilities may be replaced by the socio-economic means like drinking water from a polluted well can be replaced by bottled water), but the cultural values of an ecosystem or a landscape are irreplaceable. Therefore, a current global analysis has stressed that, although societies become less dependent on provisioning and regulating services in the course of a country's economic development, their dependency on cultural services increases (Guo et al., 2010).

The people have shaped immeasurably rich and diverse, frequently interconnected systems over the millions of years to manage water in low lying lands, hilly areas, wetlands and deserts followed by the agricultural landscapes, urban networks, and on urban waterfronts. At present, those systems are termed as heritage that broadly incorporates both the documented World Heritage Sites (WHS) along with the historical buildings that people have selected to preserve. These heritage structures/ sites/building are still functional, which may be of dimension from resourceful small-scale water harvesting systems and aqueducts to bigger water pumping infrastructures, irrigation and drainage systems, defense systems and dike structures (Steenhuis 2015; Labanca Correa de Araujo 2015). These also include canals, harbors, waterfronts and maritime cultural landscapes, (Daly 2015; Hein 2011; Meyer 1999) having contribution towards portraying local knowledge, skills and regional traditions in water engineering in historical past (Sugiura et al. 2015; Scarborough 2003).

At present, the phenomenon like worldwide climate change and pollution along with the change in political dynamics and societal configurations have manifolds impact equally on both the water and associated heritage perspectives. these include systems for drinking water, irrigation, and drainage as well as the heritage of coastal areas, deltas, and port cities (Lieske et al. 2015; Okamura 2015; Comer 2015). Recurrent rise Sea level poses challenge before the Pacific archipelagos (Peterson 2015) in addition to the coastal plains and main port cities situated in the southern and eastern (SE) portions of the United States of America. Further, the rivers frequently getting flooded are having devastating impact on the urban areas of the low-lying countries around the world. On the contrary, the natural

calamities like droughts and desertification have enormous impact on degradation of land in rest parts of the globe posing challenge before the living pattern of many people. Climate-change is responsible for other burning challenges like famines and migration of people, which in turn adversely influence the thinking process of age-old association of water with culture and our related heritage issues. The factors like environmental, cultural, political, economic and spatial frameworks have also play a key role in the interrelation of water and heritage structures in combination with globalization and privatization of water and heritage assemblies. Moreover, the havoc caused by the plastic waste pollution of canals, rivers, and seas have strong bearing on the nature, people, and heritage structures especially in relation to the new forms of inquiry vis-a vis design components. Huge areas belonging to ports, harbours and petroleum installations are one of the examples of prospective forthcoming water-oriented heritage sites.

History and heritage have a key role to play for designing the new relationships with water. Water-oriented heritage structures conserves and communicates ancient history of best practices and catastrophic occasions and also portrays the pretty old histories of water management systems and defends the cultural reminiscence of India for future generation (Hein et al 2019). Fresh research towards the history of water and related heritage can help to yield various source of facts, encouragement and landmarks in water management, wetland based recreation and marine engineering. The recycle, reuse, alteration, or redesign of old water safeguarding systems can contribute towards enhancement of the living standards of communities and to their sense of place and belongingness. More broadly, the understanding of tangible and intangible heritage would be accomplished through proper understanding and analysis of the relationship in between water and heritage components.

Generally, the holy places are situated on the banks of rivers, coasts, seashores, mountains, and valley areas. The sacred rivers are believed to be a great equalizer. In 2001 the General Conference of UNESCO adopted the Convention on the Protection of the Underwater Cultural Heritage (UNESCO, 2001a). Majuli Island is the threatened hydrogeo-cultural heritage of Assam, which is often highlighted as the 'Cultural Capital' of the state (Bharasa P. et al, 2020). Tanks perform as an indispensable part of every large Hindu temple. A good-sized water tank is available in every village/town/city temple. Conventional beliefs indicate that the water of tank/ pond located in the sacred places have cleansing properties. To take a holy dip in the temple tank/ pond before offering prayers to the deities is therefore purifying oneself. In reality, the tanks function as a valuable reservoir to help communities tide over the scarcity of water.

The availability of water is mostly dependent on the monsoons in our country. In case the monsoon rains flop, people can depend on these temple ponds/ tanks to fulfil their water requirements. At present, the tanks are generally found in a state of abandonment. The ponds and dug wells are either dried up or ill-maintained with wastes, which leads to water contamination of both phreatic as well as deeper aquifer systems.

2.0 Collected works appraisal

The literature review includes all Vedas like Rig Veda, Sam Veda, Yajur Veda, and Atharva Veda in addition to Upanishads, Manu, and epics namely Ramayana and Mahabharata. Detailed analysis of accessible information on the role of water, its use, and significance during the then civilization depicts an ample understanding of the interrelation of water heritage and cultural perspectives in the context of India. Water was an amazing and ubiquitous element in Rig Veda. Apart from Rig Veda, the societies existing even before it in the ancient world practiced spiritual worship of water.

The world is therefore spoken of as having been originally water without light (Salilam apraketam; Rig Veda X.29.3). The water is contained in an egg from which everything else emanated (Rig Veda. X.82.5). Apah or Apas or the God of water comes from the Vedic Sanskrit term Ap (ap) for "Water." It turns into Ab - the Persian word for water. In Rig Veda, the god Apas is somewhere described as a mother, somewhere as a woman, and somewhere as the Master Lord. He blesses those who follow the gods and conduct 'yagyas'. Indra, the bearer of 'Vajra', had created a path for Water and he never diverts from that path. Indra is called the "liberator of waters" (Rig Veda). The Rishis tried to establish a relationship between Indra, Parjanya, and Marudagan and believe that rainfall is possible only when the three come together. "A man who gives water obtains complete satisfaction in life" (Manu 4-229). As per the Chandogya Upanishad, the soul and the body are like salt and water (Upanishad volume 6.13).

The ancient Greeks had various ideas on the hydrologic cycle. According to Thales of Miletus during the late 6th to early 5th century BC), the streams and rivers emerged from underground. Greek Philosophers like Plato and Anaxagoras of Clazomenae (500–428 BC) believed that the earth would be full of watery caverns that provided springs for rivers as well as rainfall. The interlinking of groundwater and cultural perspectives remain at risk in many parts of the world not just from the natural course of decay of the fabric, but also due to looting, often despite localized attempts to protect such sites (Blake 1996; O'Keefe 1996). The convention for the protection of Underwater Cultural Heritage (UCH) was enacted by UNESCO in 2001.

3.0 Materials and Methods

The article aims to assess and establish the interrelations of water, cultural aspects and heritage perspectives through literature review, analysis of historical scenarios, and detailed study on the related parameters followed by compilation of information/facts from the published reports / papers in the context world scenario with an emphasis of Indian panorama.

