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EDITORIAL

It is with great pleasure that we present the 10th Bulletin of the Nepal Hydrogeological Association (NHA). This edition highlights contributions from senior hydrogeologists and professionals providing useful popular types of articles. The diverse types of articles have provided information on water resource management, sustainable development, and climate resilience and exploration techniques of groundwater.

We extend our heartfelt gratitude to all the authors who have shared their invaluable research and insights. Your dedication to excellence and commitment to the advancement of hydrogeology is commendable. We also appreciate the efforts of the reviewers, who ensured the quality of this publication.

The success of this bulletin would not have been possible without the generous support of our sponsors, well-wishers, and professionals whose unwavering commitment to our cause has been instrumental. We highly wish to acknowledge the contributions of our members of the association, partners, advertisers, and individual supporters who continue to believe in and support our vision.

We would also like to express our sincere thanks to the executive committee for providing us with the opportunity to work together for such a respected organization. The editorial team members, with their unique contributions, have played a pivotal role in bringing this bulletin to its present stage. Your hard work, dedication, and collaborative spirit are the backbone of our success.

We hope this bulletin serves as a valuable resource and history of the association for all our readers, and we look forward to continued collaboration in the future.

Warm Regards,

Thank you !!!

The Editorial Board
Nepal Hydrogeological Association (NHA)

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MESSAGE FROM THE PRESIDENT OF SEVENTH EXECUTIVE COMMITTEE ON FOURTEENTH AGM

The Nepal Hydrogeological Association (NHA) represents all groundwater specialists from all disciplines working on various areas of groundwater resources and development throughout Nepal. Since its inception, it has consistently pushed for the advancement of professionals working in the groundwater sector in Nepal, with a primary focus on groundwater investigation, exploration, regulation, and management. Professional activities include the organization of various discussions, talk programs, seminars, and conferences, while academic activities include the publication of books, bulletins, journals, and so on.

The involvement of hydrogeologists in the government organization has been the matter of serious debate in the context of changed administrative arrangement. The Groundwater Resources Development Board was a key institution responsible for policy making, hydrogeological study and study data preservation for the entire country. In addition to further strengthen this organization, GWRDB has been completely disappeared from the Government framework. Likewise, the hydrogeologists involvement in the government organizations, especially in Department of Irrigation has become further deteriorated due to unstable administrative framework in the provincial level. In view of the requirement of proper assessment, sustainable exploitation and protection of this important natural resources that has direct connection in the agriculture, industry, and domestic use, it is high time to improve the administrative framework and technical expertise in this area that ultimately lead towards groundwater availability for the coming generation.

NHA has been annually publishing Bulletin since 2016 and present Volume 9 is the reflection of its continuity. It is our pleasure to further enhance academic endeavors of the professional organization through initiating the publication of the first volume of Journal of Nepal Hydrogeological Association from this year-2024.

We are eagerly looking for collaborations with groundwater enthusiasts from all over the world for the betterment of environment and society with sustainability of the groundwater resource.

Prof. Dinesh Pathak
President
Nepal Hydrogeological Association
2081/05/25

एशोसिएशनको १४ औं वार्षिक साधारण सभामा महासचिव अनिल खत्रीको प्रतिवेदन

नमस्कार,

यस नेपाल हाइड्रोजियोलजिकल एसोसिएसन (NHA) का अध्यक्ष तथा सभाका सभाध्यक्षज्यू, यस एसोसियशनका पूर्व अध्यक्षज्यूहरू, एसोसियशनका पधाधिकारीज्यू तथा सम्पूर्ण सदस्यज्यूहरू । यस ल्ज्ब को १४औं वार्षिक साधारण सभामा उपस्थित सम्पूर्ण आजिवन सदस्यज्यूहरू तथा अतिथिज्यूहरूलाई स्वागत गर्न चाहन्छु ।

आज मिति २०८१ भाद्र २८ गते शुक्रवार यस NHA को चौधौ बाषिर्क साधारण सभामा महासचिवको हैसियतले आ.ब. २०८१।८२ मा यस एसोसियशनबाट भएका गतिविधिहरू प्रस्तुत गर्न पाउँदा मलाई ज्यादै खुशी लागेको छ ।

समस्त जीवन र जगतको अस्तित्व रक्षा गर्ने प्रकृतिप्रदत्त वरदानका स्र्पमा रहेको भूमिगत जलको महत्त्व, संरक्षण र दिगो प्रयोगका बारेमा जनचेतना अभिवृद्धि गर्ने यस संग सम्बन्धित विशेषज्ञहरूको हक हित को संरक्षण तथा भूमिगत जलश्रोतको संस्थागत बिकास गर्ने उद्देश्यसहित स्थापना भएको यस एसोसियशनबाट गत आ.वमा भएका कार्यहरूको विवरण यहाँहरू समक्ष प्रस्तुत गर्न गईरहेको छु ।

अब म यस एसोसियशनबाट भएका कार्यहरूको विवरण यहाँहरू समक्ष प्रस्तुत गर्न गईरहेको छु ।

१. विगतका बर्षहरूमा झैं यस बर्षपनि यस एसोसियशनको वार्षिक गतिविधी तथा Research Articles हरू समावेश भएको 10th Edition of Bulletin प्रकाशन भएको जानकारी गराउँदछु ।

२. महत्वपूर्ण लेखरचना सहित यस संस्थाबाट Scientific Journal प्रकाशन गर्ने कार्यलाई बिशेष प्राथमिकता दिइएको छ । उक्त Journal Website मा upload भैसकेको छ ।

३. यस वर्ष पनि एसोसियशनको तर्फबाट विगत बर्षहरूमा झैं दशैं तिहार छठ जस्ता चाडपर्ब को शुभकामना आदान प्रदान गरी सम्पन्न गरियो ।

४. NHA को Website लाई आवश्यकता अनुसार update गरिएको छ र महत्वपूर्ण तथ्यांक तथा लेख रचना एबम सूचना सामग्रीलाई समयानुकुल upload गरिएको छ ।

५. आजका मिति सम्म यस एसोसिएसनका आजिबन सदस्यहरूको संख्या बढेर १८६ पुगेको व्यहोरा जानकारी गराउन चाहन्छु ।

६. भूमिगत जलस्रोतको अतिदोहन र शहरी क्षेत्रमा निर्माण गरिएका पक्की संरचनाका कारण पुनर्भरणमा अवरोध उत्पन्न भएका कारण जमिनमुनिको पानीको सतह निरन्तर घटिरहेको देखिरहेको छ । साथै, अव्यवस्थित मानव वस्ती र बढ्दो औद्योगीकरणका कारण भूमिगत जलस्रोत प्रदूषित हुँदै गएको छ । भविष्यमा आउनसक्ने जलसंकटको चुनौतीलाई मध्यनजर गर्दै भूमिगत जलस्रोतको पुनर्भरणका लागि जलाधार क्षेत्रहरूको संरक्षण गर्ने तथा भूमिगत जलश्रोतको आम नागरिकमा जनचेतना जगाउन अत्यावश्यक देखिएको

छ । भूमिगत जलश्रोत विकास समिति खारेजी पश्चात राज्यको अमुल्य सम्पतिको नियमन र संरक्षणको अभाब खड्किएको अवस्थामा नियमन निकायको आवश्यकताका सम्बन्धमा आफ्नो धरणा राख्दै आएको जानकारी गराउन चाहन्छु ।

७. उर्जा जलस्रोत तथा सिचाइ मन्त्रालयका सचिव, जलश्रोत तथा सिंचाइ बिभागका महानिर्देशक लगायतका ब्यक्तित्वहरूसंग हाइड्राजियोलोजिष्ट तथा भूमिगत जलश्रोतको संस्थागत बिकास सम्बन्धि विषयमा छलफल गरिदै आएको छ ।

८. यस बाहेक यस संस्थाले वार्षिक रूपमा गर्ने नियमित गतिविधिहरू जस्तै संस्थाको प्रशासनिक काम, लेखा परिक्षण, संस्था नविकरण, बैंक खाता नविकरण जस्ता महत्त्वपूर्ण कार्यहरू सम्पन्न भएको छ ।

यो एसोसियसन आफ्नै संस्था हो यस्तै गरी बाँकी कार्यकालमा आ-आफ्नो ठाउँबाट विभिन्न भूमिकामा रहेर यस कार्यकारिणी समितिलाई सफल बनाउन सहयोग गर्नु हुने छ भन्ने अपेक्छ्या राखेको छु ।

नेपाल हाइड्रोजियोलजिकल एसोसिएसनको आगामी बर्षको भाबी कार्यक्रम

१. भूमिगत जलस्रोतको क्षेत्रसँग सम्बन्धित बैज्ञानिक अनुसन्धान तथा खोजमुलक विषयमा Groundwater Talk Program सम्बन्धी कार्य संचालनको लागि उच्च प्राथमिकता दिइनेछ ।

२. +महत्त्वपूर्ण लेखरचना सहित यस संस्थाको वार्षिक बुलेटिन तयार गर्ने कार्यलाई आगामी वर्ष पनि निरन्तरता दिइनेछ र Scientific Journal प्रकाशन गर्ने कार्यलाई बिशेष प्राथमिकता दिइनेछ ।

३. भूमिगत जलस्रोतसँग सम्बन्धित महत्वपूर्ण खोज अनुसन्धानलाई पहिचान गरि आवश्यक समन्वय गरेर Talk Programme/Seminar तथा Workshop संचालन गर्ने कार्यलाई उच्च प्राथमिकता दिइनेछ ।

४. यस कार्य समितिले NHA का सदस्यहरूको हकहित संरक्षण र बृतिविकासको लागि सम्बन्धित निकायमा आवश्यक पहलकदमी (Advocacy) गर्ने उद्देश्य राखेको छ । साथै भूमिगत जलस्रोतसँग सम्बन्धित संस्थालाई स्थायी, दिगो र भरपर्दो बनाउने तर्फ समेत नेपाल सरकारका बिभिन्न निकायसंग आवश्यक समन्वय गरिनेछ ।

५. भूमिगत जलस्रोतको अध्ययन, अनुसन्धान र विकासमा महत्वपूर्ण योगदान पुर्याएका व्यक्तिहरूलाई उच्च मुल्यांकन गरि स-सम्मान मानार्थ सदस्य र सम्मानपत्र प्रदान गर्ने लक्ष्य राखिएको छ ।

६. आगामी बर्षमा NHA को Fund Raising कार्यलाई अझ बढी प्रभावकारी रूपले अगाडि बढाइनेछ ।

७. NHA को Website लाई आवश्यकता अनुसार update गरिएको छ र महत्वपूर्ण तथ्यांक तथा लेख रचना एबम सूचना सामग्रीलाई समयानुकुल upload गरिनेछ ।

८. समयमा लेखा परिक्षण र साधारण सभाको कार्य सम्पन्न गरि NHA को संस्था नबिकरण गर्ने र खाता संचालन गर्ने कार्यलाई प्राथमिकता दिइनेछ ।

९. यस आ.ब देखि हाईड्रोजियोलोजिस्टहरूको क्षमता अभिवृद्धि विभिन्न कार्यक्रम संचालन गरिने छ ।

एसोसियसन कृयाकलापहरूमा सबैको चासो तथा आशा बढ्नु स्वभाबिक नै हो । वर्तमान परिस्थितिमा संस्थाको विकास तथा सामुहिक समस्याको समाधानको निमित्त आगामी दिनहरूमा संस्थालाई निरन्तर अझ सशक्त सहयोग तथा सुझावहरूको आवस्यकता रहेको छ ।

यो एसोसियसन आफ्नै संस्था हो यस्तै गरी बाँकी कार्यकालमा आ-आफ्नो ठाउँबाट विभिन्न भूमिकामा रहेर यो १४ औं कार्यकारिणी समितिलाई सफल बनाउन सहयोग गर्नु हुने छ भन्ने अपेक्छ्या राख्दै यो बार्षिक प्रतिवेदनको यहि बिट मार्दछु ।

अनिल खत्री

महासचिव

NHA ACTIVITIES OF THE YEAR 2081/082

Nepal Hydrogeological Association (NHA) represents all groundwater specialists from all disciplines working on various areas of groundwater resources and development throughout Nepal. Since its inception, it has consistently pushed for the advancement of professionals working in the groundwater sector in Nepal, with a primary focus on groundwater investigation, exploration, regulation, and management. Professional activities include the organization of various discussions, talk programs, seminars, and conferences. In the year 2081/082 NHA had Organized various talked program, workshop and Seminars which are summarized below.

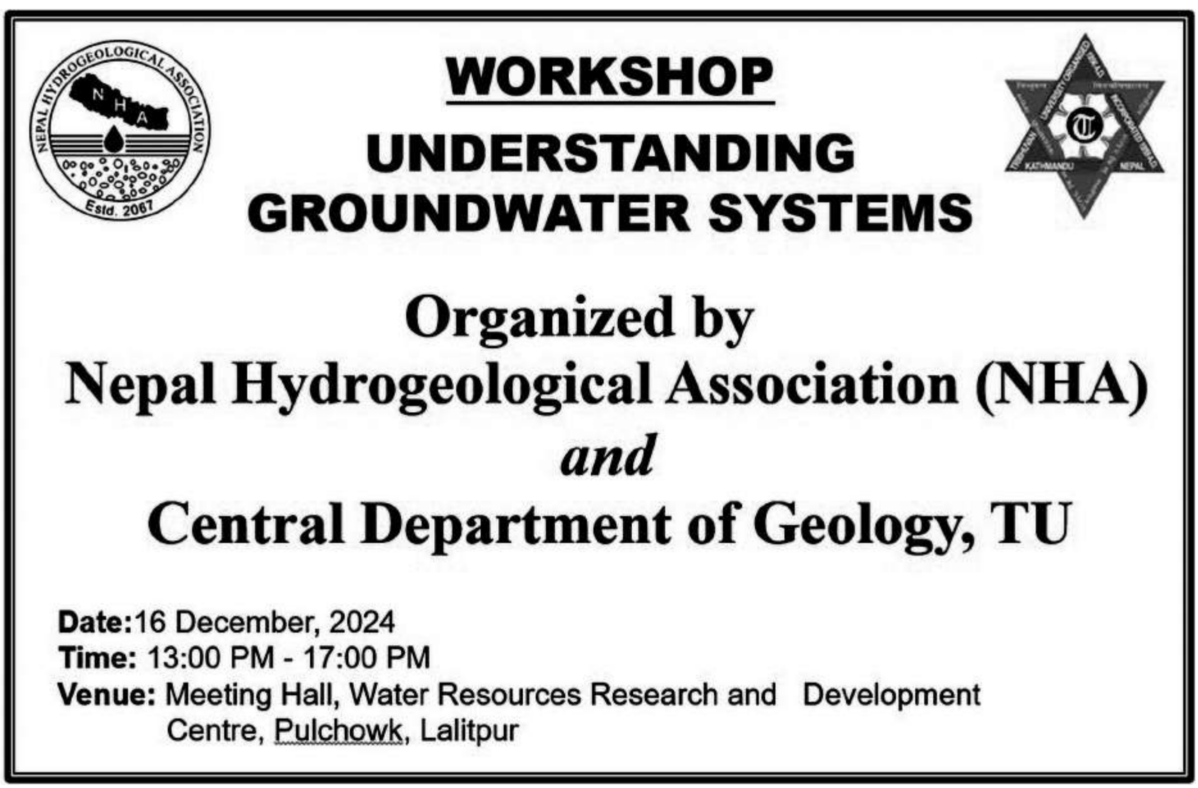
WORKSHOP ON HYDROGEOLOGY

A half-day talk program was jointly organized by NHA and CDG TU in Lalitpur on 16 December, 2024. The main presenters of the talk program were Professor John Cherry and Professor Jimmy Jiao, both from the Department of Earth Sciences at the University of Hong Kong. Three presentations were made during the talk program, which were as follows:

Multi-depth systems for groundwater monitoring by John A. Cherry, Department of Earth Sciences, University of Hong Kong

Slope hydrogeology by Prof Jimmy Jiao, Department of Earth Sciences, The University of Hong Kong

Researches in hydrogeology and Challenges in Groundwater Management in Nepal, Dinesh Pathak, NHA/TU



WORKSHOP ON THE BASICS AND APPLICATIONS OF STABLE ISOTOPES ON WATER RESOURCES

Half day Workshop regarding the Basics and Applications of Stable Isotopes on Water Resources Studies at Water Resource Research and Development Board (WRRDC), Pulchok, Lalitpur was held on 7th October 2024. The presentation was delivered by Dr. Chidambaram S., Research Scientist, Water Research Center, Kuwait Institute for Scientific Research Kuwait. The Highlight of the presentation were as follows

- Determination of sources of Fugitive gasses
- Dating of younger groundwaters
- Carbon isotopes in groundwater –Case study
- The Inferences Climatic Variations with Respect to $d^{18}O$ and d-excess of the Groundwater Samples.


IAEA
International Atomic Energy Agency
Atoms for Peace and Development
Basics and Applications of Stable Isotopes in Water Resoruces Studies
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MULTI-DEPTH SYSTEMS FOR GROUNDWATER MONITORING

John A. Cherry, Department of Earth Sciences, University of Hong Kong

This presentation covers the general history of multi-depth systems for groundwater monitoring and then introduce an important recent development of a multi-depth monitoring system (MDS) invented at the University of Hong Kong. This monitoring system is produced at exceptionally low cost in China using 3-D printing and readily available materials. It is suitable for use in nearly all types hydrological circumstances however, the maximum depth to which can be installed is yet to be determined from field experience, but it is estimated to be greater than 200 m. The purpose of this device is to measure, at many different depths in a single borehole, water pressure or water levels and enable collection of water samples for analysis so that at each monitoring location, data profiles of hydraulic head and water chemistry, are obtained rather than sparse data points. The number of monitoring depths (monitoring, ports) depends on the selected design for each monitoring location, however, generally the aim is for 8 to 20 or more ports. Seals must be positioned each of the ports so that the measurement each port represent the groundwater, conditions and information formation. The HKU MDS has a new type of seal to be effective for this purpose. The seal expands as bentonite clay does, but it is more effective. This MDS can be installed in boreholes in fractured rock, karst and consolidated deposits, however in each case the most appropriate drilling method to suit this MDS must be chosen. In rock, the most appropriate drilling method is diamond bit core drilling that produces continuous core and a smooth hole wall. For bore holes in a consolidated deposits drilling mud should be avoided, and therefore the best drawing methods, Roto sonic and cable tool drilling and any other drilling method that results in a continuous steel casing to the bottom extending of the hole into which the MDS is inserted, and then the casing withdrawn and the seals expand on contact with water. Other versions of multi depth systems have been available commercially beginning in the late 1970s, however, although they show how important it is to use MDS on many projects our little used because of excessive cost and difficulty of use. The HKU system has much potential to become widely used globally for more rapid advancement of the understanding of groundwater conditions, including the three pillars of groundwater systems-groundwater flow, hydrogeochemistry and contamination.