4.0 Interrelations of water and Cultural aspects

The discovery of Harappa, and thereafter, Mohenjo-Daro civilization, was the culmination of work beginning in 1861. Excavations of Harappan sites have been on-going from 1920 onwards, with important breakthroughs occurring as recently as 1999. Until 1999, over 1,056 cities and settlements had been found, of which 96 have been excavated, mainly in the general region of the Indus and Ghaggar-Hakra Rivers and their tributaries.

Hygiene and sanitation were given the paramount importance during Indus Valley Civilization. This was the world's first sanitation system. Sewerage through underground drains and well-organized water management with many reservoirs and wells were scientifically managed. Mohenjo-Daro had over 700 wells, which were generally within 15 meter depth built with trapezoid bricks. Each house had a common well for their water usage and had its own separate bath. The entire city was served by extensive system of drainage.

The climate change poses the greatest long-term threat to important sea and water elements, including the World Heritage. The growth of water infrastructure is narrowly linked to human progress. In the 4th World Water Development (WDD) Report of the United Nations (2012b; see also Kelleher, 2010), water is explained as "Ethical, Social and Cultural drivers are at the heart of the human family's interaction with the natural environment.

5.0 Interrelations of water, religion and culture

Indigenous people honour and respect water as sacred and sustaining all life. Their traditional knowledge, laws and ways of life teach them to be responsible in caring for this sacred gift that connects all life.

Sl. No.	Religion	Interrelations of water, religions and rituals heritage
1.	Hinduism	To Hindu people, all water is sacred, especially rivers. Hindu belief holds that bathing in the river causes the forgiveness of sins and likewise that immersion of the ashes of the dead in the Ganges will send the departed soul to heaven. The water fetches life as trees, flowers bloom and crops grow. This cycle of life is seen as a symbol of Hinduism. The widespread aspiration of Hindus lends itself to a reverence for water as well as the integration of water into most Hindu rituals, as it is believed that water has spiritually cleansing powers.
2.	Buddhism	For Buddhists, water is said to symbolize purity, clarity, and serenity. It is vital for Buddhists to live in coordination with the environment.
3.	Judaism	Water plays a significant role in ritual cleansing practices. Already two thousand years ago, before the environment became a worldwide human concern, Judaism had spoken about local environmental subjects. According to the Talmud perspective on the environment "We may use the world for our own needs; we may never irresponsibly damage or destroy the environment".
4.	Christianity	Water in Christianity is mainly linked with baptism. Environmental stewardship, or the concern to take worthy care of resources, including water, is a predominant and important part of Christianity.
5.	Islam	Water is considered life and a gift from God; as such water should not be sold or bought. There is also an embargo on the monopolization, leakage and contamination of water. Islam is also acquainted with the perception of environmental stewardship. There is a saying about water "Allah sent down from the Heavens and brought with it life to Earth after being dead and gave life in it to every kind of land animal, and in directing the winds; and in the clouds that are enslaved between the Heavens and the Earth" (Quran 2.164).
6.	Taoism	According to the Taoist philosophy "Be still like a mountain and flow like a great river", where water seems as the heart of nature and a model for human behaviour.
7.	Baha'i	Baha'i view on water management mirrors the Baha'is idea of unison between all people and the interconnectedness of all things.

The measure of life is expressed by water and Hindus hold the rivers in marked respect. India not only values resources nature has offered to her, but also loves them for their manifold accomplishment they carry in their wake. The rivers in India are generally considered as female divinities, food and life bestowing mothers. Seven sacred rivers of India are worshiped namely Ganges, Yamuna, Godavari, Saraswati, Narmada, Sindhu, and Kaveri. Among these, the noteworthy river is the Ganges. The sacred water of Ganga is used in pooja (worship) and also a sip is given to the dying person. There is a saying that those who bathed in Ganges and those who leave some part of themselves (like hair, piece of bone, etc.) on the bank will attain Swarga (paradise) of the God Indira. The river is stated as the Goddess and is believed to flow from the toe of Lord Vishnu to be spread around the world through the matted hair of the god Lord Siva.

According to myths, the Ganga flowed from the heavens and purified the people of India. The main sacred places, situated on the Ganga are Varanasi, Haridwar and Prayag and these places are treated as the holy places of India, as these are situated in the bank of the holy river. River Ganga holds pronounced importance in the economic, social and cultural life of the Indian people in general, and Hindus in particular. People love to give the name of Ganga to their children. One can find millions of people in India with the name of Ganga and this denotes the love, warmth and link of people with river.

The biggest crowd of people in the world assembles at the Kumbh Mela, which is a divine pilgrimage celebrated every three years in one of four sacred cities of India that includes Allahabad, Ujjain, Nasik and Haridwar. Millions of Hindus travel to this Mela to take holy bath in the sacred River the Ganga, having a faith that their sins will be washed away and they will attain salvation.

Gangasagar mela in West Bengal coast is the biggest pilgrimage of eastern India and famous as the second biggest pilgrimage gatherings in the world. Millions of pilgrims from all over the world assemble in this mela to take a holy dip in the occasion of Makar Sankranti (14th January). Chhath puja, an ancient Vedic festival is celebrated on the banks of rivers and ponds to extend prayers to Lord Surya in the states of Bihar, Jharkhand, Uttar Pradesh and the Madesh region of Nepal. Further, innumerable tourist spots, parks, sanctuaries and resorts have been developed based on sea and rivers, which are important tourist destinations across the world.

6.0 Present water scenario and cultural issues in India

The man was in need to manage water to find protection from its dearth in future and the need for that is ever increasing. In forthcoming decades, the impact of climate change is expected to intensify the floods and droughts, sea level rise, river bank erosion, pollution, increased frequency and degree of disasters. Consequently, the groundwater resources would be adversely affected in terms of quantity as well as quality. Societies around the world are to face challenge to adapt these threats to ensure the water security, economic prosperity followed by environmental and cultural sustainability.

The Green Revolution in India was commenced in the year 1960s marking a changeover from traditional agriculture to introduction of high-yielding varieties of seeds. On account of that the demand for water including groundwater has amplified to a significant extent. India is one of the world's largest food producers, making the sustainability of its agricultural system of global importance. Groundwater irrigation supports India's agriculture and is currently enhancing crop production by sufficient to feed 170 million people.

In India, the changing patterns of weather and rainfall, past policies associated with conventional methods in water storage mechanism, and a frequently developed dry basin have forced the central and state governments to be engaged more in conserving water. Further, more inclinations have been developed in looking at ways to adapt ancient and traditional water conservation techniques that are simple, reliable, and environment friendly.