SLOPE HYDROGEOLOGY

Prof Jimmy Jiao, Department of Earth Sciences, The University of Hong Kong

This presentation will explore various aspects of slope hydrogeology, focusing on our comprehension of groundwater flow in hillslopes, with specific reference to case studies in Hong Kong. Hillslope groundwater should be considered within a broader system context, as it operates within a regional framework and encompasses recharge, by-pass, and discharge zones. Traditional geotechnical studies on slope stability typically concentrate on a limited area near the point of failure, which may only represent a fraction of the by-pass region. Groundwater flow can extend much deeper and across a larger area than commonly assumed by engineers. The existence of deep circulation implies that bedrock groundwater is a crucial and dynamic element of hillslope hydrogeology, yet it is frequently disregarded in current slope stability analyses. Confined groundwater often exists in slopes but may be overlooked due to the use of shallow piezometers and inaccurate assessments of hydraulic conductivity. Human activities frequently alter natural groundwater flow systems and can potentially trigger deep-seated landslides, although this human-induced impact is frequently omitted from site investigations. Through case studies in Hong Kong, the presentation demonstrates how construction activities can alter hillslope hydrogeology and ultimately impact slope stability.

NHA: ARC-15

NHA Partnership in ARC-15

Published At: Nov 13, 2024 (Kartik 28, 2081)

Nepal Hydrogeological Association (NHA) is a National Organizing Partner of 15th Asian Regional Conference (ARC-15) of International Association of Engineering Geology (IAEG) to be held in Kathmandu, Nepal from 27-29 November 2025. The conference will be held with main theme "Geological Engineering for Societal and Sustainable Development".

The association is happy to support for the successful organization of ARC-15.

The first Nepal Hydrogeological Conference – 2025 "Groundwater for People and Ecosystems: Sustainability and Resilience in the changing world

The first Nepal Hydrogeological Conference - 2025 was successfully organized by the Nepal Hydrogeological Association (NHA) in association with the Kathmandu Valley Water Supply Management Board (KVWSMB), Bhaisepati, Lalitpur, and Geo Hydro Consult Pvt. Ltd. (GHC) on 20–21 August 2025 at Square Hotel Lalitpur, Nepal. The conference focused on "Groundwater for People and Ecosystems: Sustainability and Resilience in a Changing World." It was the first national event solely dedicated to hydrogeology, aiming to create a vibrant, recurring platform for knowledge exchange, innovation, and cross-sectoral collaborations to understand groundwater systems in Nepal from science to policy.

More than 150 professionals from Nepal and abroad, including scientists, engineers, policymakers, development partners, and industry leaders were participated in the conference. The event spotlighted Nepal's critical groundwater challenges and explored strategies for sustainable groundwater use, governance, and resilience-building. The program highlighted groundwater-related challenges such as over-extraction, pollution, land subsidence, and climate-induced shifts in recharge systems in the Himalayan country of Nepal. A total of 35 technical papers were presented, including six keynote presentations from both national and foreign participants, including those from America, Bangladesh, India, and Taiwan.

This conference enhanced the dissemination of information within the global geoscientific community.

PROGRAM

Inaugural Session

Session	Time	Activities
Inaugural Session	8:00 – 9:00	Registration and Refresher
	9:00 – 9:15	Session chairing- NHA President and calling Dignitaries on the dais
	9:15 - 9:20	**National Anthem**
	9:20 - 9:25	Welcome speech by **Mr. Khila Nath Dahal**, Vice-President, NHA
	9:25 - 9:30	Conference Inauguration by the **Chief guest Hon'ble minister** **Pradip Yadav,** Ministry of Water Supply, Government of Nepal
	9:30 - 9:40	Briefing of the conference by **Dr. Dibya Ratna Kansakar**, Convener, 1st Nepal Hydrogeological Conference - 2025
	9:40 – 9:50	Remarks by **Special Guest Mr. Mitra Baral,** Director General, Department of Water Resources and Irrigation
	9:50 - 10:00	Remarks by **Special Guest Mr. Ram Kumar Shrestha ,** Director General, Department of Water Supply and Sewerage Management
	10:00– 10:15	Speech by **Chief Guest**: Hon'ble Minister **Pradip Yadav,** Ministry of Water Supply, Government of Nepal
	10:15 - 10:25	Remarks by Prof. **Dr. Dinesh Pathak**, President, Nepal Hydrogeological Association
	10:25 – 10:35	Vote of thanks by **Mr. Bala Ram Upadhyaya**, Secretary of NHA and closing of the inauguration's ceremony
	10:35 – 11:00	**Tea break, Photo Session**

MC: **Mr. Anil Khatri**, General Secretary of NHA


NEPAL
HYDROGEOLOGICAL
CONFERENCE
An International Event
1ST NEPAL HYDROGEOLOGICAL CONFERENCE
HYDROGEOLOGY OF NEPAL HIMALAYA AND ADJACENT REGION
"Groundwater for People and Ecosystems: Sustainability and Resilience in the changing world"
ORGANIZED BY
Nepal Hydrogeological Association (NHA)
NEPAL HYDROGEOLOGICAL ASSOCIATION
Estd. 2061
In association with
Kathmandu Valley Water Supply Management Board (KVWSMB)
and
GeoHydro Consult Pvt. Ltd.
20-21 August, 2025
Bhadra 4-5, 2082

Nepal Hydrogeological Association
1st Nepal Hydrogeological Conference
HYDROGEOLOGY Of NEPAL HIMALAYA AND ADJACENT REGION
"Groundwater for People and Ecosystem: Sustainability and Resilience in the changing world"
August 20-21, 2025, Kathmandu, Nepal

CONFERENCE PROGRAMME

Day 1: August 20, 2025

Time	Activities
8:00-9:00	**Registration**
9:00-10:35	**Inauguration Programme**
10:35-11:00	**Tea Break/Refreshment**
Technical Session I: Groundwater Quality, Contamination, and Health Risks Chair: Mr. Narendra Khatri Rapporteur: Mr. Shrawan Shakya	
11:00-11:20	**Keynote Talk: Prof. D.P. Jaisi** ***Water-rock interaction in aquifers: Tracing sources and dating groundwater ages using stable and radioactive isotopes (Online)***
11:20-11:35	**D.R. Pathak:** From Dumpsites to Engineered Landfills: Protecting Groundwater through Sustainable Solid Waste Management in municipalities of Nepal
11:35-11:50	**R. Mishra & M.L. Rijal:** Assessment of Groundwater Quality and Utilization in Morang District, Eastern Nepal
11:50-12:05	**R. Malla, S. Pathak & L. Pathak:** Hydrogeochemical and Microbial Dynamics of Groundwater-Surface Water Interactions in Pokhara Valley, Nepal
12:05-13:30	**Lunch Break**

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Technical Session II: Groundwater Sustainability, Policy, and Management **Chair: Mr. Churna Bahadur Oli** **Rapporteur: Mr. Manoj Khatiwada**	
13:30-13:50	**Keynote Talk: P.S. Tater** ***Groundwater Management Challenges in Nepal: Institutional Perspectives and Future Directions***
13:50-14:10	**V.P. Pandey & K. Pudaisaini:** Responding to Water Insecurity in Madhesh Province: Insights and Ways Forward
14:10-14:25	**S.R. Uprety:** Establishment of the Groundwater Wing in the Department of Hydrology and Meteorology for Groundwater Management of Nepal
14:25-14:40	**M.L. Rijal:** Groundwater Resources of Nepal: Are they drying or dying?
14:40-14:55	**A.K. Azad and R. Warriar:** Groundwater for People and Ecosystems: Sustainability and Resilience in the Changing World
14:55-15:10	**D. Kafle & N. Dahal:** Balancing the Water Supply in the Changing Climate: Pathways to Climate Resilient Water Governance in Syangja District, Nepal
15:10-15:25	**K.R. Neupane, P.R. Dahal, & M. Pokhrel:** A Proposal for Regional Water Budget Studies and Groundwater Diplomacy in the Nepal–India Region (Online)
15:25-15:40	**Tea Break/Refreshment**

Nepal Hydrogeological Association

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Technical Session III: Hydrogeological Hazards, Climate Change, and Environmental Stress Chair: Mr. Mr. Suresh Raj Uprety Rapporteur: Mr. Ishwor Thapa	
15:40-16:00	**Keynote Talk: Dr. R.K. Dahal** ***Engineering Geological Implications of Rainwater Harvesting in the Nepal Himalaya***
16:00-16:15	**B. Acharya, B. Ghimire, B. Baral, A. Baniya, A. Shakya, B. Joshi, & V.P. Pandey:** Chure-Bhabar Degradation and Groundwater of Terai: Insights from Aquifers in Koshi Province
16:15-16:30	**S. Panthee & P. Ghimire:** Ground Water Influence on Support System in Soft Ground Tunneling: A Case Study of Super Madi Hydroelectric Project, Kaski District, Nepal
16:30-16:45	**A.K. Mishra & S.R. Shrestha:** Drying Wells of Madhesh: Causes, Evidence, and Solutions
16:45-17:00	**K.K. Shrestha, P.B. Thapa, & K.R. Paudyal:** Hydrogeological Influence of Groundwater Level Fluctuations on Debris Slope Stability in the Lesser Himalayan Terrain
17:00-17:15	**S. Paudel & D. Pathak:** Hydrogeological Study of Karst Landscapes and Evaluation of Sinkholes and Subsidence risk in Armala Area, Pokhara Valley
17:15-17:30	**I Tiwari, A. Triphathi, B. Bhandari, S. Malla, & C.B. Silwal:** Status of Land Subsidence in Biratnagar Metropolitan City, Nepal
17:30-18:00	**Refreshment**
18:00 onwards	**Gala Dinner: (Restaurant)**

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DAY 2: AUGUST 21

Technical Session IV: Tools, Methods, and Innovations in Hydrogeology **Chair: Mr. Surendra Raj Shrestha** **Rapporteur: Mr. Arpan Parajuli**	
9:00-09:20	**Keynote Talk: Prof. B.S. Chaudhary** ***Applications of Geoinformatics for Sustainable Land and Water Resources Management in Himalayan Ecosystem: A case study of K-J Watershed, Shiwalik Region, North India (Online)***
09:20-09:35	**A. Ganesh, V.P. Pandey, & R. Talchabhadel:** Groundwater Storage Variation in the Indo-Gangetic Aquifer from Downscaled GRACE/GRACE-FO Data
09:35-09:50	**R. Bajracharya, T. Nakamura, N.K. Tamrakar, & S. Ghimire:** Spatio-temporal variation of stable isotope and chemical concentration in river water of the Kathmandu Valley
09:50-10:05	**B.M. Shakya, B.R. Thapa, D. Pathak, A.M. Shrestha, & B.N. Shrestha:** Layer by Layer: Transforming Nepal's Groundwater Data for Next-Generation Modelling and Policy
10:05-10:20	**B.M. Shakya, J.L. Singh, & N. Chhatkuli:** Tracing Seepage Pathways in Concrete-Faced Rockfill Dams Using Stable Isotopes
10:20-10:35	**P.C. K.C, S.B. Rana, & B. Khatiwada:** Groundwater Monitoring Well Network Design using Arc GIS and Multi-Criteria Analysis for Kathmandu Valley
10:35-12:00	**Lunch Break**

Nepal Hydrogeological Association

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Technical Session V: Groundwater Recharge, Springs, and Surface-Water Interactions Chair: Mr. Andy Prakash Bhatt Rapporteur: Mr. Manjari Acharya	
12:00-12:20	**Keynote Talk: Prof. Jimmy Jiao** ***Multi-Tracer Isotopic Approach to Quantifying Groundwater Discharge and Classifying Lake Hydrology in the Badain Jaran Desert, China (Online)***
12:20-12:35	**K.R. Paudyal, R.B. Sah, & P.N. Paudel:** Groundwater Recharge in Siwalik and Bharbar Zones of Nepal: Case Studies from Siwalik-Bhabar River Systems
12:35-12:50	**G. Pokhrel, M.L. Rijal, & G. Krishan:** Understanding recharge systems of springs using δ18O isotope in Seti Khola Watershed, western Nepal
12:50-13:05	**K. Bashar:** Scope of Artificial Recharge of Aquifers using Induced Bank Filtration in Bangladesh (**Online**)
13:05-13:20	**M. Khatiwada, J. Khanal, C.B. Silwal, K. Yadav, & N. Rijal:** Exploiting River Bank Filtration (RBF) for Sustainable Water Supply in the Water-Scarce Midhills of the Nepal Himalaya
13:20-13:35	**P. Neupane & M.L. Rijal:** Spring hydrogeochemistry in diverse lithology of Jyagdi Khola Watershed, Syangja District
13:35-13:50	**K. Chaulagai & R.K. Dahal:** Application of Oneway Valve for the Management of Groundwater in Tunnelling of Nepal Himalaya
13:50-14:00	**Tea/Refreshment**
14:05-14:15	**IEC Session**

Nepal Hydrogeological Association

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Technical Session VI: Case Studies and Regional Groundwater Assessments Chair: Dr. Moti Lal Rijal Rapporteur: Mr. Khagendra Dahal	
14:15-14:35	**A Paudel, K. Pandey, & D. Pathak:** Water Poverty Index and Groundwater Potential Delineation to Mitigate Geo-Environmental Disasters at the Lower Reaches of the Manahari Khola Watershed, Makwanpur District (Online)
14:35-14:50	**C.B. Silwal, M. Nepal, B. Karkee, K. Dahal, M. KC, & D. Pathak:** Delineation of Groundwater Potential under projected climatic conditions in Kankai River Basin, East Nepal Himalaya
14:50-15:05	**R.B. Mandal, S. Adhikari, S. Acharya, K. Rijal, & S. Duwal:** Citizen Science-Based Shallow Groundwater Monitoring in the Kathmandu Valley
15:05-15:20	**S. Shah & M. Bista:** Geospatial Assessment of Groundwater Potential, Utilization and Recharge Status in Koshi
15:20-15:50	**IEC Session**
15:50-17:00	**Valedictory Session**
17:00-18:00	**High Tea**

Photographs of Conference Program


SQUARE
hotel


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20-21 August 2025 | 4-5 Bhadra 2082
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AUDITOR'S REPORT (2080/81)

Reg. No. 2780 PAN No. 500020971

M.K. Paudel & Company
Registered Auditor
Gokarneshwor-5, Kathmandu

Independent Auditor's Report

To the Members of Nepal Hydrogeological Association

Opinion

We have audited the financial statements of Nepal Hydrogeological Association (the "Organization"), which comprise the Balance Sheet as at Asadh 31, 2081 (July 15, 2024), and the Income Statement and Statement of Cash Flow for the year then ended, and significant accounting policies and notes to financial statements.

In our opinion, the accompanying financial statements presents fairly, in all material respects, the financial position of the organization as at Asadh 31, 2081 (July 15, 2024), and of its financial performance and its cash flows for the year then ended in accordance with Nepal Accounting Standards.

Basis for opinion

We conducted our audit in accordance with Nepal Standards on Auditing (NSAs). Our responsibilities under those standards are further described in the Auditors Responsibilities for the Audit of the Financial Statements section of our Report. We are independent of the organization in accordance with the ICAN'S Handbook of Code of Ethics for Professional Accountants together with the ethical requirements that are relevant to our audit of the financial statements in Nepal, and we have fulfilled our other ethical responsibilities in accordance with these requirements and ICAN's Handbook of Code of Ethics for Professional Accountants. We believe that the audit evidence we have obtained is sufficient and appropriate to provide a basis for our opinion.

Key Audit Matters

Key audit matters are those matters that, in our professional judgment, were of most significance in our audit of the financial statements of the current period. These matters were addressed in the context of our audit of the financial statements as a whole, and in forming our opinion thereon, and we do not provide a separate opinion on these matters. We have determined that there are no key audit matters to communicate in our report.

Responsibility of Committee and Those Charged with Governance for the Financial Statement

Committee is responsible for the preparation and fair presentation of the financial statements in accordance with Nepal Accounting Standards and for such internal control as committee determines is necessary to enable the preparation of financial statements that are free from material misstatement, whether due to fraud or error.

In preparing the financial statements, committee is responsible for assessing the organization's ability to continue as a going concern, disclosing, as applicable, matters related to going concern and using the going concern basis of accounting unless committee either intends to liquidate the organization or to cease operations, or has no realistic alternative but to do so.

M.K. Paudel and Company, Gokarneshwor-5, Kathmandu, Registered Auditor

Those charged with Governance are responsible for overseeing the organization's financial reporting process.

Auditor's Responsibilities for the Audit of the Financial Statements

Our objectives are to obtain reasonable assurance about whether the financial statements as a whole are free from material misstatement, whether due to fraud or error, and to issue an auditor's report that includes our opinion. Reasonable assurance is high level of assurance, but is not a guarantee that an audit conducted in accordance with NSAs will always detect a material misstatement when it exists. Misstatement can arise from fraud or error and are considered material if, individually or in the aggregate, they could reasonably be expected to influence the economic decisions of users taken on the basis of these financial statements.

As part of an audit in accordance with NSAs, we exercise professional judgment and maintain professional skepticism throughout the audit. We also:

- Identify and assess the risk of material misstatement of thy financial statements, whether due to fraud or error, design and perform audit procedures responsive to those risks, and obtained audit evidence that is sufficient and appropriate to provide a basis for our opinion. The risk of not detecting a material misstatement resulting from fraud is higher than for one resulting from error, as fraud may involve collusion, forgery, intentional omissions, misrepresentations, or the internal control.
- Obtain an understanding of internal control relevant to the audit in order to design audit procedures that are appropriate in the circumstances, but not for the purposes of expressing an opinion on the effectiveness of the organization's internal control.
- Evaluate the appropriateness of accounting polices used and the reasonableness of accounting estimates and related disclosures made by the committee,
- Conclude on the appropriateness of the committee's use of the going concern basis of accounting and, based on the audit evidence obtained, whether a material uncertainty exists related to events or conditions that may cast significant doubt on the organization's ability to continue as a going concern. If we conclude that a material uncertainty exists, we are required to draw attention in our auditor' report to the related disclosures in the financial statements or if such disclosures are inadequate, to modify our opinion. Our conclusions are based on the audit evidence obtained up to the date of our auditor's report. However, future events or conditions may cause the organization to cease to continue as a going concern.
- We communicate with those charged with governance regarding, among other matters, the planned scope and timing of the audit and significant audit findings, including any significant deficiencies in internal control that we identify during our audit.
- We also provide those charged with governance with a statement that we have complied with relevant ethical requirements regarding independence, and to communicate with them all relationships and other matters that may reasonably be thought to bear on our independence, and where applicable, related safeguards.
- ***Report on the Requirements of the Companies Act, 2063***

We have obtained information and explanations asked for, which, to the best of our knowledge and belief, where necessary for the purpose of our audit. In our opinion, the balance sheet, the statements of Income and

M. K. Paudel and Company
Gokarneshwor-5
Kathmandu
Registered Auditor

the Cash Flow Statements have been prepared in accordance with the requirement of the companies Act, 2063 and are in agreement with the books of account of the organization, and proper books of accounts as required by law have been kept by the organization.

To the best of our information and according to explanations given to us and from our examination of the books of account of the organization necessary for the purpose of our audit, we have not come across cases where Committee or any employees of the organization have acted contrary to the provisions of law relating to the accounts, or committed any misappropriation or caused loss or damage to the organization relating to the accounts in the organization.

Report on Other Legal and Regulatory Requirements

Based on our examination, we would like to further report that:

- We have obtained all the information and explanation, which to the best of our knowledge and belief were considered necessary for the purpose for our audit.
- The organization has kept proper books of accounts as required by law, in so far as it appears from our examination of those books of account.
- The Statement of Financial Position, the Statement of Income and the statement of Cash Flows and attached Schedules dealt with by this report are in agreement with the books of account maintained by the organization.
- In our opinion and to the best of our information and according to the explanations given to us, the Committee or, the representative or any employee of the organization has not acted contrary to the provision of law relating to accounts not caused direct loss or damage to the organization deliberately or acted in a manner that would jeopardize the interest and security of the organization.
- The operations of the organization were within its jurisdiction.
- We have not come across any fraudulence in the accounts, based on our sample examination of the books.

....

M.K. Paudel & Company Gokarneshwor-5 Kathmandu Registered Auditor

M.K. Paudel & Company
Registered Accountant
Place: Kathmandu
Date: 2024.09.17
UDIN Number: 240917RA00522byTTb

Nepal Hydrogeological Association
Babarmal-11,Kathmandu, Nepal
STATEMENT OF FINANCIAL POSITION
As at 31 Ashad, 2081 (15 July 2024)

(in Nepalese Rupees)

Particulars	Notes	As at 31 Ashad 2081	As at 31 Ashad 2080
Assets:			
Non-Current Assets			
Property, plant and equipment	4.1	-	-
Long term Investment	4.2	-	-
Total non-current assets		-	-
Current Assets			
Inventories	4.3	-	-
Account Receivables	4.4	836	83,971
Cash and Cash Equivalent	4.5	184,059	32,987
Total Current Assets		**184,895**	**116,958**
Total assets		**184,895**	**116,958**
Liabilities & Reserves			
Accumulated Reserves			
Unrestricted Funds	4.6	95,681	-
Capital Fund	4.7	73,914	101,958
Restricted fund	4.8	-	-
Endowment Fund	4.9	-	-
Other Capital Reserves	4.10	-	-
Total Accumulated Reserves		**169,595**	**101,958**
Non Current Liabilities:			
Loans and Borrowings	4.11	-	-
Employee Benefits liabilities	4.12	-	-
Deferred Revenue	4.13	-	-
Total Non-Current Liabilities		-	-
Current Liabilities			
Account Payables	4.14	15,300	15,000
Loans and Borrowings	4.15	-	-
Provisions	4.16	-	-
Bank Overdrafts	4.17	-	-
Total current liabilities		**15,300**	**15,000**
Total liabilities		**15,300**	**15,000**
Total equity and liabilities		**184,895**	**116,958**

The accompanying notes are an integral part of these financial statements

As per our report of even date

Treasurer

Chairperson

Auditor

Date:
Place: Kathmandu

M. K. Paudel and Company
Gokarneshwor-5
Kathmandu
Registered Auditor

Nepal Hydrogeological Association
Babarmal-11,Kathmandu, Nepal
Statement of Income and Expenditure
For the year ended Ashad 31, 2081 (15 July 2024)

(in Nepalese Rupees)

Particulars	Notes	Current Year	Previous Year
Incoming Resources	4.18	273,269	446,200
Financial Income	4.19	4,573	3,657
Other Income	4.20	-	-
Total Income		**277,842**	**449,857**
Staff Cost/Expenses	4.21	-	-
Program Expenses	4.22	-	-
General Administrative Expenses	4.23	273,269	315,055
Depreciation	4.1	-	
Other Expenses	4.24	-	-
Total Expenditure		**273,269**	**315,055**
Net Surplus/(Deficit) Before Tax		**4,573**	**134,802**
Income Tax expense	4.25	-	-
Surplus/(Deficit) for the year		**4,573**	**134,802**
Appropriation of Surplus for the year			
Allocation to Reserves			
Allocation to Endowment Fund			

The accompanying notes are an integral part of these financial statements

As per our report of even date

Treasurer | Chairperson | Auditor

Date:
Place: Kathmandu

M. K. Paudel and Company
Gokarneshwor-5 Kathmandu
Registered Auditor

Nepal Hydrogeological Association
Babarmal-11,Kathmandu, Nepal
Cash Flow Statement
For the year ended Ashad 31, 2081 (15 July 2024)

(in Nepalese Rupees)

Particulars	Current Year	Previous Year
Cash flow from operating activities		
Surplus/(Deficit) before tax	4,573	134,802
Add:		
Depreciation	-	-
Cash Flow before working capital changes	**4,573**	**134,802**
Decrease/(Increase) in Current Assets	83,135	(49,691)
Increase/ (Decrease) in Current Liabilities	300	(130,000)
Net Cash Flow from Operating Activities	**88,008**	**(44,889)**
Cash Flow from investment activities		
(Purchase)/Sales of Fixed Assets	-	-
Decrease/(Increase) in Investments	-	-
Net Cash Flow from Investment Activities	-	-
Cash flow from financing activities		
Increase/(Decrease) in Funds	95,681	-
Increase in Capital Funds	(32,617)	-
Net Cash Flow from Financial Activities	**63,064**	-
Increase/(Decrease) in cash and cash equivalent	**151,073**	**(44,889)**
Cash and cash equivalents at begining of the year	32,987	77,876
Cash and cash equivalents at end of the year	**184,059**	**32,987**

The accompanying notes are an integral part of these financial statements

As per our report of even date

Treasurer

Chairperson

Auditor

Date:
Place: Kathmandu

M. K. Paudel and Company
Gokarneshwor-5
Kathmandu
Registered Auditor

Nepal Hydrogeological Association
Babarmal-11,Kathmandu, Nepal
STATEMENT OF ACCOUNTING POLICIES AND NOTES TO FINANCIAL STATEMENTS

1. General Information
Nepal Hydrogeological Association is a non-governmental not for profit distrubution organization established and registered in Inland Revnue Office with PAN -304960556 : It is affiliated with District Administration Office. Its registered office is in Kathmandu as principle place of activities.

It is domiciled in Nepal. Except for certain activities that will conclude on the realization of their relevant activities in accordance with the relevant terms of reference, the financial statements have been prepared on going concern basis.

2. Basis of Preparation

2.1 Statement of Compliance
The Statement of Financial Position, Statement of Income & Expenditure, Statement of Changes in Reserves, Statement of Cash Flows together with the Accounting Policies and Notes to the financial statements as at 31 Ashadh 2081 and for the year then ended comply with the Generally Accepted Accounting Principles to the extent applicable and the Nepal Accounting Standards for NPOs (NAS for NPOs) issued by Accounting Standard Board of Nepal. The Financial Statements were authorized for issue as per decision of the Board or Executive Committee

2.2 Basis of Measurement

The financial statements have been prepared using the historical cost convention or at Fair value wherever specifically disclosed.

2.3 Functional and Presentation Currency
The financial statements are presented in Nepali Rupees (NRs.), which is the organization's functional and presentation currency. All financial information presented in Rupees has been rounded to the nearest rupees/thousands/million, except when otherwise indicated.

2.4 Change in Accounting Policies and Disclosure

The organization has revised its accounting policy regarding the recognition of donations received, effective from the current fiscal year. Previously, donations were explicitly acknowledged as part of Incoming Sources. In order to more precisely align with best practices and reflect the organization's financial position, donations will now be recognized in the Fund/Reserve. These funds will be used to pay for subsequent expenses, which will be recorded as Incoming Sources. This modification is designed to address the issue of surplus being classified as profit to provide a more accurate representation of the organization's financial activities. From the commencement of the current fiscal year, this policy modification has been implemented prospectively.

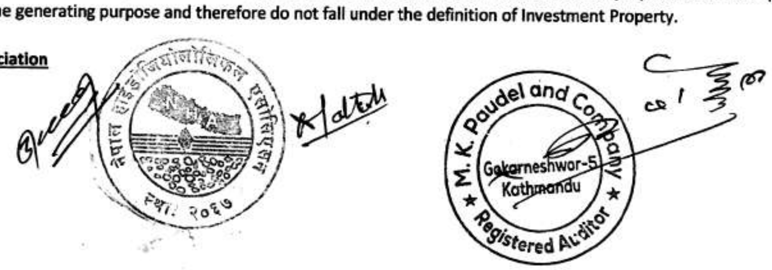
2.5 Significant Accounting Judgements, Estimates and Assumptions

The preparation of the financial statements requires the use of certain critical accounting estimates and judgments. It also requires management to exercise judgment in the process of applying the accounting policies. The management makes certain estimates and assumptions regarding the future events. Estimates and judgments are continuously evaluated based on historical experience and other factors, including expectations of future events that are believed to be reasonable under the circumstances. In the future, actual result may differ from these estimates and assumptions. (The estimates and assumptions that have a signifi cant risk of causing a material adjustment to the carrying amounts of assets and liabilities within the next financial year are to be disclosed).

3. Summary of Significant Accounting Policies
3.1 Property, Plant and Equipment
a. Cost and Valuation

All items of property, plant and equipment are initially recorded at cost. Subsequent to the initial recognition of an asset, property plant and equipment are carried at cost less any subsequent depreciation. Subsequent expenditure is capitalized only when it increases the future economic benefits embodied in the item of property and equipment. All other expenditure is recognized in the Statement of Income & Expenditure as an expense as incurred.Buildings owned are used for purposes of this company only and not for income generating purpose and therefore do not fall under the definition of Investment Property.

b. Depreciation



Depreciation is provided for on all Property Plant and Equipment on the straight line basis and is calculated on the cost of all property, plant and equipment other than land, in order to write off such amounts less any terminal value over the estimated useful lives of such assets.

The annual rates of depreciation currently being used based on useful life less residual/terminal value are:

Assets	Rate pa.
Scooter/Motercycle	15%
Motor Vehicles	20%
Computer equipment	25%
Computer software	20%
Office Equipment	25%
Furniture and Fittings	25%

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Gokarneshwor-5
Kathmandu
Registered Auditor

Donated Assets

Where property plant and equipment is purchased as a part of a project through restricted funds which initially written off as project cost with corresponding income, if on conclusion of the project, the asset is not handed over to the beneficiary or returned to the original donor, the asset is valued on the conclusion of the project with the approval from funding agencies and brought into the financial statements under property plant and equipment with corresponding credit to a Capital Reserve. Depreciation provided on such assets will be charged against such capital Reserve. For purpose of depreciation the date of valuation for inclusion in the financial statements is considered the date of purchase.

3.2 Intangible Assets

Intangible assets acquired separately are measured on initial recognition at cost. Following initial recognition, intangible assets are carried at cost minus any accumulated amortization, except for assets with indefinite useful lives. Internally generated intangible assets are not capitalized; expenditure is therefore reflected in the Statement of Income & Expenditure in the year in which the expenditure is incurred. The useful lives of intangible assets are assessed to be either finite or indefinite. Intangible assets with finite useful lives are amortized over their useful economic life. The amortizati on period and method for an intangible asset with a finite useful life are reviewed at least at each financial year-end. Accordingly, straight line amortization over the useful life is carried out.

Intangible assets with indefinite useful lives are tested for impairment annually. Such intangibles are not amortized. The useful life of an intangible asset with an indefinite life is reviewed annually to determine whether indefinite life assessment continues to be supportable. If not, the change in the useful life assessment from indefinite to finite is made on a prospective basis.

3.3 Foreign Currency Transaction

Transactions in currencies other than Nepal Rupees are converted into Nepal Rupees at rates which approximate the actual rates at the transaction date. At the reporting date, monetary assets (including securities) and liabilities denominated in foreign currency are converted into Nepal Rupees at the rate of exchange at that date. Realized and unrealized exchange differences are reported in the Statement of Income & Expenditure.

3.4 Cash and Cash Equivalents

This organisation considers and classifies cash in hand, amounts due from banks and short-term deposits with an original maturity of three months or less under the category of "Cash and cash equivalents". Bank borrowings that are repayable on demand and form an integral part of this organization cash management are included as a component of cash and cash equivalents for the purpose of the Statement of Cash flows.

3.5 Inventories

Inventories are valued at the lower of cost and net realizable value. Net realizable value is the price at which inventories can be reasonably expected to be sold in the market place, less any estimated cost necessary to make the sale. The cost is determined on first-in first-out (FIFO) method and includes expenditure incurred in acquiring the inventories and bringing them to their present location and condition.

Items donated for distribution or resale are not included in the financial statements until such time they are distributed or resold.

3.6 Provisions

A provision is recognized in the statement of financial position of the company has a legal or constructive obligation as a result of a past event, it is probable that an outflow of assets will be required to settle the obligation, and the obligation can be measured reliably.

3.7 Employee Benefits Liabilities

The organization's obligation in respect of the defined future benefit plans is calculated separately for each benefit plans by estimating the amount of future benefit that employees have earned in the current and prior periods. The calculation of the defined benefit obligations is performed annually.

Gratuity, medical facilities & accumulated leave provision has been provided as per ByLaws, assuming that all the staffs will be retired at the reporting date.

3.8 Loans and Borrowing and Account Payables

Loans and Borrowings and Accounts payables are stated at their cost.

3.9 Accounting for the receipt and utilizationof Funds/Reserves

Reserves

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Kathmandu
Registered Auditor

3.10 Grants and Subsidies

Grants and subsidies are recognized in the financial statements at their fair value. When the grant or subsidy relates to an expense it is recognized as deferred income necessary to match it with the costs over the accounting years, which is intended to compensate for on a systematic basis. Grants and Subsidies in the form of PPE (Fixed assets) are generally shown as deferred income in the Statement of Financial Position and credited to the Statement of Income & Expenditure over the useful life of the asset by the amount of depreciation with corresponding debit to deferred income over more than one accounting period.In the case of grants received to fund an entire project or activity, which includes the purchase of an asset, and the cost of such asset is charged with the project costs to the Statement of Financial Performance, the grant value is recognized as income in the same period as the cost of the asset is charged to the Statement of Income & Expenditure. At the end of the project, when there is certain fair value remains of such assets charged to Statement of Income & Expenditure, same will be recognized as capital reserve at fair value with corresponding value of PPE. Each year and over its useful life, the depreciation will be charged to capital reserve with corresponding credit to related PPE.

3.11 Income Recognition

a. Contributions/Incoming Sources

Income realized from restricted funds is recognized in the Statement of Income & Expenditure only when there is certainty that all of the conditions for receipt of the funds have been complied with and the relevant expenditure that it is expected to compensate has been incurred and charged to the Statement of Income & Expenditure. Unutilized funds are carried forward as such in the Statement of Financial Position.

Gifts and donations received in kind are recognized at fair value at the time that they are distributed to beneficiaries, or if received for resale with proceeds being used for the purpose of this company at the point of such sale. Items not sold or distributed are inventoried but not recognized in the financial statements. All other income is recognized when the company is legally entitled to the use of such funds and the amount can be quantified. This would include income receivable through fund raising activities and donations.

b. Financial Income

Interest earned is recognized on an accrual basis when there is certainty of receipt. Dividend received is recognized when the right to receive dividend is established. Revenues earned on services rendered are recognized in the accounting period in which the services were rendered and accepted by the clients. Net gains and losses on the disposal of property, plant and equipment and other non-current assets, including investments, are recognized in the Statement of Income & Expenditure after deducting from the proceeds on disposal, the carrying value of the item disposed of and any related selling expenses.

c. Other income is recognized on an accrual basis except otherwise categorically explained to be on cash basis.