In Indian culture, water is associated with every social aspect of life. Divine water is consumed in temple after puja (worship) rituals, idols of worship are sprinkled with water (abhishekam), and a fresh leaf kept for a meal is

cleaned with water for prayer. Many other rituals also highlight the significance of water in Indian culture. The Holy River Ganges is mythologically interconnected to Lord Shiva as the fountain that flows through the Himalayan terrain, reaching first Haridwar and then Benaras. People from pan-India throng for a dip in the holy river to wash away their sins. The Holy River Ganges is considered as symbol of Hindu to accord the purification of soul and rejuvenation of mind. Other rivers, such as the Brahmaputra, Indus, Godavari, Krishna, Narmada, Cauveri, and Mahanadi, are also symbolic places in Indian culture with flourishing agriculture and plantations on their shores. The river Cauvery is connected closely to the culture, tradition, and history of state of Tamilnadu. The Aadi Perukku festival (Adi means a Tamil month, Perukku means swelling) is celebrated in mid-July when the river is in full flow. The Mettur Dam is built across the river, storing water to release for cultivation of wetlands. The water level touches the maximum height of the dam during the festival and then the water is released to help the farmers for their cultivation and irrigation. During the festival, people assemble around the dam and its surroundings to offer pujas (prayers) to River Cauvery, the mother. The weapons adorning the temple gods are cleaned by water on the eighteenth day of the month Aadi to remember the eighteen long days of battle between Pandavas and Gauravs, mythological characters of the epic, Mahabharatha. During the second century AD, the Kallanai dam near Tiruchirappalli was built with stones by Karikalan (a king of the Chola dynasty). All rivers including the Cauvery are worshipped as a mother, because river water sustains life for agriculture, which provides main source of revenue to the farmers as well as the government.

7.0 Conclusions

Water forms an integral part of life. As 71% of earth is covered by water, the planet earth is called 'Blue Planet'. Moreover, 60% of our body is containing water. Hence, the survival of life forms without water is beyond imagination. With the advent of human civilization, the necessity of water has been augmented in an accelerated rate. Especially, in our country water has become an inseparable part of civilization includes religions, rituals, festivals, architectures and cultures. Application of water in irrigation sector is an age-old practice. Over the time water has played a crucial role in human belief systems. The history of water conservation through various indigenous mechanisms is cited in different Vedas. Since the beginning of civilisation, Indians especially have made close relationship with water, not only for the sake of existence, but also to make water as part and parcel of their religions, cultures, spiritual developments and aesthetical aspects.

Water plays a key role for human existence and overall development of our society. The young generation should know and respect our country's water tradition, related cultures and efforts put behind the construction of marvelous water-oriented structures/ installations. To encourage the young fraternity, water literacy needs to be expanded across the India, which would help to provide justice towards the efforts made by our ancestors for water conservation and the then innovative water management endeavours. In India, water is basically dependent on the monsoons. In case the rains fail, people can depend on these temple tanks to fulfil their basic water needs. Now-a-days, the dug wells and tanks are generally found in a state of neglect. At present, these water storage structures are either dried up or poorly maintained, which in turn may lead to the water contamination. Water has led to the development and generation of significant material culture in the form of items, technology and places. Motivation of human endeavour has been influenced in many ways towards storage, harnessing and conservation of water. It has also been the catalyst for development of significant cultural practices, which have generated intangible cultural heritage values. Water has inspired poetry, literature, artistic endeavour such as painting, dance and sculpture. It has informed and

signify the relationship of humanity with water and can be replicated the cultural heritage. It is invaluable to understand the importance and value of the heritage and historical journey of mankind for water, which represents the importance of water management for the protection of the cultural water heritage in India. Future innovative research in this line would be beneficial in evolving the insights and concepts about water heritage and related cultural aspects.

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Sites selection for managing aquifer recharge in hard rock terrain

Variety of hard rock such as granites, granulites, basalts etc occupy almost two third territorial areas of India. The most prominent among them is basaltic rocks of Deccan traps which occupy almost half a million square kilometers surface areas spread over in parts of Maharashtra, Madhya Pradesh, Gujarat, Rajasthan and Telangana. Similarly, most parts of the Telangana state, Andhra Pradesh, Karnataka, Tamil Nadu and Kerala are occupied by granites and granitic gneisses of Archaen age. In these regions hard rocks are covered by soil and weathered formations of varying thicknesses. Hard rocks are rendered permeable to allow movement and storage of groundwater in limited quantity in secondary porosity in the form of fractures, faults and joints and primary porosity in weathered formation and intertrapeans. Thus, a two-tier set up of aquifer system comprised of weathered rock at shallower depths and fractured/faulted units at deeper levels prevails over the most part of these hard rock terrain. In case of Deccan traps, intertrapeans sandwiched between two layers of lavas flows at deeper level below are a major source of groundwater. Precipitation is the main source of groundwater recharging. The weathered zone is the main source of groundwater availability in dug wells which were traditionally used for water supply almost before three decades. But because of withdrawal of groundwater to meet the ever-increasing demand of water supply mostly for irrigation and domestic uses in excess to its recharging, the weathered zones remain almost dry except during short period of rainy season. Thus, the only possibility of groundwater availability lies in geological structures (fractures, faults, joints) within hard rock units at deeper levels. If geological formations/ structures are saturated with groundwater, a noticeable contrast between the water saturated geological formation/structures (and their dry counterparts would be observed. The former will be characterized with appreciably lower resistivity ($< 40 \text{ ohm-m}$) than that of the later one ($> 70 \text{ ohm-m}$). Because of this fact, geophysical resistivity method is found to be most suitable method among all geophysical methods (gravity, magnetic, seismic etc) in delineation of not only groundwater resources but suitable sites for managing aquifer recharge by diverting surface water below the ground surface. Sources of surface water can be nearby reservoir or run off during rainy season. A suitable site for managing groundwater recharge should be hydraulically connected to the deeper aquifers and should be either exposed to the ground surface or extended near to the ground surface within the depth range of traditional recharging structures such as large diameter dug wells and ponds. Such sites in hard rock terrains are of finite areal extent and are sporadically distributed. Therefore, delineation of their exact locations poses a challenging task. The following sections present some case studies to demonstrate the efficacy of 2-D electrical resistivity tomography (ERT) in delineation of suitable sites for the development of recharging structures.

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Case 1

This site is falling within the administrative unit of Raulgaon which is located in Deccan traps occupied area of Kalmeshwar Taluk in Nagpur district of draught prone Vidarbha region. 2D resistivity model of ERT survey is presented in figure1. This model shows the presence of a groundwater saturated zone (characterized with less than 40-ohm m) below a layer impervious lava flow (>100-ohm m). This layer of lava flow is divided in to two units by a fracture which connects the water saturated aquifer with the weathered formation overlying the layer of lava flow. This fracture lies between 320 m to 330 m measured from the left end of the model. The distance is marked on top of the model by vertical lines placed at 10m spacing. Index of the resistivity values are given at the bottom of the models. Geographical coordinates of the centre are also given on right side below the model. Direction of the profile is in west to east marked by W-E. This model suggests the suitable sites for construction of a dug well between 320 m to 330m to manage the aquifer recharge.

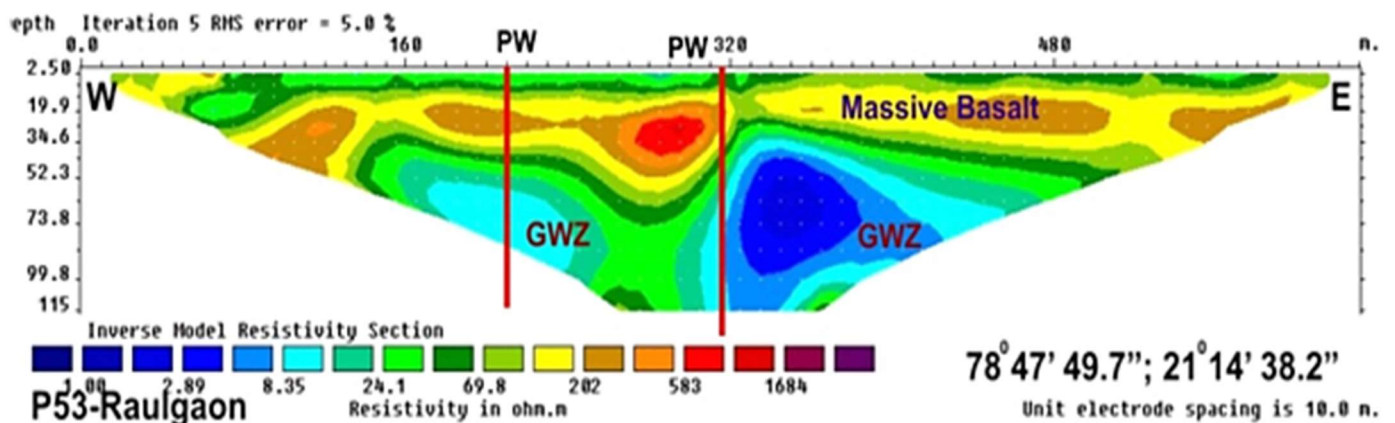


Figure 1. 2-D resistivity model showing different geological formations

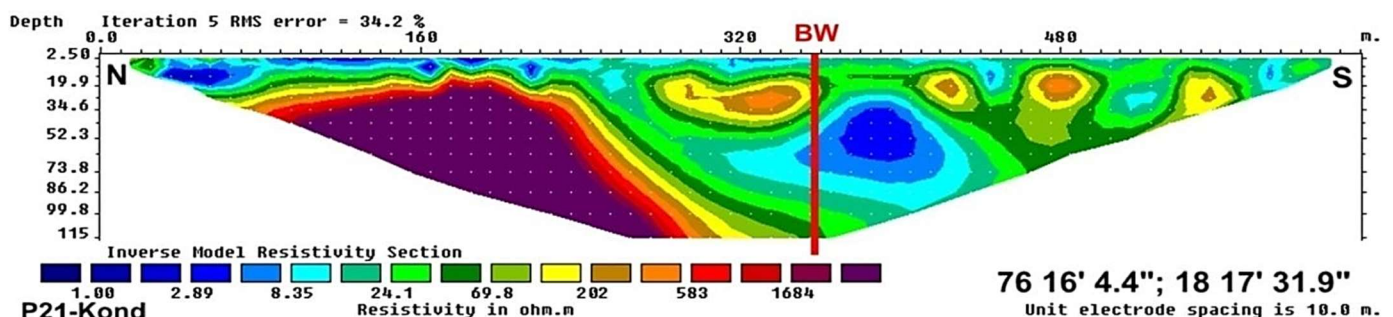
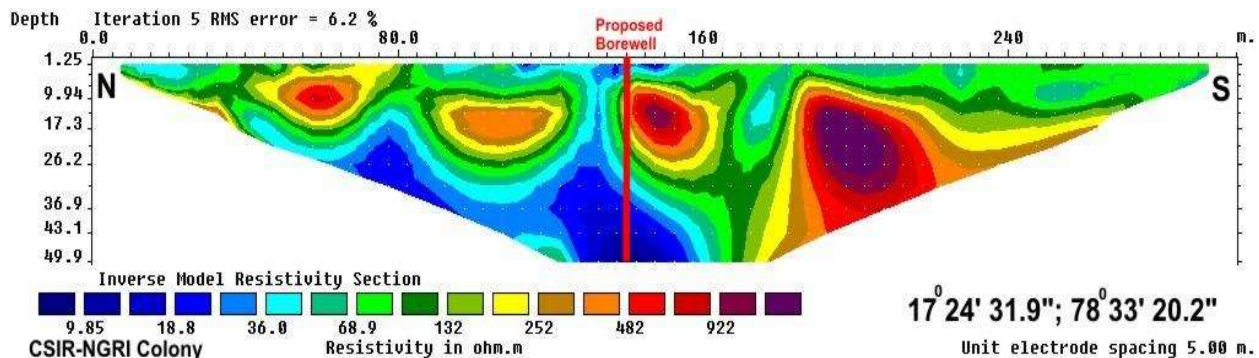


Figure 2: 2-D resistivity model showing different geological formation.

Case 2:

This site is falling within the Deccan traps covered Tawarja basin located in Latur district of draught prone Marathwada region. The 2-D resistivity model is shown in figure 2. This model shows a unit of water saturated aquifer at varying depth characterized with less than 40 ohm-m resistivity value. This aquifer unit is extended downwards further beyond 115m between 360 m and 440. This unit is connected to the ground surface between 360 m to 400m. In this case the suitable sites for the development of regarding structure would be 360m to 400 m.



Case 3

This site is located in the campus of CSIR-National Geophysical Research Institute at Hyderabad. The host rock is granite which is covered by weathered formation of varying thickness. The 2-D resistivity model of the site is shown in figure 3. This model shows the presence of an aquifer unit (<50 ohm-m) below the three units of granite. The aquifer adjuncts to another unit of massive granite at 180 m distance. The aquifer is connected to the ground surface through a fracture zone which is exposed to the ground surface between 170 m to 180 m. In this case the suitable sites for development of a recharging infrastructure would be between 170 to 180 m. These examples of case studies show the efficacy of electrical resistivity tomography for selection of sites suitable for managing aquifer recharge in complex geohydrological environ of hard rocks.

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Source of high fluoride concentration in groundwater in three major geographical parts of Gujarat state, India

Abstract

In Gujarat mainland, large alluvial tract extends from Banaskanta in north to Surat and Valsad in the south. High fluoride concentration observed in north Gujarat covering Mehsana, Banaskanta, Patan and Sabarkanta districts. Alluvial deposits of north Gujarat are deposited by river transport. These rivers Luni, Mahi and Sabarmathi originate from Aravalli mountains and some of the rock formations of these hills consists of fluoride bearing minerals.