3.12 Expenditure recognition

Expenses in carrying out the projects and other activities of this company are recognized in the Statement of Income & Expenditure during the period in which they are incurred. Other expenses incurred in administering and running this company and in restoring and maintaining the property plant and equipment to perform at expected levels are accounted for on an accrual basis and charged to the Statement of Income & Expenditure.

3.13 Taxation

This firm has no objective of profit making and accordingly no provision for tax has been made.

3.14 Borrowing Costs

Borrowing costs that are attributable to the acquisition, construction or production of a qualifying asset, are charged off to Statement of Income & Expenditure as expense. Other borrowing costs are treated as an expense in the period in which it is incurred.

3.15 Contingent Liabilities

A contingent liability is a possible obligation that arises from past events and whose existence will be confirmed only on the occurrence or non-occurrence of one or more uncertain future events that are not wholly within the control of this company. It may also be a present obligation that arises from past events but in respect of which an outf low of economic benefit is not probable or which cannot be measured with sufficient reliability. Such contingent liabilities are recorded under Note xx. For certain operational claims reported as contingent liabilities, it is not practical to disclose detailed information on their corresponding nature and uncertainties.

Reserves are classified as either restricted or unrestricted reserves.

a. Unrestricted Reserves/Funds/accumulated surplus

Unrestricted funds are those that are available for use by this company at the discretion of the Board, in furtherance of the general objectives of this company and which are not designated for any specific purpose. Surplus funds are transferred from restricted funds to unrestricted funds in terms of the relevant Donor Agreements or with the prior approval of the Donor. Contributions received from the members are recognized as unrestricted funds on a cash basis.

b. Designated Reserves/Funds

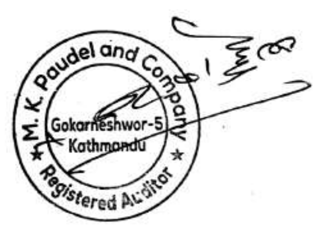
Unrestricted funds designated by the Board to a specific purpose are identified as designated funds. The activiti es for which these funds may be used are identified in the financial statements. Where grants are received for use in an identified project or activity, such funds are held in a restricted fund account and transferred to the Statement of Income & Expenditure to match with expenses incurred in respect of that identified project. Unutilized funds are held in their respective Fund accounts and included under accumulated fund in the Statement of Financial Position until such ti me as they are required. Funds collected through a fund raising activity for any specific or defined purpose are also included under this category. Where approved grant expenditure exceeds the income received and there is certainty that the balance will be received such amount is recognized through Debtors in the Statement of Financial Position.

c. Restricted Fund:

The activities for which these restricted funds may and are being used are identified in the notes to the financial statements Restricted Reserves/Funds. Such restricted fund may include conditions for refund should there be balance of fund at the end of the project.

d. Endowment Reserves/Funds

Where assets are received as an endowment, which are not exhausted, only the income earned from such assets may be recognized and used as income. i.e. Investment Income and other gains realized from funds available under each of the above categories are allocated to the appropriate funds, unless the relevant agreement or minute provides otherwise. Where such income can be used for general purpose, same shall be treated as income in the Statement of Income & expenditure.



Nepal Hydrogeological Association
Babarmal-11,Kathmandu, Nepal

4. Other Explanatory Notes

4.1 Property, Plant and Equipment

Particulars	L & B	Furniture	Office	Vehicle	Scooter	P & M	Software	Under Const.	Total
Cost									
Balance at 1 Shrawan 2080	-	-	-	-	-	-	-	-	-
Additions	-	-	-	-	-	-	-	-	-
Disposals	-	-	-	-	-	-	-	-	-
Balance at 31 Ashadh 2081	-	-	-	-	-	-	-	-	-
Accumulated Depreciation and Impairment Losses									
Balance at 1 Shrawan 2080	-	-	-	-	-	-	-	-	-
Depreciation charged for the year	-	-	-	-	-	-	-	-	-
Adjustment due to Impairment Losses	-	-	-	-	-	-	-	-	-
Disposals	-	-	-	-	-	-	-	-	-
Balance at 31 Ashadh 2081	-	-	-	-	-	-	-	-	-
Carrying Amount									
Balance at 1 Shrawan 2080	-	-	-	-	-	-	-	-	-
Balance at 31 Ashadh 2081	-	-	-	-	-	-	-	-	-

Security
There is no Bank borrowings and non of the PPE are secured against bank borrowings.

Property, Plant and Equipment under construction
There is not any PPE under construction for the period.

Notes to Account

4.2 Long Term Investment

Item	shares of Listed	Others
Opening Balance	-	-
Additional during the year	-	-
Disposal during the year	-	-
Closing Balance	-	-

4.3 Inventories

Particulars	Current year	Previous year
Finished Goods and Goods for Sale	-	-
Donation received in kind	-	-
	-	-
Total	-	-

4.4 Account Receivables

Particulars	Current year	Previous year
Sundry Debtors, Deposits and Advances	-	82,222
TDS Receivables	836	1,749
Other Account Receivable	-	-
Less: Allowance for Account receivable	-	-
Total	**836**	**83,971**

4.5 Cash and Cash Equivalent

Particulars	Current year	Previous year
Cash in hand	8,368	-
Cash in Bank	-	
-NMB Bank	184,059	32,987
Short-term Deposits	-	-
Total	**184,059**	**32,987**

4.6 Unrestricted Funds

Particulars	Current year	Previous year
Balance as at begining of year	-	-
Members Contributed Funds	40,300	-
Funds received during the year	328,650	-
Unrestricted fund availed in Operating activities	273,269	-
Balance at the end of the year	**95,681**	-

4.7 Capital Fund

Particulars	Current year	Previous year
Restated Reserve upto Previous year	69,341	(32,844)
Reserve this year	4,573	134,802
Other Funds	-	-
Total	**73,914**	**101,958**

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Registered Auditor

4.8 Restricted Funds

Particulars	Current year	Previous year
Balance as at begining of year	-	-
Additional funds received during the year	-	-
Less: T/f to Statement of Income and Expenditure	-	-
Less: Interest Income on Restricted Fund	-	-
T/f to Unrestricted Fund	-	-
	-	-
Total	-	-

Project wise allocation and movement in Restricted Funds

Name of Donor Organisation		
Project Name / Description		
Opening Balance	-	-
Received / Restricted Surplus during the year	-	-
T/f to Statement of Income and Expenditure	-	-
Interest Income on Restricted Fund	-	-
Balance c/f shown in Restricted Fund balance	-	-

4.9 Endowment Funds

Particulars	Current year	Previous year
Balance as at begining of year	-	-
Addition during the year	-	-
Surplus / Deficit of the year	-	-
	-	-
Balance at the end of the year	-	-

4.10 Other Capital Reserves

Particulars	Current year	Previous year
Revaluation Surplus	-	-
Deferred Income Machine (Not Handed Over)	-	-
Less: Depreciation for the Year	-	-
Balance at the end of the year	-	-

4.11 Loans and Borrowings

Particulars	Current year	Previous year
Term Loan	-	-
Less: Current Portion of Term Loan	-	-
Balance at the end of the year	-	-

4.12 Employees Benefit Liabilities

Particulars	Current year	Previous year
Defined Employment Benefit Plan	-	-
	-	-

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Kathmandu
Registered Auditor

4.13 Deferred Revenue

Particulars	Current year	Previous year
Deferred Income Machine (Donation)	-	-
Less: T/f to Statement of Income and Expenditure	-	-
Balance at the end of the year	-	-

4.14 Account Payable

Particulars	Current year	Previous year
Accrued Expenses	-	-
Other Payables	-	-
-Audit Fee Payable	14,800	14,800
-TDS on Audit Fee	200	200
-TDS on Salary	300	-
Total	**15,300**	**15,000**

4.15 Loans and Borrowing

Particulars	Current year	Previous year
Current portion of Term loan	-	-
Total	-	-

4.16 Provisions

Particulars	Current year	Previous year
Balance at the begining of the year	-	-
Allocation during the year	-	-
Use of Provision during the year	-	-
Release of Provision during the year	-	-
Total	-	-

4.17 Bank Overdraft

Particulars	Current year	Previous year
Overdraft from Bank	-	-
Total	-	-

4.18 Incoming Resources

Particulars	Current year	Previous year
Grants- Restricted Funding	-	-
Grants- Unrestricted Funding	273,269	-
General Donation	-	25,000
Donation for Bulletin	-	364,200
Other Income	-	19,000
AGM Registration fee	-	30,000
Profit from trading or other activities (refer 4.18.1)	-	-
Other Income	-	8,000
Total	**273,269**	**446,200**

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Registered Auditor

4.18.1 Profit from Trading Activities

Particulars	Current year	Previous year
Sale Proceeds	-	-
Less: Cost of Sales	-	-
Opening Stock	-	-
Add: Purchase	-	-
Less: Closing Stock	-	-
Cost / Fair value of items **(2)**	-	-
(Choose the lower of 1 or 2)	-	-
Profit Earned (1)	-	-

4.19 Financial Income

Particulars	Current year	Previous year
Interest Income from deposit	4,573	3,657
Dividend from Investment	-	-
Total	**4,573**	**3,657**

4.20 Other Income

Particulars	Current year	Previous year
Rental Income	-	-
Exchange Difference: Revaluation Gain	-	-
Total	-	-

4.21 Staff Cost

Particulars	Current year	Previous year
Wages and Salaries	-	-
Allowances and Benefits	-	-
Post-employment benefits costs	-	-
Total	-	-

4.22 Program Expenses

Particulars	Current year	Previous year
	-	-
	-	-
Total	-	-

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Gokarneshwor-5
Kathmandu
Registered Auditor

4.23 General Administrative Expense

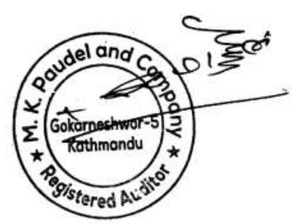
Particulars	Current year	Previous year
Audit Fee	15,000	15,000
Registration and Renewal Expenses	1,250	2,750
Flex and Printing Expenses	17,655	45,882
Refreshment and Tea Expenses	12,655	6,660
Office Expenses	12,419	6,500
Water Expenses	3,360	3,000
Courier Expenses	-	325
Cleaning Expenses	3,300	1,000
Mask and Papercup Expenses	-	410
AGM Expenses	23,196	215,728
Stationery Expenses	17,834	14,800
Salary Expenses	30,000	-
Website Expenses	-	3,000
Travelling Expenses	1,000	-
Bulletin Expenses	135,600	-
Total	**273,269**	**315,055**

4.24 Other Expenditure

Particulars	Current year	Previous year
Interest Expense	-	-
Amortization of Intangible Assets	-	-
Allowances for Doubtful Accounts for Account Receivable	-	-
Fair Value of Long term Investment	-	-
Revaluation on Deficit on Budgeting	-	-
Total	-	-

4.25 Income Tax Expense

Particulars	Current year	Previous year
Current Tax Expense	-	-
Current Tax Expense on profits for the year	-	-
	-	-
Total Tax Expense	-	-



Nepal Hydrogeological Association
Babarmal-11,Kathmandu, Nepal
Notes to the Financial Statements
For the year ended Ashad 31, 2081 (15 July 2024)

Depreciation u/s 19				
Particulars	**Pool A**	**Pool B**	**Pool C**	**Pool D**
Opening Depreciation Basis (1 Shrawan 2080)	-	-	-	-
Addition upto Poush 2080	-	-	-	-
Addition upto Chaitra 2080	-	-	-	-
Addition upto Ashadh 2081	-	-	-	-
Allowable Addition Amount	-	-	-	-
Disposal During the year	-	-	-	-
Depreciation Basis for the year	-	-	-	-
Depreciation Rate	5%	25%	20%	15%
Depreciation for the year	-	-	-	-
Unabsorbed Addition	-	-	-	-
Unabsorbed Repair Expenses.	-	-	-	-
Depreciation Basis for next year	-	-	-	-

Particulars	**Pool E**	
	Software	**Leasehold**
Original Cost		
Purchase date	-	-
Useful life (years)	5	5
Opening Depreciation Basis (1 Shrawan 2080)		
Addition upto Poush	-	-
Addition upto Chaitra	-	-
Addition upto Ashadh	-	-
Allowable Addition Amount	-	-
Disposal During the year	-	-
Depreciation Basis for the year	-	-
Depreciation Rate	20%	20%
Depreciation for the year	-	-
Unabsorbed Addition	-	-
Depreciation Basis for next year	-	-

Repair & Improvement expense u/s 16				
Asset Pool	**Actual**	**Allowable(7%)**	**Allowed**	**Capitalized**
Pool A	-	-	-	-
Pool B	-	-	-	-
Pool C	-	-	-	-
Pool D	-	-	-	-
Pool E	-	-	-	-
Total	-	-	-	-

नेपाल हाइड्रोजियोलोजिकल एसोसियसन स्था. २०६९

M. K. Paudel and Company, Gokarneshwor-5 Kathmandu, Registered Auditor

Nepal Hydrogeological Association
Babarmal-11,Kathmandu, Nepal
COMPUTATION OF INCOME TAX
FOR FISCAL YEAR 2080/81

Particulars	As per Books	For Income Tax	Difference
Inclusions			
Sales u/s 7(2)(Kha)	-	-	-
Interest Income	4,573	4,573	-
Other Income	-	273,269	(273,269)
Total Inclusion	**4,573**	**277,842**	**(273,269)**
Deductions			
General Deduction u/s 13	273,269	273,269	-
Interest u/s 14	-	-	-
Cost of Trading Stock u/s 15	-	-	-
Repair & Improvement u/s 16	-	-	-
Depreciation u/s 19	-	-	-
Total Deduction	**273,269**	**273,269**	-
Assessable Income	(268,696)	4,573	(273,269)
Less: Donation u/s 12	-	-	-
Income/ (Loss)	**(268,696)**	**4,573**	**(273,269)**
Carry forward of losses u/s 20	-	(149,933)	149,933
Taxable Income/ (Loss)	**(268,696)**	**(145,360)**	**(123,336)**
Income Tax Rate	-	25%	
Income Tax Liability	-	-	
Fee U/S 117	-	-	
Interest U/S 118	-	-	
Interest U/S 119	-	-	
Total Tax Liability		-	

Carry Forward of Losses u/s 20(1)(Kha)	
Loss for Fiscal Year	**Amount**
2079/80	134,802
2078/79	(181,631)
2077/78	(103,104)
2076/77	-
2075/76	-
2074/75	-
2073/74	-
Total	**(149,933)**

१४ औं वार्षिक साधारण सभाका झलकहरू


Indreni


Indreni
BANQUET


NEPAL HYDROGEOLOGICAL ASSOCIATION
१४ औ बार्षिक साधारण सभा
14TH AGM
New Baneshwor, Kathmandu


Albelo


NEPAL HYDROGEOLOGICAL ASSOCIATION

Photographs of Talk Program


KISR

CONGRATULATIONS

Promotions/Appointments/Academic Award

Nepal Hydrogeological Association proudly congratulates the following members on their achievements and extends best owishes for a successful tenure ahead.

Appointment

Mr. Chhabilal Pokharel (LM 125)
Assistant Professor, Prithvi Narayan Campus, TU, Pokhara

Mr. Prakash Gyawali (LM78)
Senior Divisional Hydrogeologist, Groundwater Resources and Irrigation Development Division Birgunj, Parsa

Ms. Anupama Dhakal (LM 68)
Senior Divisional Hydrogeologist Madhesh Province

Mr. Dharma Raj Pandey (LM165)
Hydrogeologist, Groundwater Resources and Irrigation Development Division, Lahan

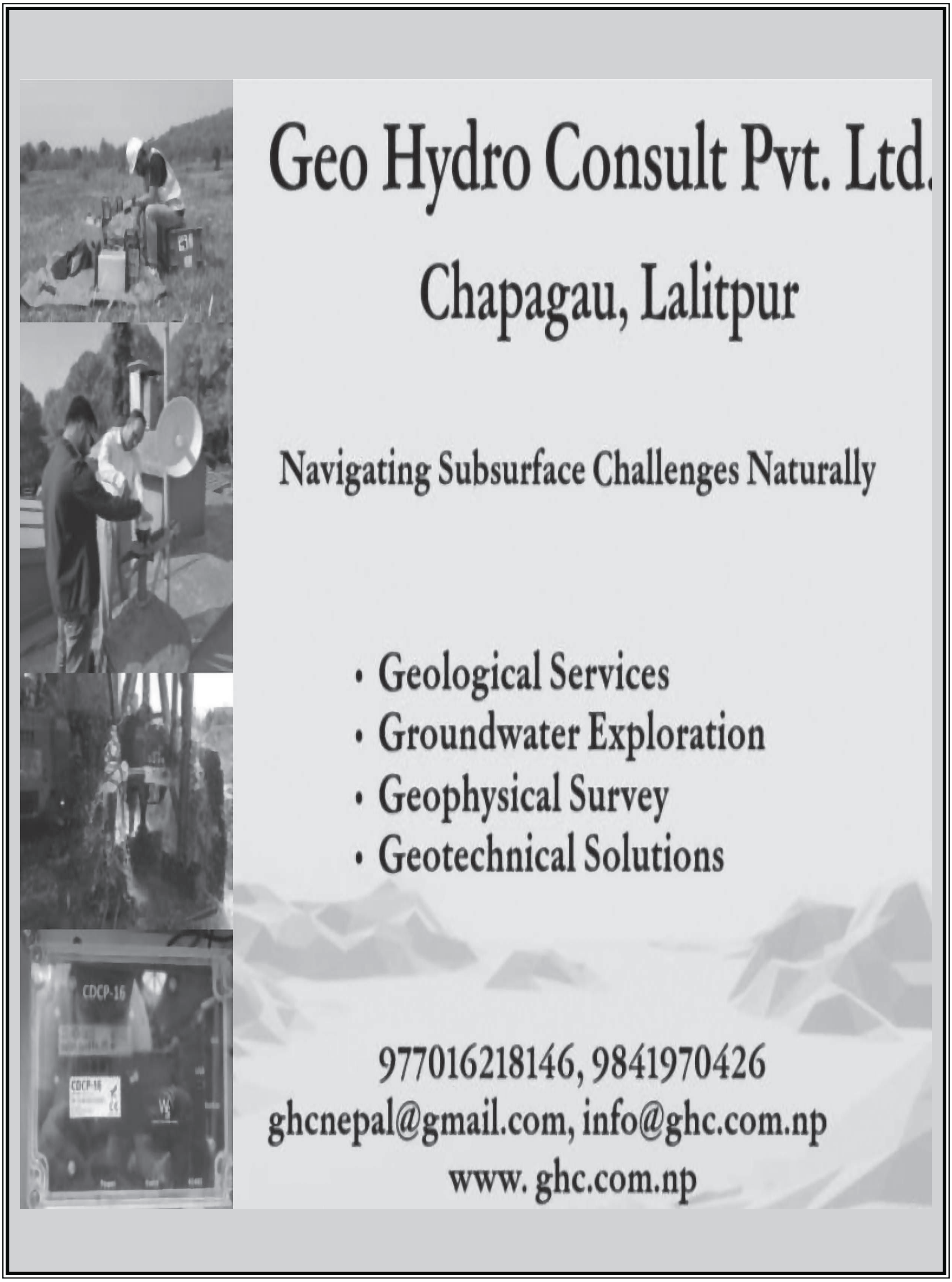
Promotions

Ms. Monika Jha (LM 150)
Director General (DG),
Department of Mines and Geology,
Ministry of Industry, Commerce and Supplies,
Government of Nepal