In south Gujarat except in few pockets of Bharuch and Vadodara districts, in other districts like Surat, Valsad, Narmada, Navsari and The Dangs, the fluoride concentration in groundwater is within permissible limits. In Saurashtra region, the areas, upstream of volcanic dykes, in Basalt aquifers, high fluoride concentration in groundwater observed. In south of Saurashtra, near Unai region hot springs exists. In these springs, high fluoride in groundwater reported. In Kachchh district, high fluoride in groundwater observed in Bhuj taluk and in Mundra region in three villages Chasara, Gundala and Mundra.

Key words: Mainland Gujarat, Alluvial areas, Deccan traps, Unai springs, Kachchh sedimentary rocks, high fluoride.

Introduction

Geographically Gujarat state has been divided into three major parts.

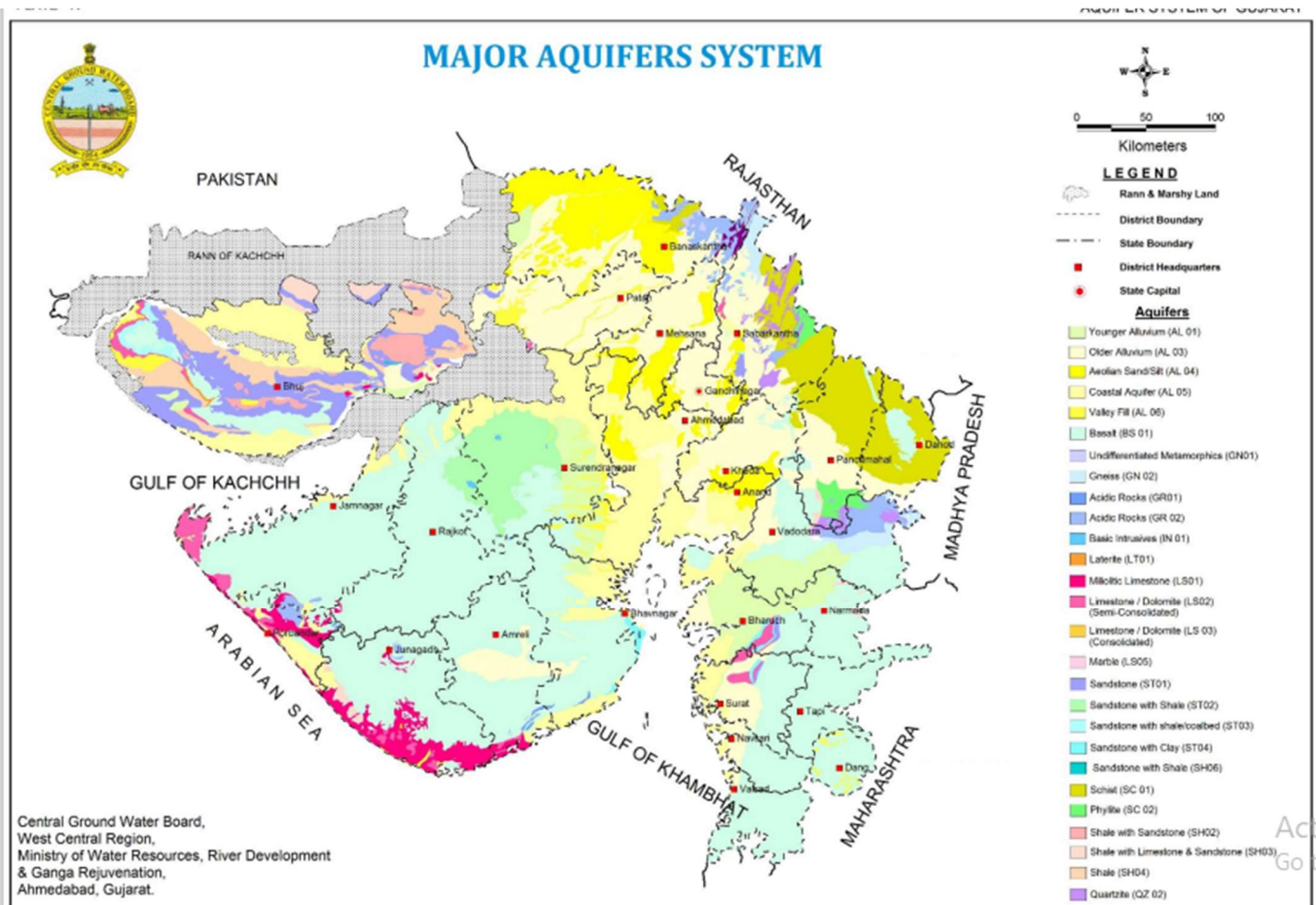
1. Gujarat mainland.
2. Saurashtra.
3. Kutch region.

1. Gujarat mainland

Large alluvial tract extends from Banaskanta district in north to Surat and Valsad in the south. This area forms a most potential groundwater reservoir in the state. In south Gujarat except in few pockets of Bharuch and Vadodara, in other districts like Surat, Valsad, Narmada, Nava sari, and The Dangs the fluoride concentration in groundwater is within permissible limits. In south Gujarat, alluvial (or sedimentary) deposits are transported by Narmada and Tapti rivers, where source rocks of these sediments are not having significant fluoride bearing minerals.

High fluoride concentration is observed in north Gujarat covering Mehsana, Banaskanta, Patan and Sabarkanta districts. In all these districts, groundwater exploitation in last 3 to 4 decades was quite high and there was steep decline of groundwater levels approximately 2m

decline per year. With the result farmers in this region forced to pump out the groundwater from deeper aquifers.



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1.1 Geology of area

Alluvial formations occupy about 85% of area, comprise of sand and clay in the form of alternate bands. North-Eastern part of area covered by hard rocks like granites, gneiss, schist, Marble, Phyllite, Slate etc. of crystalline formations of the Aravalli group of rocks which underlie deeper aquifers in north Gujarat. In these deeper aquifers groundwater is contaminated with high fluoride.

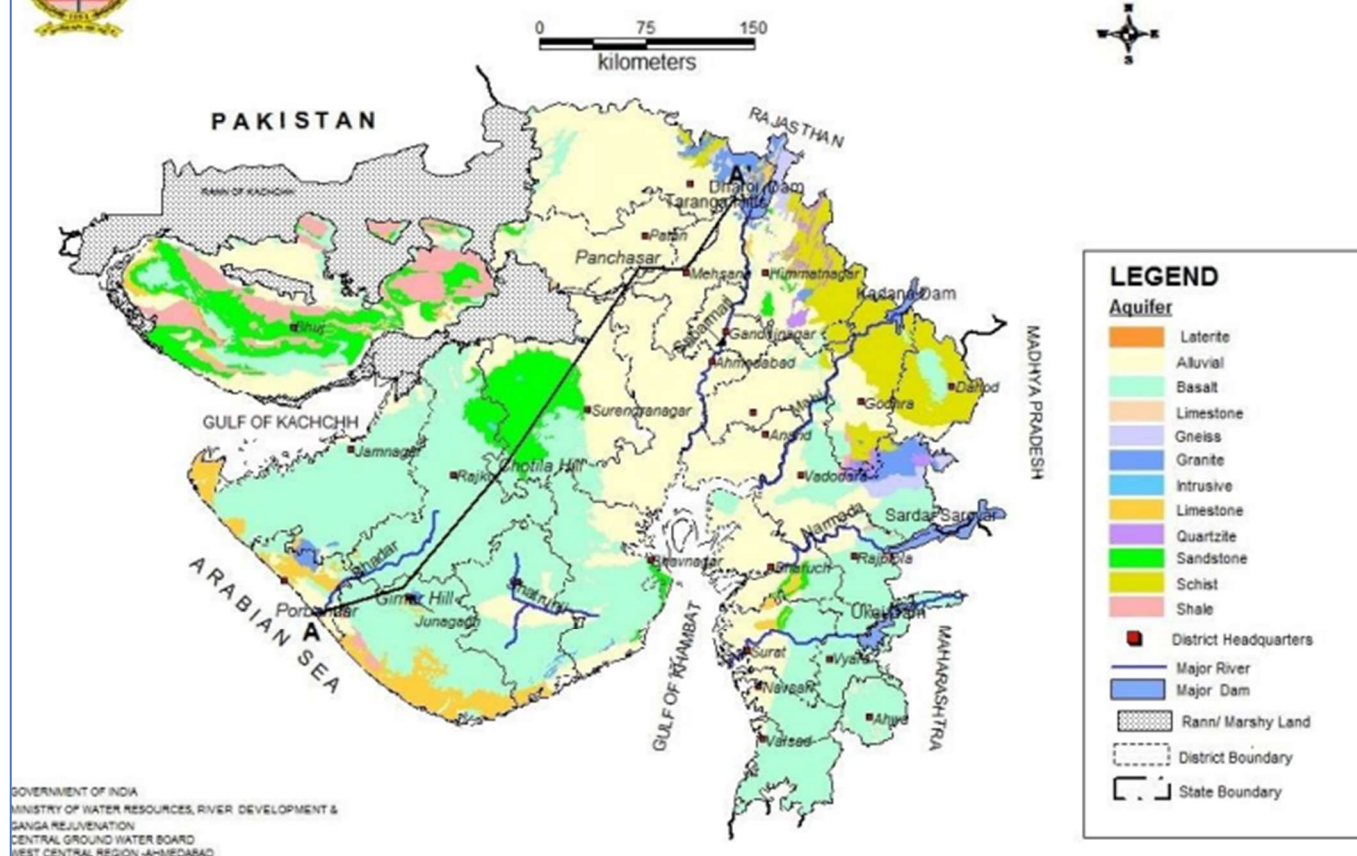
Sediments of this area deposited by river transport. These rivers (Luni, Mahi, sabarmathi) originate from Aravalli mountains and some of the rock formations contain fluoride bearing minerals. Due to increase in exploitation of groundwater since last 3 to 4 decades, farmers tapping deeper aquifers with the depth ranges from 150- to 400m. The fluoride content in deeper aquifers is high as the recharge of water took place few thousands of years back and groundwater was in contact with fluoride bearing rock formations and particularly aquifers since long time. Hence increase the concentration of fluoride in groundwater.

As per the studies of Radio Carbon dating of groundwater from deeper aquifers, it is observed that age of groundwater is 15-20 KY old (Bhandari et.al,1986). That means groundwater was in contact with water bearing formations since long time. High fluoride levels in groundwater are a result of leaching and dissolution from aquifers which have the source from metamorphic rocks of Aravalli mountains.



PRINCIPAL AQUIFER SYSTEMS OF GUJARAT

Plate -



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2. Saurashtra

Major portion of Saurashtra region is covered by Deccan Traps. In north west portion, Mesozoic, Tertiary and Quaternary formations are covered. The main rock formation of Deccan Trap is Basalt. Average thickness of Basaltic lava flows varies from 250 to more than 600m and encountered about 25 individual lava flows in various part of Rajkot district. Average thickness of individual flow varies from 9 to 15m (Prakash R. Gupte, 2012). However, flows as thin as 1m and more than 40m thick flows also recorded. In few areas, below Deccan Traps, Cretaceous sandstone also struck.

In southern part of Saurashtra, Dykes and Sills exists as intrusive bodies in Basalt rocks. These dykes and sills have considerable impact on the availability and quality of groundwater. The discordant dykes in some places act as barrier to groundwater flow. In upstream side of Dykes, the groundwater potential may be higher compared to downstream side. In severally fluoride affected areas of south Gujarat, the areas down stream of volcanic dykes, in basalt aquifers contain fluoride within permissible limit in groundwater in contrast to the high concentration of fluoride in upstream of the dykes.

The contact between two individual lava flows characterized by red bole, vesicular amygdaloidal basalt often filled with numerous secondary minerals like zeolites, quartz and calcite.

Besides fractured basalt, the vesicular amygdaloidal trap is good source of groundwater. The groundwater in Deccan traps occur under unconfined condition in shallow depth and semi-confined condition in deeper aquifers. The groundwater potential of deeper aquifer depends on the fracture/joint's density.

The contact between two individual lava flows characterized by red bole, vesicular amygdaloidal basalt often filled with numerous secondary minerals like zeolites, quartz and calcite.

Besides fractured basalt, the vesicular amygdaloidal trap is good source of groundwater. The groundwater in Deccan traps occur under unconfined condition in shallow depth and semi-confined condition in deeper aquifers. The groundwater potential of deeper aquifer depends on the fracture/joint's density.

High yield zones of groundwater generally available up to 300m and beyond 300m the yield of groundwater reduces. The deeper confined and semi-confined aquifers in fractured jointed basalt rocks are prone to high fluoride groundwater. The long residence time in deeper aquifers enables groundwater to dissolve the fluoride bearing minerals (like fluorite, fluorapatite) existing in Basalt rocks and increase the concentration of fluoride in groundwater.

In few places cretaceous sandstone aquifers struck below the depth range varies from 250-600m.

2.1 Geothermal hot springs & high fluoride in thermal water

Large number of geothermal hot springs located in Saurashtra and central region of Gujarat. The collision of Eurasia plate and Indian plate causing Eurasia plate to deform and Indian plate to compress. The compressive forces in India plate give rise to faults perpendicular to the direction of compression (Manan Shab, Anirbid circar et.al 2019). Son-Narmada-Tapti fault zone running East-West is an example of the same. The Son-Narmada-Tapti major fault might be the reason for the geothermal hot spot around Unai. The Unai hot spring is located in Narmada-Son lineament.