Award

Dr. Prakash Pokhrel (LM 131)
Ph.D on "Tectono-Geomorphic model for the landscape evolution of the Kathmandu Basin, Nepal" University of Edinburgh, UK

Dr. Champak Babu Silwal (LM 132)
Ph.D on "Delineation of Groundwater System and Groundwater Potential in Kankai River Basin, Nepal Himalaya." Tribhuvan University,
Institute of Science and Technology,
Central Department of Geology, Kirtipur, Kathmandu, Nepal
Assistant Campus Chief Of Trichandra Campus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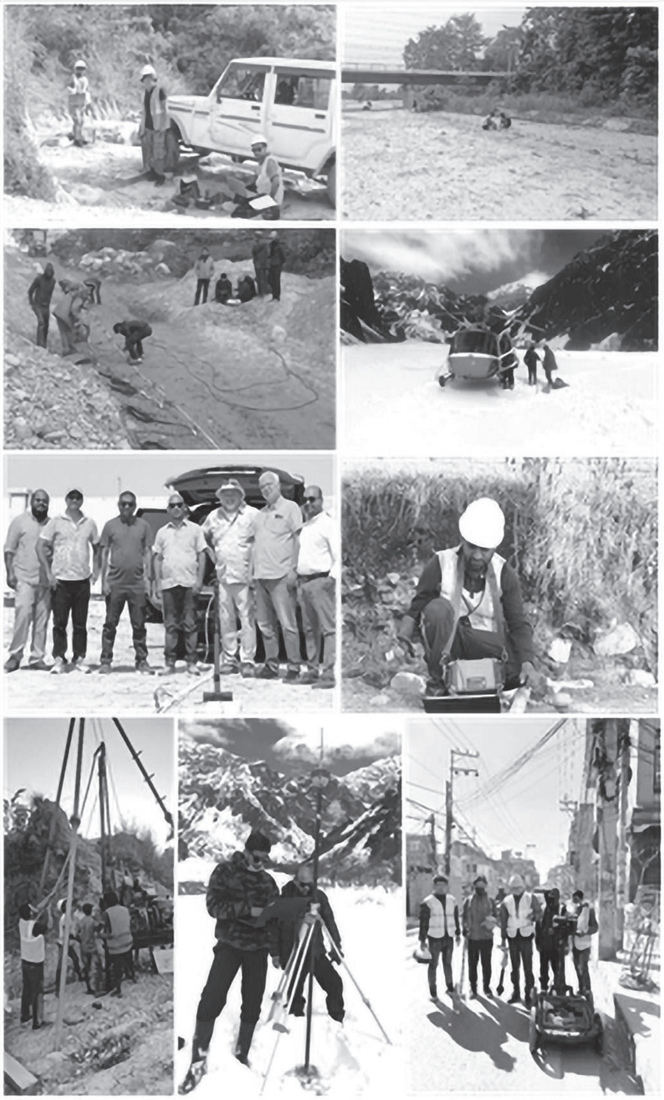

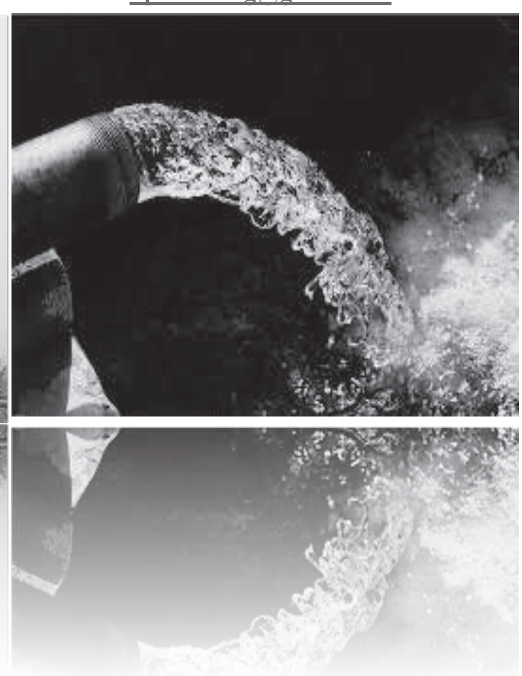

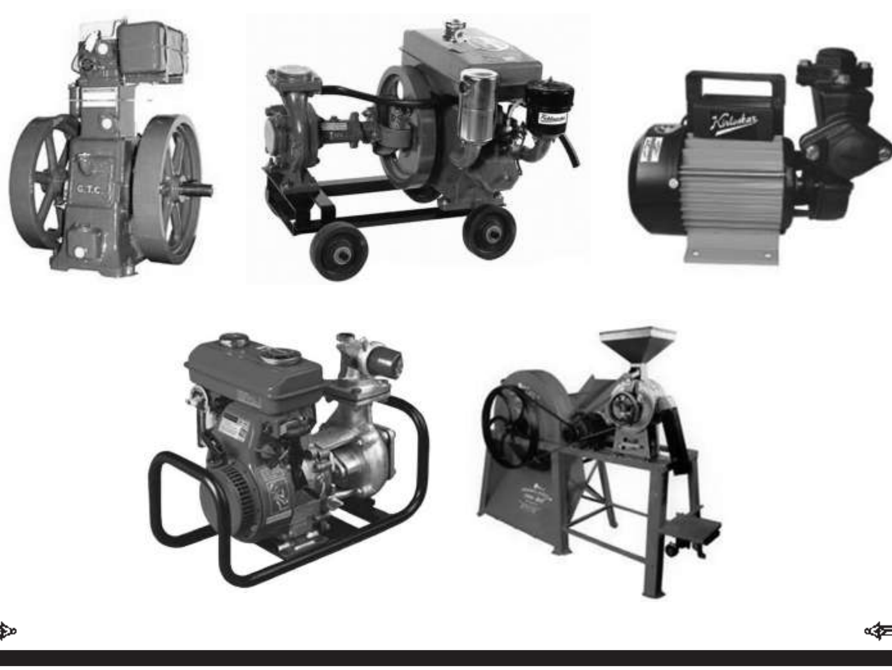

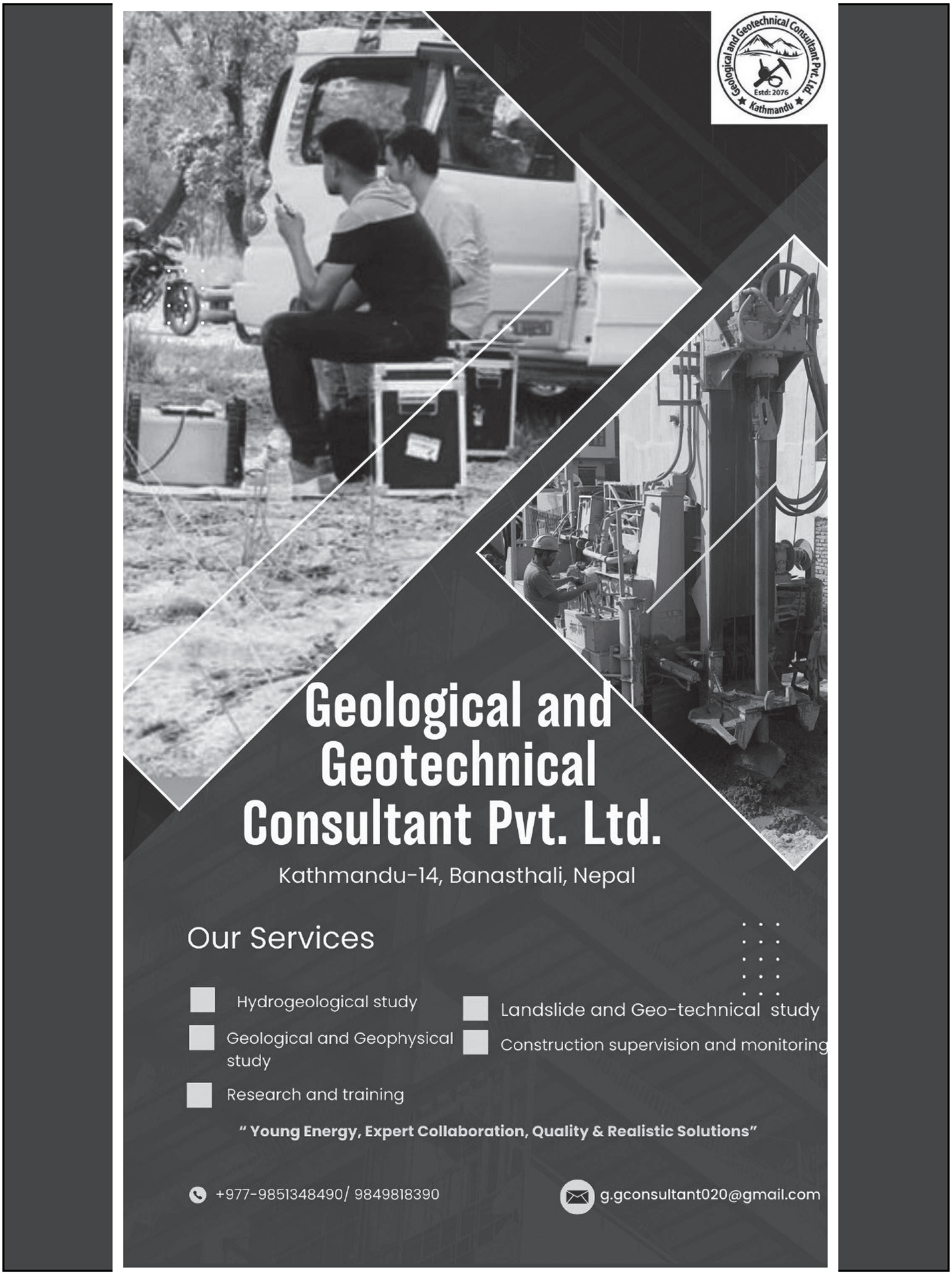
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Estd: 2076
Kathmandu
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Kathmandu-14, Banasthali, Nepal
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Geological and Geophysical study
Research and training
Landslide and Geo-technical study
Construction supervision and monitoring
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Supporting Organization of 1st Nepal Hydrogeological Conference

Kalika Drilling Pvt. Ltd.

कालिका ड्रिलिंङ्ग (प्रा.) लि.

काठमाडौँ –३४, नयाँ बानेश्वर । सम्पर्क : ९८५५०५८३७८

हाम्रा सेवाहरु :–

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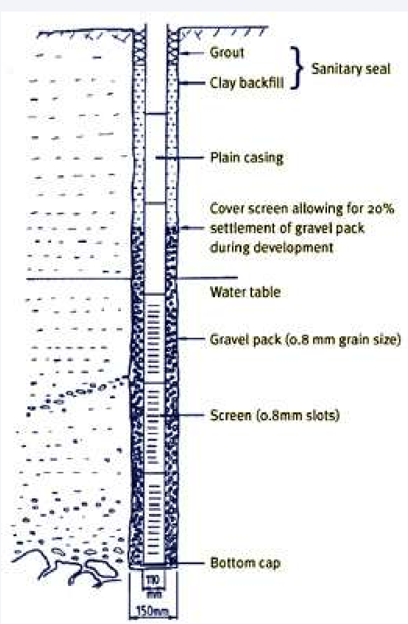

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On the occassion of it's 14th Annual General Meeting

From

Groundwater Resource and Irrigation Development Division
Jaleshwor, Mahottari

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10	Executive Member	Mr. Shrawan Shakya	LM 86
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12	Executive Member	Ms. Alina Karki	LM 84
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9	Executive Member	Mr. Lelin Raj Dhungel	LM 60
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8	Executive Member	Mr. Saroj Niraula	LM 73
9	Executive Member	Mr. Nir Shakya	LM 3
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11	Executive Member	Ms. Sabina Khattri	LM 83

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ARTICLE SECTION

CAVES IN NEPAL AND THEIR IMPORTANCE

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Corresponding Email: paudyalkabi1976@gmail.com

INTRODUCTION

According to Ford and Williams (2007), a cave is a naturally occurring subterranean depression or chamber that is usually big enough for a person to enter and is created by geological processes such rock disintegration, erosion, or volcanic activity.

Caves are categorized according to how they were formed. The most prevalent kind of caves are limestone ones, which form over thousands or even millions of years as carbonate rock dissolves in acidic water (Palmer, 1991). Other varieties include sea caves, which are sculpted by wave action along coasts (Trenhaile, 1987), glacier caves, which are created by melting and refreezing processes beneath ice (Benn & Evans, 2010), and lava tubes, which are created by flowing molten lava (Wood, 1981).

Caves are important to ecology because they provide as homes for unusual creatures like blind fish, bats, and invertebrates that can survive in low light levels (Culver & Pipan, 2009). Because early people utilized them for shelter, art, and religious activities—as seen by places like the Lascaux Caves in France—they are also significant in the fields of archaeology and anthropology (Clottes, 2008). Caves are now researched for their cultural legacy, biodiversity, and geological significance.

SPELEOLOGY

Speleology is the scientific study of caves. The study of cave formations, including their geology, biology, hydrology, and ecosystem dynamics, is included in this field. Speleologists investigate caves to learn about their mineral makeup, formation processes, and the organisms that call them home. To preserve caves, comprehend their biological relevance, and use them for tourism and scientific research, speleology research is essential.

IMPORTANCE OF CAVES FOR HUMAN

Humans may benefit greatly from caves in a number of ways, including as conservation, education, entertainment, ecotourism, and geotourism. They are essential to many facets of human existence because of their distinctive forms, historical significance, and ecological function.

1. Geotourism and ecotourism

Because of their amazing rock formations, underground rivers, and abundant biodiversity, caves are essential to geotourism and ecotourism, drawing millions of tourists each year. Renowned caverns including Mahendra Cave, Bat Cave, and Halesi Cave etc. are popular tourist destinations in Nepal that attract both local and foreign visitors. These natural beauties greatly boost the local economy in addition to giving tourists the opportunity to explore unusual subterranean landscapes. Guided tours, conservation fees, and adventure tourist pursuits like cave exploration and spelunking are the sources of income. These caverns support local populations' livelihoods while simultaneously protecting their delicate ecosystems by encouraging sustainable tourist practices.

2. Education and scientific research

For geologists, archaeologists, and biologists, caves are natural laboratories that provide important insights into the ecosystems and history of Earth. Scientists can examine long-term climate change and environmental transformations thanks to the preservation of past climatic data provided by their stalactite and stalagmite formations. Furthermore, cave archeological finds—like the prehistoric cave paintings in France's Lascaux Caves—offer vital proof of early human civilizations and provide insight into the art, culture, and way of life of the past. Additionally, caves are home to unusual creatures that have evolved to harsh conditions, which makes them a crucial area of study for biologists. These investigations advance our knowledge of microbial life, evolutionary adaption, and perhaps possible alien environments.

3. Entertainment and adventure activities

Caves provide exciting chances for fun and adventure, drawing fans of subterranean river exploration, rock climbing, zip-lining, and spelunking (caving). Gupteshwor Cave in Pokhara, Nepal, is a well-liked site for adventurers due to its subterranean waterfall. Similar to this, Tanahu's Siddha Cave, one of Nepal's biggest caves, is renowned for its expansive chambers and daring caving adventures. Caves are not just places for adventure; they are also unusual places for entertainment. Around the world, subterranean concerts and light displays are held in places like Reed Flute Cave in China and Postojna Cave in Slovenia, which create a captivating ambiance. These gatherings emphasize the caves' cultural and recreational value, elevating them above the status of just geological phenomena.

4. Environmental and cultural conservation

Numerous caves have spiritual and religious importance; they are hallowed places for meditation and devotion. Halesi Mahadev Cave in Khotang, Nepal, is a significant Buddhist and Hindu pilgrimage site that is said to be the location of Guru Padmasambhava's meditation. Similar to this, hundreds of devotees go to Pokhara's Gupteshwor Mahadev Cave, which is well-known for its naturally occurring Shiva Lingam. In addition to having cultural and religious significance, caves are essential for preserving the equilibrium of ecosystems since they serve as homes for insects, bats, and other animals that are suited to caves and support biodiversity and ecological stability. Cave protection is crucial because human exploitation and climate change pose challenges to these delicate ecosystems. These natural treasures are safeguarded for future generations via conservation efforts and sustainable tourism.

GEOLOGICAL CONDITION FOR CAVE FORMATION

The dissolution, erosion, volcanic activity, or tectonic movement that affects subterranean rock formations can result in the construction of caves. The most frequent process that creates karst caves is chemical weathering of carbonate rocks (gypsum, limestone, and dolomite). Other caves are created by erosion, volcanic action, or structural collapse. The following are the main geological requirements for cave formation:

Type of Rock: Because they dissolve in water, limestone, dolomite, gypsum, and marble are the main materials that make caves. Less frequently, caves can also form in granite (tectonic caves), sandstone, or basalt (lava tubes).

Chemical weathering and water action:

Carbonic Acid Dissolution: Rainwater creates weak carbonic acid (H_2CO_3) by absorbing carbon dioxide (CO_2) from the soil and environment. Because this acid dissolves limestone, it causes fissures to widen and subterranean chambers to form.

Reaction

$$CO_2 + H_2O \rightarrow H_2CO_3$$

$$H_2CO_3 + CaCO_3 \rightarrow Ca^{2+} + 2HCO^{-}_3$$

Hydrothermal Activity: Large cave systems can occasionally be formed when limestone is dissolved by sulfuric acid from groundwater.

Tectonic activity and structural weakness: Cave development is accelerated by water seeping in through pre-existing joints, fractures, and faults in rocks. Caves may become visible at the surface because to erosion and uplift.

Time: Cave formation is a slow process, taking thousands to millions of years for significant underground networks to develop.

CAVE TOPOGRAPHY

The distinctive internal and exterior landforms connected to subterranean cave systems are referred to as cave topography. The main processes that create the characteristics within and outside of caves include chemical dissolution, erosion, volcanic activity, and tectonic movements.

1. Speleothems (Cave Mineral Deposits)

Speleothems are secondary mineral formations that are mostly made of calcium carbonate ($CaCO3$) and are found inside caves. When mineral-rich water falls from cave ceilings and evaporates, solid deposits are left behind, creating these formations (White, 1988).

- Icicle-shaped structures that dangle from the ceiling are called stalactites.
- Stalagmites are formations that resemble cones that emerge out of the ground.
- Stalactites and stalagmites combine to form columns.
- Flowstones are deposits of calcite that resemble sheets and cover the walls and floors of caves.

2. Cave Passages and Chambers

The composition of rocks and water flow determine the size and shape of caves (Palmer, 1991).

- Tunnels created when water dissolves rock along fissures are known as solution passages.
- Water cutting downhill via the cave system creates vertical shafts, which are deep pits.
- Found in deep karst systems, underground rivers and lakes are frequently observed in caverns filled with water, as the cenotes in Mexico.

3. Sinkholes and Surface Depressions

Cave collapses and underground drainage often create depressions on the Earth's surface.

- Dolines, or sinkholes, are round indentations created when cave roofs collapse.
- Uvalas: Bigger depressions created when many sinkholes combine.
- Resurgence Springs: Locations where subterranean rivers emerge again.

KARST TOPOGRAPHY

Over thousands to millions of years, soluble rocks, mostly limestone, weather chemically to create karst topography, a unique terrain. Sinkholes, caverns, subsurface drainage systems, and vanishing rivers are all the results of this process (Ford & Williams, 2007) (Figure 1).

Surface Features

- **Sinkholes (Dolines):** Large indentations brought on by subsurface erosion or cave ceiling collapse.
- **Disappearing Streams:** Rivers that disappear into caverns beneath the surface and then reappear as karst springs.
- **Limestone Pavements:** Grikes are exposed, level limestone surfaces with deep fissures.
- **Poljes:** Large valleys with flat floors in karst areas that flood sometimes.

Underground features

- **Caverns and Caves**: Huge spaces created when limestone dissolves.
- **Speleothems:** Mineral deposits (such as flowstones, stalagmites, and stalactites) that form inside caves.
- **Underground rivers and lakes**: Found in deep cave systems, such as the Phong Nha Caves in Vietnam, include

Tropical and Tower karst

- **Tower Karsts**: Remote, precipitous limestone hills that can be found in tropical areas (like Guilin, China).
- **Cone Karst**: Tropical karst habitats are characterized by rounded limestone hills.

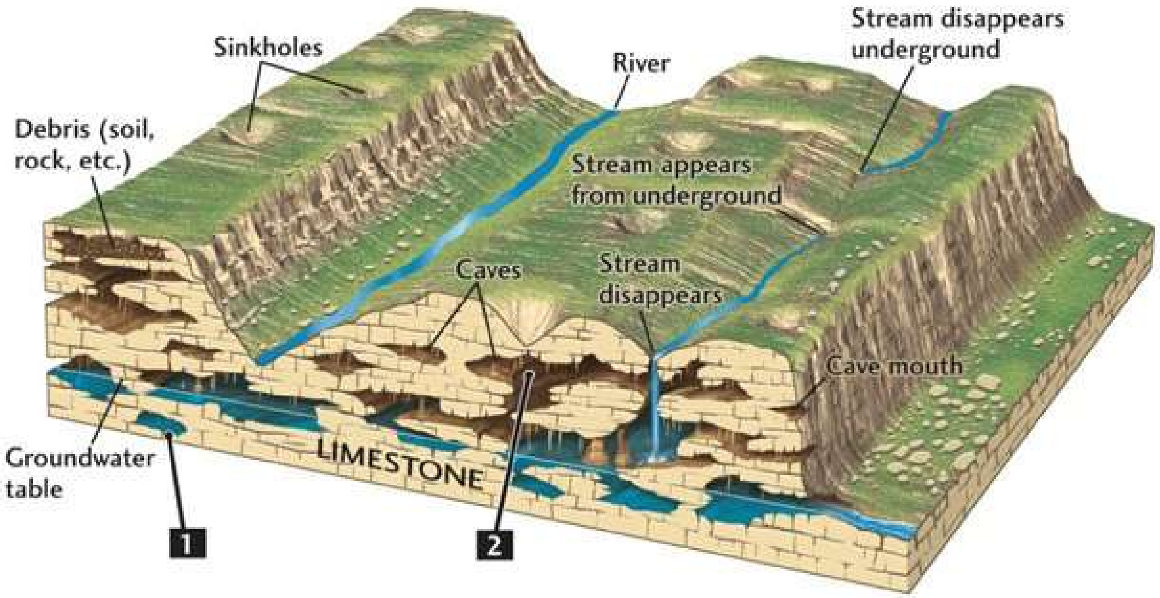

Figure 1 Schematic diagram illustrating Karst Topography (Source: google image)

Table 1 List of some Caves found in Nepal

S.N.	Caves	District	Remarks
1	Bagdwara cave	Kavrepalanchowk	
2	Bajura cave	Bajura	
3	Bat Cave	Kaski	150m * 15m dimension; U-shaped solutional cave, known for the habitat of Horseshoe bat inside the cave, popular tourist destination
4	Bichitra Cave (Dhurkot Cave)	Gulmi	185 m long; Have several interconnected chamber, walls and ceilings are decorated with natural stalactites and stalagmites, tourist destination
5	Buddha Cave	Mustang	Component of the Mustang cave complex, and is said to contain old Buddhist relics and artwork
6	Chhobhar Cave	Kathmandu	Minimum length of 1250 m, Largest in Asia, Longest cave in Nepal, naturally formed stalactites and stalagmites
7	Ghalegaun Cave	Lamjung	Known for its historical and cultural significance
8	Gupteshwar Cave	Parbhat	

9	Gupteshwor Mahadev Cave	Kaski	2057 m long; Davis fall passes through this cave, dark, moist, and has limestone formations
10	Halesi Mahadev Cave (Halesi Maratika Cave)	Khotang	Entrance is shaped as half-moon, has religious significance
11	Jaleshwor Cave	Mahottari	Associated with Hindu mythology and Lord Shiva
12	Kali Gandaki cave	Parbat	Found along the Kali Gandaki River, this cave has historical significance with ancient paintings and inscriptions
13	Kumari cave	Kaski	
14	Kanchan Cave	Chitwan	Limestone cave with underground water passages, known for its narrow tunnels.
15	Kusma Cave	Parbat	Deep limestone cave with unique rock formations; less explored compared to other caves.
16	Mahendra Cave	Kaski	Was known as Adhero Bhawan, contains stalagmites and stalactites, tourist destination
17	Mustang Cave (Sky Cave)	Mustang	Thousands of man-made caves carved into cliffs, believed to be ancient meditation chambers and burial sites
18	Pandav Cave	Dailekh	Linked to the Mahabharata, it is said to have been a refuge for the Pandavas during their exile.
19	Patal Gufa	Syanja	Dark, mysterious cave with multiple chambers
20	Pindeshwor Cave	Sunsari	Sacred cave dedicated to Lord Shiva, where pilgrims visit during the Bol Bom festival.
21	Ranchung Chungsi Cave	Mustang	Stunning Stalactites and Stalagmites, hidden entrance, Buddhist Sacred Site
22	Rasuwagadhi Cave	Rasuwa	Located near the Tibetan border, used historically as a hideout and resting place for traders.
23	Rupse Cave	Palpa	Contains a waterfall inside and is considered sacred by locals
24	Siddha Cave	Tanahu	Approx. 437 meters deep and 50 meters high; One of the largest caves in Nepal, with vast chambers, rock formations, and home to various species of bats
25	Tiger cave	Dang	Associated with local legends of tigers residing in the cave, and ancient human settlements.
26	Tila Gufa	Jumla	Lesser-known cave in the remote Karnali region, believed to have been used by ancient sages.

CASS STUDY

Case I: Gadhare Cave

Gadhare Gufa is a naturally occurring limestone and sandstone cave that was sculpted over thousands of years by chemical weathering and erosion. It is situated in Nepal's Syangja district (Sharma, 2015). The cave's geological and biological significance is enhanced by its exquisite stalactite and stalagmite formations, subterranean water streams, and small passageways (Figure 2 and 3) (Koirala, 2018). The interior of the cave is still being shaped by these water channels, which support distinctive microbiological life in its moist, dark environment (Acharya, 2019). Legends associate Gadhare Gufa with ancient hermits and historical wars, adding to its cultural and historical significance beyond its natural beauty (Thapa, 2021). The cave's historical significance is further enhanced by ancient writings and items discovered inside that point to its previous usage as a haven (Kandel, 2022). The cave is a popular tourist destination, but it confronts problems including uncontrolled tourism, trash, and environmental deterioration. To preserve its natural and cultural legacy, conservation measures like guided tours and awareness campaigns are needed (Shrestha, 2023). Maintaining Gadhare Gufa's geological, ecological, and historical value for future generations depends on its preservation.

Figure 2 Lamination observed in the wall rock

Figure 3 Stalactite and Stalagmite formed inside the Gadhare Gufa

Case II: Byas Gufa

Sage Ved Vyasa, the author of the Mahabharata, is said to have meditated and written in Byas Gufa, an old cave near Tanahun, Nepal. The cave is a sacred place for spiritual study and meditation since, according to Hindu legend, Vyasa wrote the Mahabharata here while dictating it to Lord Ganesha (Sharma, 2008). Byas Gufa is a naturally occurring cave made of sedimentary rock (limestone) that is located on the banks of the Madi River (Figure 4). It has small entrances and a dimly illuminated interior that contributes to its peaceful and ethereal feel (Dahal, 2015). The cave is still a popular pilgrimage site, drawing followers from Nepal and India, particularly during religious holidays like Guru Purnima and Mahashivaratri, where a symbolic figure of Sage Vyasa is worshipped (Joshi, 2019).

However, the cave faces challenges like poor maintenance, lack of tourist facilities, and environmental concerns, which necessitate further conservation efforts by local authorities and cultural organizations. Byas Gufa remains a vital cultural and religious landmark in Nepal, and its long-term preservation and infrastructure development are essential to maintaining its historical and spiritual significance. The site also supports businesses like hotels and souvenir shops through tourism, but increased infrastructure and preservation efforts are needed to maximize its potential (Gurung, 2021).

Figure 4 Photographs of Byas Gufa

Case III: Bichitra Gufa

The distinctive limestone cave known as Bichitra Gufa is situated in Nepal's Gulmi district and was created over thousands of years by tectonic action, chemical weathering, and hydrological processes. Tunnels, chambers, and complex stalactite and stalagmite formations are formed when calcium carbonate ($CaCO_3$) in the limestone is dissolved by the slightly acidic water (Smith et al., 2012). The area was formerly covered by an ancient sea, as evidenced by the sedimentary rock layers and fossil imprints found there (Koirala, 2018). Due to fractures and cracks caused by tectonic movements in the Himalayas, water was able to seep deeper into the rock, speeding up weathering and contributing to the cave's expansion (Gurung, 2020). There are several chambers, tight corridors, and tall rock formations in the cave; some parts are too deep to be explored (Figure 5). Bichitra Gufa attracts visitors and spiritual seekers due to its cultural and religious significance in addition to its natural significance. Its delicate habitat is threatened by uncontrolled tourism and environmental deterioration, though, thus conservation measures including restricting tourist access and encouraging sustainable cave tourism are required (Thapa, 2021). Preserving the cave's biological, cultural, and geological integrity for future generations depends on its preservation.

Figure 5 Photographs of Bichitra Gufa and its surrounding

DISCUSSION

Caves have always been intriguing natural structures because of their cultural, ecological, and economic relevance in addition to their geological significance. This talk emphasizes the many facets of caves, from their topography and creation to their significance to humans, highlighting their many functions in both natural and social situations.

Complex geological processes, including tectonic movements, erosion, the breakdown of soluble rocks, and occasionally volcanic activity, are required for the development of caves. The main materials that aid in the construction of caves are limestone, gypsum, and marble because of their water solubility, which causes processes like carbonation and hydrothermal activity. These processes produce a wide variety of cave formations throughout time, ranging from underground rivers and lakes to stalactites and stalagmites. The forces of water and rock contact create the topography of caves as they grow, creating enormous underground chambers and breathtaking speleothems. Caves are a tribute to the gradual yet potent forces of nature, since this process takes place over thousands to millions of years.

Caves have numerous advantages, but they are also seriously threatened by climate change and human activity. Unauthorized excavation, pollution, and overtourism can harm delicate cave ecosystems and cause permanent biodiversity loss. Furthermore, animals that have evolved to survive in certain subterranean circumstances may be impacted by changes in cave ecosystems brought about by climate change. Therefore, preserving the fragile balance of these ecosystems depends on cave protection. This entails putting in place sustainable tourism procedures, limiting access to delicate locations, and spreading knowledge about the value of caves for the preservation of the environment and culture.

Importance to develop and make conservation of Caves in Nepal

For many reasons, including scientific, cultural, ecological, and economic ones, the development and preservation of Nepal's caves is essential. For scientists studying geology, archeology, and biology, caves act as natural laboratories that yield important information about the planet's past, prehistoric societies, and distinctive ecosystems. Ancient antiques and religious treasures may be found in caves like Mustang and Gupteshwor, which makes them crucial for conserving Nepal's cultural legacy. Many caverns, like Halesi Mahadev Cave, have great spiritual significance as well, drawing pilgrims and boosting Nepal's cultural tourist industry. Rare species like insects, bats, and other cave-adapted creatures can find a home in caves, which supports biodiversity and the equilibrium of regional ecosystems.

In terms of the economy, Nepal's caverns are a major source of tourists. Both domestic and foreign tourists are drawn to tourist destinations including Mahendra Cave, Bat Cave, and Siddha Cave, which provide revenue for the local communities through admission fees, guided tours, and associated services. Caves are also thriving destinations for adventure tourism, which supports local companies and creates jobs via activities like rock climbing and spelunking. Furthermore, by protecting these natural riches, their delicate ecosystems are preserved and future generations will be able to continue exploring these geological gems. In the end, Nepal can preserve its caverns and capitalize on their economic potential while preserving its natural and cultural legacy by emphasizing sustainable tourist practices and conservation initiatives.