The geothermal field at Unai is located in southern most boundary of Saurashtra region in Gir Somnath district and 100 Km away from Cambay basin. Hot springs at 70 degree centigrade located in Unai. About 17 identified hot water springs or Geysers includes Lasundra, Tuwa Kawi, Tulsi shyan, Lalpur. The terrain around Uni is covered with Deccan traps. The chemical analysis of water samples from hot springs of Unai indicate the following results: - (Manan Shah et.al 2019)

pH	7.5 - 8.5
Temp	51 - 56 degree centigrade
Na	158 - 340 mg/l
HCO ₃	42 - 126 mg/l
TDS	623 - 957 mg/l
Fluorine	2 - 8 mg/l

Higher concentration of fluorine indicate that the water is in contact with subsurface rocks with Mica and Apatite bearing minerals.

3. Kachchh region

Kachchh district is surrounded by Arabian sea in the west, Gulf of Kachchh in the east, Rann of Kachchh in north and north east. The semi-arid region of Kachchh district with low rainfall (378 mm), unique geological features covered by alkali, silicate, igneous and sedimentary rock formations. Chances of high fluoride concentration in groundwater is high (MH Trivedi, et.al 2017).

Kachchh district is covered with hill ranges and isolated peaks. Almost all the hill ranges follow E-W trend. The Rann forms a conspicuous land form and has been divided into Great Rann in the north and little Rann in the east. Rann is mainly consisting of marshy land, Salt/Mud flats and is devoid of vegetation and very less human population.

3.1 Geology of area

The geological succession of Kachchh district is as given below-

Quaternary

Tertiary

Deccan Traps

Mesozoic

Mesozoic formations--- Sedimentary formations belong to marine and non-marine.

In Jurassic period-

Palcham series

Chari series

Katrol series

The main rock formations are sandstone, shale, limestone, Oolitic limestone etc. of marine sedimentary rocks.

Cretaceous period— Umia or Bhuj series--- Bhuj sandstone interbedded with siltstone and shale.

Deccan Traps--- Continuous belt from Anjar to Lakhpat taluks. light to dark grey basalt to dolerite.

Tertiaries--- Under Tertiary formations the following series demarcated

Kirtha series

Nari & Gaj series

Mancher series

Mottled sandstone, grit of marine origin, argillaceous and calcareous types. Shales clay, Sandy clay with gypsum.

Quaternary sediments--- Milliolite limestone and alluvium are main geological formations.

3.2 Quality of groundwater

High fluoride in groundwater

In cretaceous sandstone and limestone high fluoride concentration up to 5.02 mg/l observed in groundwater of Bhuj taluk.

In Mundra region, in three villages namely, Chasara, Gundala and Mundra high fluoride concentration in groundwater observed (3.42,1.8,1.9 mg/l respectively). (Trivedhi M H, Sangai N P,Patel R S,Payak M, Vyas S I)

In Naliya village also high fluoride concentration in groundwater observed.

In all the above cases, high fluoride in groundwater observed in semi-consolidated rocks like sandstone, shales and limestones.

4. Conclusions

- A. In North Gujarat in eastern and north eastern side, underlying Aravalli rocks acts as aquifers and enrich the groundwater with fluoride contamination.
- B. The alluvial deposits in North Gujarat are originate from Aravalli hills and transported by rivers like Luni, Mahi and Sabarmati. These alluvial deposits are fluoride bearing as the source rocks are Granite, Biotite Schist etc. belongs to Aravalli hills.
- C. In Saurashtra area, particularly south of Saurashtra, large number of Dykes and Sills occur as intrusive in Deccan Traps. These discordant bodies act as barrier to groundwater flow and due to long residence time with host rocks, fluoride enrichment in groundwater takes place. With the increase in exploitation of groundwater, there is steep decline of water levels and farmers going for construction of deep tube wells. In deeper aquifers high fluoride in groundwater observed.
In deeper aquifers, the groundwater was in contact with water bearing formations since hundreds of years. It enables dissolution of fluorite minerals from host rocks and enrich fluoride in groundwater.
- D. South of Saurashtra near Unai region, hot springs exists. In these springs high fluoride in groundwater is reported.
- E. In Kachchh area, sedimentary rocks like sandstone, shale and limestone are fluorite bearing and hence in few pockets high fluoride in groundwater observed.

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IAH WORLDWIDE GROUNDWATER CONGRESS | 17 TO 22 SEPTEMBER 2023 | CAPE TOWN | SOUTH AFRICA



Dear Fellow Hydrogeologists

The World has changed. For the past two years we've been isolated, and we've been interacting online. But through this all, we adapted. A pandemic taught the World to engage differently and to make things work. Congresses became hybrid. Yet, through this all, hydrogeology grew stronger and hydrogeological science developed further.

In 2023, we come together as hydrogeologists at the southern point of Africa. We offer extraordinary cuisine, a diverse culture, large parks, biomes from deserts to tropical forests, and - most importantly - South African hospitality. South Africa and Cape Town are extraordinary destinations and accessible from most international airports.

The 50th IAH Worldwide Groundwater Congress of the International Association of Hydrogeologists will be hosted at the Cape Town International Convention Centre in Cape Town, South Africa from 17 to 22 September 2023. Excluding council meetings in Pretoria in 2011, it is the third on the continent after Cape Town in 2000 and Marrakech in 2014. Following congresses in Brazil in South America, Belgium in Europe, China in Asia, and now South Africa in Africa, this is the fourth continent for an IAH congress in four years.

In 2023, we celebrate the early careers and their importance in the development of the IAH and the hydrogeology profession. We celebrate the growth into younger membership. In 2023, we look at growing membership. We call for new members, but also for new chapters, groups, and networks. Groundwater affects the entire planet. Our community is growing, but it should also expand into new countries and scientific developments.

Research, modelling and consulting work is developing at discrete scales right through to regional scale work related to the critical zone and transboundary aquifers. Data starts at the molecular level and moves to "big data". We up-scale data and we down-scale data. Datapoints become temporal data. And we govern at different scales of involvement. So, in 2023, we look at Groundwater: A Matter of Scale.

We invite you all to join us in-person in Cape Town in 2023!

Welcome to South Africa!

Matthys Dippenaar
Chair

Julian Conrad
Co-Chair

Call for abstracts: [Click here to submit your abstract.](https://iah2023.org.za/)

IAH Congress Home Page: <https://iah2023.org.za/>

Abstract submission: <https://abstracts.iah2023.org.za/>



Upcoming Groundwater Conferences



INC of IAH

HQ. c/c Central Ground Water Board, Bhujal Bhawan, NH-IV, Faridabad – 121001

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www.inciah.org

Upcoming Groundwater Conferences

20-24 Mar 2023 – Medellín

IAH Events

VII Colombian Congress of Hydrogeology

Groundwater for sustainable development. The Colombian Association of Hydrogeologists and IAH Colombia extend a cordial invitation to the VII Colombian Congress of Hydrogeology to be held in the city of Medellín from March 20 to 24, 2023.

For this VII version of our emblematic event, we will have the participation, discussion and knowledge of international experts, private entities, governmental, associations, Academy and Community for "Groundwater for Sustainable Development".

We look forward to your participation, sharing your ideas, experiences and Knowledge of the latest advances in hydrogeology
See you soon!