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तराईको भूमिगत जलः हल्ला, यथार्थ र प्रभावकारी अनुगमनको आवश्यकता

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परिचय

सतहमुनि रहने अदृश्य पानी, अर्थात् भूमिगत जल, नेपालको जनजीवनको एक महत्त्वपूर्ण आधार हो, र तराई क्षेत्रका लागि त यो जीवनरेखा नै हो । यो समग्र जलचक्रको एक अभिन्न अंग भएकाले मौसम परिवर्तनसँगै यसको स्तरमा घटबढ हुनु स्वाभाविक प्रक्रिया हो । वर्षायाममा पुनर्भरण भएर बढ्ने र सुक्खायाममा घट्ने यसको चरित्र हो । तराईमा चापाकल र ट्युबवेलदेखि पहाडमा पानीका मूलसम्म, हाम्रो जीवन भूमिगत जलस्रोतमा आश्रित छ । तर, बढ्दो जनसंख्या, अव्यवस्थित सहरीकरण र पानीको बढ्दो मागले यस स्रोतमाथि निरन्तर दबाब बढाएको छ । पछिल्लो समय तराईका ट्युबवेल र पहाडका मूलहरू सुक्न थालेको भन्ने समाचार आइरहँदा यसको वास्तविक अवस्था, उपयोग, चुनौती र दिगो व्यवस्थापनका उपायहरूबारे गम्भीर विमर्श गर्नु अपरिहार्य भएको छ ।

भूमिगत जलमा निर्भरताः तराईको समृद्धिको आधार

नेपालको कुल भूभागको १७% हिस्सा ओगट्ने तराईमा देशको आधाभन्दा बढी जनसंख्या बसोबास गर्छ । यहाँका अधिकांश मानिसहरू पिउने पानीका लागि भूमिगत जलमा पूर्ण रूपमा निर्भर छन् । गाउँदेखि सहरसम्मका बासिन्दाहरूले आफ्नो दैनिक आवश्यकता चापाकल वा ट्युबवेलमार्फत पूरा गर्छन् ।

यसको महत्त्व खानेपानीमा मात्र सीमित छैन । तराईको कुल सिञ्चित भूमिको ६० प्रतिशतभन्दा बढी हिस्सा भूमिगत जलमा आधारित छ, जसले कृषि उत्पादन र स्थानीय अर्थव्यवस्थामा मेरुदण्डको काम गरेको छ । साथै, उद्योगधन्दाहरू पनि आफ्नो सञ्चालनका लागि यही स्रोतमा निर्भर छन् । यसरी हेर्दा, तराईको जीवन र समृद्धि भूमिगत जलसँग अभिन्न रूपमा जोडिएको छ ।

सञ्चार माध्यममा संकटको चर्चा र वास्तविकता

पछिल्ला केही वर्षयता नेपाली सञ्चारमाध्यमहरूले तराईमा भूमिगत जलस्रोतको कमीलाई गम्भीर समस्याका रूपमा प्रमुखताका साथ उठाएका छन् । विशेषगरी सुक्खायाममा संकट चुलिएको देखाउने गरी प्रकाशित केही प्रतिनिधि समाचारहरू यस्ता छन्ः

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यी र यस्ता कैयौं समाचारहरूले भूमिगत जलस्रोतको संकटलाई उजागर गरेका छन् । तर, यी अधिकांश समाचार प्रभावित स्थानीय बासिन्दाको अनुभव र भनाइमा आधारित देखिन्छन् । केहीमा अध्ययन प्रतिवेदनलाई आधार मानिए पनि ती अध्ययनहरू पनि स्थानीयको भोगाइमा केन्द्रित छन् । भूमिगत जलको तह र मूलको बहाव (डिस्चार्ज) को नियमित वैज्ञानिक मापनमा आधारित विस्तृत विश्लेषण भने देखिँदैन । कुनै पनि निष्कर्षमा पुग्न अनुमान र अनुभव मात्र पर्याप्त हुँदैन, त्यसका लागि वर्षौंसम्मको नियमित तथ्यांक संकलन र वैज्ञानिक अनुसन्धान आवश्यक पर्छ । सुक्खायाममा पानीको तह घट्नु एक सामान्य मौसमी प्रक्रिया हो, तर विगतको तुलनामा यो गिरावट अस्वाभाविक छ भने मात्र चिन्ता र चासोको विषय हुन सक्छ ।

जलस्रोत ह्रासका कारणः भ्रम र यथार्थ

समाचारहरुमा कथित स्थानीय विज्ञहरूले जलस्रोत घट्नुको मुख्य कारण चुरे दोहन, वन विनाश र सहरीकरणलाई मानेको पाइन्छ । तर, यी कारणहरूको वैज्ञानिक विश्लेषण भने फरक देखिन्छः

१. **चुरे दोहनः** चुरे दोहनले तराईको भूमिगत जल सुक्छ भन्ने भाष्य व्यापक छ, तर यो पूर्ण सत्य होइन । चुरे क्षेत्रको दोहनले त्यही क्षेत्रका खोलानाला र पानीका स्रोतमा प्रत्यक्ष असर पार्छ । तर, तराईको समथर भूभागको भूमिगत जल पुनर्भरण गर्ने मुख्य क्षेत्र चुरे नभई भावर क्षेत्र र तराईको आफ्नै मैदान हो । त्यसैले, चुरे दोहनलाई सोझै तराईको चापाकल सुक्नुसँग जोड्नु वैज्ञानिक रूपमा तर्कसंगत देखिँदैन ।

२. **वन विनाशः** "वन विनाशले पानीका स्रोत सुक्छन्" भन्ने आम बुझाइ छ । पहाडी वा भिरालो जमिनमा वनले पानीलाई माटोमा सोस्न मद्दत गरी पुनर्भरण बढाउँछ । तर, तराईजस्तो समथर भूभागमा यसको उल्टो असर हुन सक्छ । घना जंगलले वाष्पोत्सर्जन (Evapotranspiration) प्रक्रियामार्फत ठूलो मात्रामा पानी सोसेर वायुमण्डलमा पठाउँछ, जसले भूमिगत जलको भण्डारलाई घटाउन सक्छ । केही अध्ययनले समथर भूभागमा वन विनाशपछि भूमिगत जलको तह बढेको समेत देखाएका छन् । त्यसैले, वन विनाशले सधैँ भूमिगत जल घटाउँछ भन्ने तर्क सबै ठाउँमा लागू हुँदैन ।

३. **सहरीकरणः** भूमिगत जल ह्रासको एक प्रमुख र वास्तविक कारण भने अव्यवस्थित सहरीकरण हुन सक्छ । सहरहरूमा घर, सडकजस्ता पक्की संरचनाले गर्दा वर्षाको पानी जमिनमुनि सोसिन पाउँदैन । एकातिर पुनर्भरणको क्षेत्र घट्ने र अर्कोतिर सानो क्षेत्रमा अत्यधिक पानीको दोहन हुने हुँदा सहरी क्षेत्रमा भूमिगत जलको तह तीव्र गतिमा घट्छ । यदि यसो हो भने यो समस्या सहर केन्द्रित हुनु पर्छ तर सुदूर ग्रामीण इलाकामा कुनै प्रभाव नपरेको हुनु पर्छ ।

नियामक निकायको शून्यताः मुख्य चुनौती

नेपालमा भूमिगत जलस्रोतको विकास र अध्ययनका लागि २०२८ सालमा 'भूमिगत जलस्रोत विकास समिति' गठन भएको थियो । तर, यो समिति सिँचाइ विकासमा बढी केन्द्रित हुँदा अनुगमन, नियमन र तथ्यांक संकलनजस्ता महत्त्वपूर्ण पक्ष ओझेलमा परे । विडम्बना, भूमिगत जलको महत्त्व बढिरहेको र यसको उत्खनन सम्बन्धमा चुनौती बढ्दै गैरहेको बेला २०८० सालको बजेट भाषणमार्फत उक्त समितिलाई विघटन गरियो, तर यसको कामको जिम्मेवारी कुनै अर्को निकायलाई सुम्पिइएन । आजको दिनमा खानेपानी, सिँचाइ र उद्योगमा व्यापक प्रयोग भइरहेको यो स्रोतको अनुगमन र नियमन गर्ने कुनै आधिकारिक राष्ट्रिय निकाय छैन । यो नियामक शून्यता नै भूमिगत जल व्यवस्थापनको सबैभन्दा ठूलो चुनौती हो ।

अबको बाटोः तत्काल गर्नुपर्ने काम

नेपालको जलस्रोत नीति, २०७७ ले भूमिगत जलको पुनर्भरण क्षेत्र पहिचान गरी संरक्षण गर्ने र अत्यधिक दोहन नियन्त्रण गर्न मापदण्ड बनाउने जस्ता महत्त्वपूर्ण कार्यनीति अघि सारेको छ । तर, यसको कार्यान्वयनका लागि आवश्यक एक स्वतन्त्र, सक्षम र अधिकारसम्पन्न संस्थाको परिकल्पना गरेको देखिँदैन । यस सन्दर्भमा, निम्न कार्यहरू तत्काल अघि बढाउन सम्बन्धित निकायको ध्यानाकर्षण हुन जरूरी देखिन्छ ।

१. **संस्थागत व्यवस्थाः** भूमिगत जलस्रोतको नियमित मापन, अनुगमन, अध्ययन, नियमन र संरक्षणको समग्र जिम्मेवारी बहन गर्न एक अधिकारसम्पन्न राष्ट्रिय निकायको स्थापना गर्ने ।

२. **वैज्ञानिक अनुगमनः** देशभरका विभिन्न स्थानमा 'अब्जरभेसन ट्यूबवेल' -अवलोकन इनार जडान गरी जलतहको नियमित मापन गर्ने । साथै, देसभरिका पानीका प्रमुख मूलहरूको सूची तयार गरी निर्धारित मूलहरूमा नियमित रूपमा बहाव (डिस्चार्ज) मापन गर्ने व्यवस्था मिलाउने ।

३. **कृत्रिम पुनर्भरणः** भूमिगत जल पुनर्भरणका लागि सम्भाव्य स्थानहरूको पहिचान गरी पोखरी निर्माण, रिचार्ज पिट (पुनर्भरण खाडल) जस्ता कृत्रिम विधिको अवलम्बन गर्ने ।

४. **जनचेतना र सहभागिताः** पानीको दिगो उपयोग र संरक्षणका लागि स्थानीय समुदायको सहभागिता सुनिश्चित गर्दै जनचेतनामूलक कार्यक्रमहरू सञ्चालन गर्ने ।

निष्कर्ष

नेपालको भूमिगत जलस्रोत हाल पूर्ण रूपमा संकटमा परिसकेको त होइन, तर संकटोन्मुख अवस्थामा भने छ भन्न सकिन्छ। यसबाट उत्पन्न हुने सम्भावित चुनौतीको समाधान हल्ला र अनुमानले होइन, वैज्ञानिक तथ्यांक र विश्लेषणमा आधारित ठोस र दीर्घकालीन उपायले मात्र सम्भव छ । जमिनमुनि रहेकोले आँखाले देख्न नसकिने यो 'अदृश्य स्रोत' को संकट भने प्रत्यक्ष, गम्भीर र जनजीवनमा दूरगामी असर पार्ने खालको हुन्छ।

वर्तमानमा नेपालमा भूमिगत जलस्रोत सम्बन्धी खबरहरु प्रायः स्थानीय अनुभव, अनुमान र अनौपचारिक बुझाइमा आधारित छन्, जसले वैज्ञानिक दृष्टिकोणको अभाव स्पष्ट देखाउँछ । तथ्यमा आधारित ज्ञानको ही कमीले समस्याको सही पहिचान र समाधानमा अवरोध खडा गर्छ, जुन दीर्घकालीन रूपमा जोखिमपूर्ण हुन सक्छ।

तराईको जीवन, कृषि, उद्योग, र खानेपानी प्रणालीको मेरुदण्ड बनेको यो जलस्रोतको दिगो व्यवस्थापन आजको प्रमुख राष्ट्रिय चुनौती हो । यसको मूल जड भनेकै भूमिगत जलस्रोतको निगरानी, नियमन, संरक्षण र व्यवस्थापनको जिम्मेवारी लिने एउटा अधिकारसम्पन्न राष्ट्रिय निकायको अभाव हो । तसर्थ अबको पहिलो र अपरिहार्य कदम भनेको वैज्ञानिक अनुगमन, तथ्यमा आधारित नीति निर्माण, र स्थानीय सहभागितामार्फत भूमिगत जलस्रोतको समग्र व्यवस्थापन सुनिश्चित गर्न सक्ने एक सक्षम र स्वतन्त्र राष्ट्रिय निकायको स्थापना गर्नु नै हो। अब अनुमान र आशंकामा अल्झिने होइन, प्रमाण र तथ्यांकका आधारमा निर्णय लिने समय आएको छ, जसले भविष्यका पुस्तालाई पानीको चरम संकटबाट जोगाउनेछ । सम्बन्धित निकायहरूको ध्यानाकर्षण होस् ।

MOUNTAIN HYDROGEOLOGICAL SYSTEM IN NEPAL

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ABSTRACT

The objective of this research is to synthesize the role of lithology, structure, and climate in shaping groundwater regimes across the High Himalaya, Lesser Himalaya, Siwalik, and Terai zones, using comparative analysis of hydrogeological settings and literature evidence to highlight variability in aquifer behaviour, recharge processes, and water availability. In the crystalline and metamorphic terrains of the High and Lesser Himalaya, groundwater storage and movement are largely fracture-controlled, producing springs that are highly seasonal and sensitive to recharge, while the Siwalik foothills and Terai plains, composed of soft sedimentary rocks and unconsolidated deposits, host more continuous aquifers with greater primary porosity. Geological structures, including thrusts, folds, and fault networks, act as both pathways and barriers to groundwater flow, while stratigraphic discontinuities strongly influence spring discharge and storage. Monsoon rainfall drives distinct seasonality in recharge, whereas snow and glacier melt sustain flows during dry periods, though accelerating glacier retreat and shifting precipitation regimes are altering late-season base flows and diminishing hydrological reliability. This synthesis emphasizes the combined role of lithology, structure, and climate in shaping groundwater availability, underscoring the importance of integrated hydrogeological understanding in Himalayan water studies.

Keywords: ***Nepal Himalaya, mountain hydrology, geological structures, lithology, climate variability***

INTRODUCTION

The Nepal Himalaya is geologically complex, composed mainly of Late Precambrian to Oligocene sedimentary and low-grade metamorphic rocks. The Lesser Himalaya contains dolomite, slates, shales, quartzites, and other meta-sedimentary sequences (Stöcklin, 1980; Hashimoto et al., 1973; Stöcklin & Bhattarai, 1977; Sakai, 1983), while the Tethys and Sub-Himalaya are dominated by sedimentary rocks such as sandstones, limestone, marl, shale, and conglomerates. Also, Large-scale folding, faulting, and the presence of numerous thrust sheets create a geologically diverse landscape throughout the Himalaya. These active faults and structural deformations not only shape the topography but also influence groundwater movement, spring formation, and river flow patterns (Jouanne et al., 1999; Nakata, 1989).

Nepal's water resources come from three main sources: glacier and snowmelt in the high mountains, seasonal monsoon rainfall on the mid-slopes, and groundwater stored in fractured bedrock and alluvial aquifers. The geology of these regions strongly influences how water is stored, moves, and interacts with rocks and sediments.

In hard-rock terrains, such as gneiss, granite, and quartzite found at higher elevations, primary porosity is very low, so water availability depends largely on fractures, joints, and the connectivity of these networks. Recharge in these areas is primarily from snow and glacial melt. In contrast, soft-rock terrains, including sandstones, shales, and Quaternary alluvial deposits in the Siwalik and Terai regions, generally have higher primary porosity, supporting more continuous groundwater storage.

Together, the combination of lithology, structural features, and climatic conditions defines Nepal's mountain hydrology, creating a mosaic of water availability, spring behavior, and seasonal variability. Understanding these natural controls is crucial for managing water resources sustainably in a region facing both climate change and increasing human demands.

Hydrogeology of Springs

Springs provide visible evidence of subsurface water movement in mountain terrains. Their occurrence and flow variability depend on geology, geomorphology, slope, and rainfall. Gentle slopes allow rainfall to infiltrate and recharge subsurface storage, whereas steep slopes promote rapid runoff, reducing groundwater replenishment.

Springs can be classified based on geological and geomorphological controls. They may occur as depression springs, which form where groundwater reaches the surface in low-lying areas; contact springs, emerging at the interface of permeable and impermeable layers; fracture springs, associated with joints or cracks in bedrock; karst springs, where water flows through dissolved cavities in carbonate rocks; and fault-controlled springs, where groundwater moves along active or inactive fault zones (Bryan, 1919; Davis & De Wiest, 1966; Fetter, 1990; Kresic, 2010). Discharge rates vary widely, from large perennial springs to minor seepage (Meinzer, 1923). While temperature classification distinguishes thermal springs occur where groundwater is heated by geothermal gradients, and non-thermal springs maintain temperatures close to the annual atmospheric average (Bryan, 1919).

Modern tools such as remote sensing and Geographic Information Systems (GIS) have greatly improved the ability to map groundwater potential in mountainous regions by integrating factors like geomorphology, lithology, and lineament analysis (Pathak & Shrestha, 2016). In Nepal, weight-of-evidence studies have shown that springs in high-grade metamorphic terrains are predominantly controlled by fractures, joints, and weathered bedrock (Ghimire et al., 2019).

Recharge zones are sensitive to rainfall variability, with fracture- and joint-controlled springs showing strong correlations between rainfall and discharge (Negi & Joshi, 2004; Amon et. al., 2023). However, many springs in Nepal are drying or becoming unreliable due to erratic precipitation, unplanned road construction, loss of traditional ponds, tectonic shifts, and human infrastructure interventions (Adhikari et al., 2020).

Springs exhibit seasonal variability, with higher flows during wet periods and reduced flow in dry seasons, influenced by recharge capacity, cover strata, and water-bearing layers (Meuli & Wehrle, 2001).

Mountain Hydrology in Nepal

Mountain hydrology in Nepal is largely shaped by the interplay of lithology, geological structures, and climatic conditions. Hard-rock terrains, including crystalline and low-grade metasedimentary rocks such as gneiss, schist, quartzite, and slate, have very limited primary porosity. Groundwater storage and movement in these regions are largely confined to fractures, joints, and fault damage zones. Springs in hard-rock areas are typically fracture- or fault-controlled, with sensitive flow to recharge timing and connectivity of the fracture networks. In well-connected networks, springs can maintain perennial flow, whereas poorly connected systems may exhibit intermittent discharge (Sapkota et al., 2024). Carbonate rocks like limestone and dolomite allow both conduit and diffuse flow through karst systems, responding rapidly to rainfall or snowmelt and exhibiting highly variable discharge. These waters are typically rich in calcium and magnesium, and high-flow events can increase turbidity.

In the Siwalik Group and Bhabar belt, coarse sandstones and mudstones favor rapid infiltration, recharging both local springs and downstream Terai aquifers. (Pathak, 2017). Terai alluvial deposits provide broad storage and laterally continuous aquifers. Rapid monsoon infiltration drives strong seasonality in shallow groundwater (Winrock International, 2021).

High-elevation headwaters influenced by glacial and paraglacial deposits carry substantial suspended sediments, including quartz, mica, and feldspar that affect downstream turbidity and river morphology. Snowpack and glacier storage help buffer seasonal flows but retreating glaciers reduce late-season water availability (Miller et. al., 2012; Armstrong, et.al., 2019;).

Geological Structures and Groundwater Pathways

Geological structures such as faults, fractures, folds, and thrusts play a key role in controlling groundwater storage and movement in mountainous regions. Lineaments identified through remote sensing often correspond to structurally controlled zones of enhanced secondary porosity, guiding groundwater from recharge areas to spring outlets (Ghimire et al., 2019).