Organised by Asociación Colombiana de Hidrogeólogos and IAH Colombia.

 <https://www.asociacioncolombianadehidrogeologos.org>  congresoach@gmail.com

22 Mar 2023 – World Wide

Other Events

World Water Day

Accelerating Change. UN-Water Members and Partners decided that the theme of the 2023 World Water Day (March) and the World Toilet Day (November) campaign will be "Accelerating Change." The UN World Water Development Report will further focus on partnerships and cooperation with the provisional title "Accelerating Change through Partnerships and Cooperation".

 <https://www.unwater.org/about-un-water/what-we-do/inspire-action>

23-28 Apr 2023 – Vienna, Austria, and online

Other Events

EGU General Assembly

The EGU General Assembly 2023 brings together geoscientists from all over the world to one meeting covering all disciplines of the Earth, planetary, and space sciences. The EGU aims to provide a forum where scientists, especially early career researchers, can present their work and discuss their ideas with experts in all fields of geoscience.

November 2022: call for abstracts now open.

 <https://www.egu23.eu/>

24-25 Apr 2023 – San Antonio, Texas, USA

Other Events

Managed Aquifer Recharge: Unleashing Resiliency, Protecting Groundwater Quality

MAR Regulatory Frameworks and Water Quality Drivers. This NGWA conference will provide a forum for sharing technical, regulatory, and institutional lessons from existing projects to develop successful recharge projects addressing water supply resilience and groundwater quality. Managed aquifer recharge (MAR) is the purposeful recharge of water to aquifers for later recovery or other benefits. MAR includes various approaches including aquifer storage and recovery (ASR) and surface spreading. It is an increasingly important tool for mitigating the economic, environmental, and public health impacts of water shortages. MAR captures



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available water during wet periods, periods of low demand, or water that would otherwise be lost and intentionally moves this water underground for subsequent recovery or other benefit. While practiced for decades, MAR is of growing interest by many communities. A call for abstracts is in effect, with submissions due by January 15, 2023.

There will also be MAR workshops on April 23 and a MAR field trip on April 26.

Price: \$445 Members, \$595 Nonmembers, \$100 Students

Organised by National Ground Water Association.

 <https://www.ngwa.org/detail/event/2023/04/24/default-calendar/23apr5029>  stenney@ngwa.org

15-19 May 2023 – Online Global Event

Other Events

EEGS / AEG 2023 Virtual Symposium on “Life of Mine – Maintaining Sustainability Through Geoscience”

The Role of Geoscience in Mine Site Regulation, Running, Rehabilitation, Re-purposing, Retirement, and Reclamation. Tentative Planned Program - Seeking single and multi-disciplinary mining geoscience research and case study contributions within 6 themes (Call for Abstracts is now Open)

- Mine engineering, operation, monitoring and expansion,
- Environmental Concerns and permitting,
- Regulatory Water and soil management,
- Rehabilitation, re-purposing of historical mines (e.g., re-processing of mine wastes for critical minerals),
- Closure and reclamation planning and implementation, and
- Education Toward Future Mining Geoscience Practice.

Price: \$200

Organised by AEG and EEGS.

 <https://www.minesymposium.org/>  lifeofminesymposium@gmail.com

25-27 May 2023 – Trabzon Turkey

IAH Events

HYDRO'2023

Hydrogeology and water resources. Biannual National Symposium on Hydrogeology and Water Resources organized by the Turkish National Chapter HIDRODER in collaboration with a university.

Price: 250 Turkish Liras

Organised by Karadeniz Technical University and Turkish National Chapter HIDRODER.

 ktuhidro2023@gmail.com

14-16 Jun 2023 – Malta

IAH Events

Flowpath – National Meeting on Hydrogeology

The Italian Chapter of the International Association of Hydrogeologists (IAH) is pleased to invite you to the 6th Edition of FLOWPATH, the National Meeting on Hydrogeology. Following the tradition of the previous editions of FLOWPATH, the conference will be an opportunity for hydrogeologists and professionals to exchange ideas and discuss different issues on groundwater resources.

 <https://www.iahitaly.it/news/flowpath/flowpath-malta-2023-first-announcement>

27 Aug - 1 Sep 2023 – Stockholm, Sweden, and online

Other Events

SIWI World Water Week

Innovation for water. Further details to follow.

 <https://www.worldwaterweek.org/>

IAH membership Form 2023 (Renewal / New Membership)

INC of IAH



**International Association
of Hydrogeologists**
the World-wide Groundwater Organisation

Indian National Chapter of International Association of Hydrogeologists
(Registered under Haryana Registration and Regulation of Societies Act 2012,
Registration No. HR-019-2016-02281)
HQ. c/c Central Ground Water Board, Bhujal Bhawan, NH-IV, Faridabad – 121001

<https://inciah.org>

Application for membership (*Membership through Indian Chapter and payment in India Rupees*)

To join IAH use our quick online service at <http://www.iah.org> (credit or debit card payments only)
or complete this form and send by email (as a pdf for security), mail or fax to:

swarden@iah.org

IAH Secretariat, PO Box 4130, Goring, Reading, RG8 6BJ United Kingdom: Fax: +44 118 380 5225

Title (e.g. Dr/Mr/Mrs/Miss) _____ Family name _____

Given names _____ Gender: Male/Female

Full mailing address _____

Town _____ Post/zip code _____

Country _____ Telephone _____

Email _____

Employer/Organisation/University _____

Experiences/interests in groundwater/hydrogeology _____

Please indicate number of years' experience: student/early career /10+ / 20+ / 30+/retired

Membership type

	Full Fee	Reduced Online Fee	Student Fee	Reduced Online Student Fee
Members in "low income" countries	☐ EUR 42	☐ EUR 32	☐ EUR 22	☐ EUR 12

Fee structure for becoming / renewing IAH membership for 2023 in Indian currency through INC-IAH

Category (Fee in INR) 1. Member (3800) 2. On-line Member (2900), 3. Student Member (2000), On-line Student Member (1100), Retired Member (2000)

Option:

- Through INC-IAH: Depositing membership Fee by cheque in Bank of Baroda in the name of "INC of IAH" A/C No. 26430200000544 (Bank of Baroda, CGO Complex, NH-IV, Faridabad-121001 (Haryana).
- Through INC-IAH: Online transfer to "INC of IAH" Bank of Baroda A/C No. 26430200000544, IFSC Code: BARB0CGOFAR.
- Direct payment to IAH on <http://iah.org> (in EURO)

Details Required: (A). Renewal: Payment proof with membership number and category of membership opted **B. New Membership:** Fill up the form and send details to the Treasurer, INC of IAH on ashok.kumar@inciah.org (Mobile # 9818174707).

Note: The fee amount in Indian Rupees includes administrative costs for transferring the fee to IAH in Euro.

Contact: President – 9829010304, Vice President – 9968805450, Secretary – 9540686777, Treasurer – 9818174707