Fault zones are critical hydrogeological features. Conceptually, a fault zone consists of the fault core, which includes breccia and cataclasite with intense deformation, and the surrounding damage zone, with numerous fractures and smaller-scale faults. These components are typically bound by relatively intact host rock, or protolith (Bruhn et al., 1994; Caine et. al., 1996; Evans et al., 1997; Gudmundsson et al., 2001). The permeability of these fault zones strongly influences groundwater flow. While the fault core may act as a partial barrier, the surrounding damage zone often serves as a conduit, creating a conduit–barrier system that channels water along preferential pathways (Caine et al., 1996; Chester & Logan, 1986; Smith et al., 1990). Faults aligned with the groundwater flow direction enhance discharge and spring yield, whereas those oriented perpendicular to flow have a reduced effect (Phillips, 1991). Faults interacting with karst systems further modulate spring activation, depending on hydraulic head thresholds (Petrella et al., 2009; Celico et al., 2006; Phillips, 1991).

Active faults can temporarily increase permeability, impacting spring discharge, river baseflow, and aquifer connectivity (Barton et. al., 1995; Gudmundsson, 2000; Mayer & Sharp, 1998). In some cases, faults behave as low-flow boundaries, allowing limited but significant fluid transmission rather than being completely impermeable (Celico et al., 2006). Sapkota et al. (2024) observed that in the mid-Himalayan fracture zones, groundwater yield and spring reliability were directly correlated with fault density and orientation, with higher discharge occurring along dextral strike-slip faults and well-connected fracture networks.

Folds and imbricated thrust sheets also influence groundwater by creating zones of accumulation along bedding-plane discontinuities, anticlines, and synclines. Conversely, steeply dipping strata can rapidly direct water downslope into streams or springs, limiting subsurface storage (Timalsina & Paudyal, 2018). Structural complexity at high elevations can result in perched aquifers or isolated fracture networks, producing spatial variability in spring yield and flow reliability.

Climate and Mountain Water Dynamics

Beyond the physical characteristics of hard- and soft-rock terrains, climate-driven characteristics also major in setting up a mountain hydrological system. Hydroclimatic changes also play a growing role. Regional studies across the Himalaya and Karakoram reveal long-term shifts in precipitation, runoff, and glacier dynamics that affect water availability (Lutz et. al., 2014). In the Everest region, interdisciplinary assessments highlight the links between glacier retreat, emerging hazards, and vulnerabilities in local water supplies (Miner et al., 2020).

Climatic conditions modulate the timing and magnitude of hydrological processes. The South Asian monsoon dominates recharge in both hard-rock and alluvial aquifers, generating pronounced seasonality in spring discharge, streamflow, and groundwater levels (Adhikari et al., 2020; Winter, 2001). Snowfall and glacier accumulation serve as natural hydrological buffers, releasing water gradually during melt seasons. Glacier retreat initially increases basin runoff but reduces late-season baseflow, impacting downstream communities (Miner et al., 2020; Lutz et. al., 2014). Temperature changes influence evapotranspiration, snowmelt timing, and high-altitude spring activation (Petrella et al., 2009). Variability in rainfall intensity and distribution, including delayed monsoons or short-duration heavy events, increases flash flood and landslide risks on steep slopes, while rapid recharge in softer and alluvial terrains may transport surface contaminants into shallow aquifers, affecting water quality (Negi & Joshi, 2004; Amon et. al., 2023). Collectively, lithology, geological structure, and climate interact to govern groundwater availability, spring behavior, and hydrological resilience in Nepal's mountainous landscapes.

Nepal's mountain water systems are thus controlled by a combination of geology, structural complexity, and climate. The interplay between hard-rock and soft-rock terrains, active fault zones, recharge processes, and hydroclimatic variability determines both the quantity and quality of groundwater and surface flows over time.

Discussion and Conclusion

Nepal's mountain hydrology is governed by the interplay of lithology, geological structures, and climate. Hard-rock terrains, including gneiss, quartzite, and low-grade metamorphic rocks, store and transmit groundwater primarily through fracture networks, joints, and fault zones. In contrast, soft-rock terrains and alluvial deposits provide more continuous aquifers with higher primary porosity but are more susceptible to geogenic and anthropogenic contamination. This contrast illustrates how rock type directly influences water availability, quality, and reliability across the Himalaya, Siwalik, and Terai regions. Springs in these terrains provide critical insight into subsurface water movement, showing strong sensitivity to recharge timing, slope, and structural controls. High-elevation springs may be perched or variable due to localized fracture networks, whereas lowland alluvial aquifers exhibit more stable flows but remain vulnerable to contamination during rapid monsoon infiltration.

Geological structures such as faults, folds, and thrust sheets further regulate hydrological behavior. Fault zones, composed of fault cores and surrounding damage zones, can act as both conduits and barriers, depending on orientation, connectivity, and activity. Fractures, lineaments, and structural discontinuities guide water from recharge areas to springs and rivers, creating spatial variability in groundwater availability. Well-connected dextral strike-slip faults, for example, have been shown to enhance spring discharge (Sapkota et al., 2024). Folds and thrust sheets may accumulate water along bedding-plane discontinuities, whereas steeply dipping strata can rapidly channel water into streams. Interaction between fault systems and karstified carbonate rocks adds further complexity, affecting spring activation under changing hydraulic conditions.

Climate exerts a strong influence over mountain water systems by controlling recharge and discharge patterns. Monsoon rainfall drives seasonal variability in streamflow and spring activity, while snow and glacier storage buffer flows during dry periods. However, glacier retreat and shifting precipitation patterns are altering late-season baseflows and increasing hazards such as flash floods and landslides. Temperature changes influence evapotranspiration, snowmelt timing, and spring activation, while extreme rainfall events can transport contaminants into shallow aquifers in soft-rock and alluvial terrains.

Overall, Nepal's mountain hydrology reflects a complex interaction of lithology, structural features, and climate. Hard-rock regions rely on fractures for water storage, while soft-rock and alluvial areas support more continuous aquifers but face water quality risks. Sustainable management requires integrating geological and hydroclimatic knowledge to maintain groundwater availability, protect water quality, and enhance resilience against climate-induced changes. Understanding these dynamics is essential for the long-term sustainability of both human and ecological systems in Nepal's mountains

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HYDROGEOLOGY IN NEPAL: IS IT ONLY ABOUT TUBEWELLS?

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In Nepal, hydrogeology is often narrowly understood as nothing more than constructing tubewells to extract groundwater. But is that really the only role of a hydrogeologist? If not, then what have hydrogeologists contributed beyond this from the past to the present? If the professional role of a hydrogeologist is reduced only to tubewell construction and providing water to consumers, then that is something other technical professionals are already doing as well. If we truly call ourselves hydrogeologists, then tubewell construction is, of course, one part of our work—but shouldn't we also be focusing on the role of water within the geology? No one except hydrogeologists can truly characterize the combined relationship between geology and water, but we have ignored geology and considered only the extraction of water as an achievement. After forgetting tectonics, geomorphology, and depositional environments, and limiting ourselves only to borehole drilling, logging, and design, it is found that other professionals have also started disregarding hydrogeologists. Even senior hydrogeologists mostly talk only about tubewell construction, and there is hardly any mention of research on how hydrogeology affects tunnels, roads, landslides, slope stability or reservoirs. It also appears that the government has not given geologists an important role in these areas. Therefore, hydrogeology is not a science limited only to tubewell construction. It is a discipline that seeks to understand the origin, movement, and impact of groundwater, and to guide its use in a sustainable, safe, and scientific manner as needed. In the context of Nepal, the perception that the role of hydrogeology and hydrogeologists is limited only to tubewell construction may be the result of several underlying causes.

INSTITUTIONS WITHOUT IMPACT

Groundwater development in Nepal began in 1967 under the Department of Irrigation, and in 1976, the Groundwater Resources Development Board (GWRDB) was established to strengthen research and identify potential areas for irrigation. Over the years, several major projects were implemented to expand groundwater irrigation in the Terai region. The Groundwater Investigation Program (F.Y. 2026/27), led by USAID, carried out the first detailed studies using deep tubewells in western Terai. The Bhairahwa Lumbini Groundwater Project (F.Y. 1976/77) supported by the World Bank, constructed 181 deep tubewells, farm roads, and electrification lines, providing irrigation for 20,309 hectares. In F.Y. 1994/95, the Community Shallow Tubewell Irrigation Project (CSTIP) used manual and machine-drilled shallow tubewells to irrigate 4,855 hectares, benefiting around 60,000 people. The Irrigation Line of Credit (ILC) pilot project (F.Y. 2047/48–2053/54) aimed to irrigate 14,602 hectares but managed only 4,960 hectares across eight Terai districts. Launched in F.Y. 2054/55 with ADB support, the Community Groundwater Irrigation Support Project (CGISP) installed 19,767 shallow tubewells in 12 Terai districts, irrigating 37,685 hectares. Finally, between F.Y. 2055/56 and 2074/75, the Agriculture Perspective Plan (APP) provided irrigation to 18,225 hectares via shallow tubewells and 2,240 hectares via deep tubewells. Collectively, these programs progressively expanded groundwater irrigation and significantly contributed to agricultural development in Nepal's Terai region.

To implement all the programs mentioned above, at that time, eleven branch offices of the Groundwater Resources Development Committees were established across the Kingdom of Nepal, from east to west.

The work of all these offices was limited only to the construction of tubewells. Conducting research or studies related to groundwater required foreign consulting companies; otherwise, the hydrogeologists of that time would construct tubewells only in areas where the use of groundwater had been historically safe. Up until then, the hydrogeologists were merely trying to preserve their own reputation. In other words, the public was not yet aware. They were just safeguarding their prestige, and we know why—because even today, in the districts identified as irrigated under all the programs mentioned above, people still have to depend on rainwater. This fact has been highlighted by the declaration of drought-affected areas by the Madhesh Province Government in 2082 BS.

In 2072 BS, due to changing state circumstances, all these development committees were passively brought under the Groundwater Resources Development Board (GWRDB), and Groundwater Resources and Irrigation Development Division offices were established in the same locations. At that time, applications for hydrogeologist positions opened in the largest number in the history of the profession. There was hope that now; the scientific participation of hydrogeologists would have priority in the proper utilization and development of groundwater resources. But over time, as the state restructuring attempted to decide on bringing the Groundwater Resources Development Divisions under the authority of the provincial governments, the internal conflicts and personal interest within the some group of senior hydrogeologists contributed to guiding that decision from being implemented. Subsequently, as part of the federalization process, the state also delegated the authority to construct tubewells to local governments. An even more frustrating issue is that hydrogeologists are limited to constructing tubewells only for irrigation—they are not allowed to build tubewells for drinking water. Tubewells for drinking water are handled by civil engineers as experts, while tasks such as logging and tubewell design, which are supposed to be the hydrogeologist's responsibility, are only done for show or formality.

Now, the regulation and supervision of tubewell construction were no longer handled by hydrogeologists, but by whoever happened to be in the office. The tradition evolved where the contractors themselves became the skilled workforce for tubewell construction. While I was working in a government agency as a hydrogeologist, many tubewell contractors did not even hesitate to explain the tubewell construction process to me. If I tried to correct them or say, "This is the proper procedure," they would retort by naming senior hydrogeologists, saying, "So-and-so helped this way, and so-and-so did that." If a contractor failed to get a work done, they do not hold back from seeking political intervention. So, where is the organization that listens to the complaints of proud, newly hired hydrogeologists who don't know how to please and curry favor with political leaders or senior hydrogeologists? Whereas Universities, associations, and societies related to hydrogeology frequently host conferences. But instead of producing actionable recommendations, they end up in luxury hotels, where papers are presented and forgotten. This cycle of formality without implementation is one of the greatest failures of the sector.

THE NARROW VISION: TUBEWELL DEPENDENCY

From the early days of the Ground Water Resources Development Board (GWRDB) up to now, hydrogeologists have been limited to being "tubewell constructors." This perception still persists, even though hydrogeology is not just about drilling holes in the ground—it is about understanding the physics of water beneath our feet. Hydrogeologists are unable to make factual decisions about where to construct or not construct tubewells beyond the construction itself, fail to record whether a tubewell provides the expected yield after construction, and hold the mindset that a hydrogeologist's work ends after tubewell drilling. They also do not investigate pre- and post-construction groundwater levels and flow, construct tubewells without studying aquifer characteristics, interference analysis, or groundwater recharge and movement patterns, among other shortcomings. Leaving aside the study of the groundwater characteristics of the area based on the constructed tubewells, there is not even consolidated data on how many tubewells were constructed, what their current condition is, and whether or not they are in operation. At the same time why does Nepal continue to rely solely on ERT and VES for groundwater exploration? These methods are decades old and, on their own, provide an incomplete picture while failing to adopt modern techniques such as Magnetotellurics, Electromagnetic (EM) Methods, Gamma logging, and Sonic logging. Globally, hydrogeology combines geophysics, modeling, geotechnical studies, and engineering design to make informed decisions. In Nepal, however, practices remain stuck in outdated approaches—mainly because there is little drive to innovate. As a result, outdated thinking continues to dominate the field. These factors indicate a narrow vision among hydrogeologists. For the same reason, other technical professionals have come to believe that hydrogeologists cannot do anything beyond tubewells, something even they themselves can construct. Until this mindset changes, the hydrogeology profession will remain in decline.

THE ETHICAL DILEMA

All hydrogeologists in Nepal are mainly engaged in constructing tubewells, and that too mostly in the Terai region. It is widely known that many hydrogeologists working in the Terai spend more time deciding which contractor to award work to, rather than applying their knowledge of hydrogeology. Meanwhile, hydrogeologists in universities and freelancers, instead of engaging in healthy competition, have become entangled in nepotism and servility. In this context, rather than working to strengthen the profession, everyone chasing personal interests has caused our profession to fall into decline. Government hydrogeologists have often followed contractors since beginning—not for hydro science and policy making, but for personal gain. Is this the identity of a professional discipline? Furthermore, to make matters worse, many retired hydrogeologists have now turned into tubewell contractors themselves. Shouldn't retirement be a time to mentor the next generation and push the field forward, rather than repeat the same narrow role that held hydrogeology back for decades? In such a situation, government agencies with hydrogeologist positions are, in a sense, shooting axe themselves in the foot. If proper attention had been given to policymaking, then today hydrogeologists should have been the sole authority for constructing tube wells and regulating groundwater extraction, and the Groundwater Resources Development Board used to be the single entity responsible for regulating everything related to groundwater. Similar to how the Department of Mines and Geology is the sole authority overseeing all matters related to mines and minerals in Nepal. But due to shortsighted leadership and biased thinking, even an essential institution like the Groundwater Resources Development Board ended up being dissolved.

THE SUSTAINABLE GOALS PARADOX

Water is the fundamental element for sustainable development; both surface and groundwater. The main features of groundwater related to the SDGs are its use, management, and sustainability. Hydrogeology can either support sustainability or destroy it. If used properly, it safeguards groundwater, ensures water security, and strengthens infrastructure. If neglected, it accelerates depletion, triggers subsidence, and undermines development. Yet in Nepal, hydrogeology is mostly discussed only in terms of water supply, not sustainability. Nobody pays attention to water management practices such as the conjunctive use of water. Even the users demand tube wells within the command area where surface irrigation canals already exist. Canals are being constructed without ensuring the reliability of the water source. When tube wells are also constructed in the same command area, it results in duplication. Programs are designed in the same way, and offices feel forced to build tube wells anyway. Nobody is seriously planning for long-term and sustainable development. In the past, traditional systems like Rajkulo (canals) and Hiti (stone spouts) were both scientific and helped keep society united. Now they are being neglected, and because of that, our culture of water use is slowly disappearing. How can the goals of sustainable development be achieved by blindly constructing tubewells without studying how much water is being extracted and how much is being recharged? No area seems to have received attention for the construction of structures needed for artificial recharge, such as Recharge Pits/Ponds, Percolation Tanks/Check Dams, Recharge Wells, or Soil Aquifer Treatment (SAT). Therefore expecting sustainable development from the hydrogeology profession, as long as there are hydrogeologists who think "I wish I didn't have to work in the hilly regions," who afraid to work on hydrogeological aspects like hard rock aquifers and springs in hilly terrain, and who cannot even prepare a report of an ERT/VES study without examining the litholog of an existing well, is like trying to catch fish in muddy water.

WHERE HYDROGEOLOGY TRULY BELONGS

Hydrogeology is the science of groundwater flow, pressure, and time-dependent natural phenomena. A skilled hydrogeologist sees the invisible: how water movement triggers landslides, how pore pressure weakens slopes, how aquifer compaction causes land subsidence, and how underground excavation becomes dangerous when water physics are ignored. Hydrogeology is essential to slope stability, tunnel design, reservoir safety, and road construction not only for tubewell construction. Yet, Nepali hydrogeologists are rarely allowed to bring their knowledge into engineering discussions. Why should this science be sidelined when it can literally prevent disasters? While tubewell construction is a visible, practical application, hydrogeology as a science belongs to a much broader context—disaster prevention, infrastructure planning, environmental protection, and sustainable water management. Reducing the profession to well-drilling alone underutilizes its potential and neglects its vital role in society.

TIME TO REDEFINE HYDROGEOLOGY

We should not limit hydrogeology to just tubewell construction. At a time when the perception of hydrogeology is mostly associated with well drilling, it is the role of every hydrogeologist to demonstrate that the field has a much broader scope, including: civil engineering projects (dams, tunnels, reservoirs, road slopes, buildings), disaster risk reduction (landslides, subsidence, floods), urban planning (subsidence control, sustainable groundwater use), and sustainable development goals (ensuring long-term water security). The role of hydrogeologists is not to do for personal interest but to guide the nation in managing one of its most powerful and invisible forces: groundwater.

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ELECTRICAL RESISTIVITY TOMOGRAPHY FOR GROUNDWATER POTENTIAL AT BANEPA, NEPAL

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ABSTRACT

This study addresses the continuous water scarcity in Banepa, Nepal, a rapidly growing metropolitan area that depends on groundwater. Electrical Resistivity Tomography (ERT) with a Wenner array in Magargaon, Banepa Municipality-9, to investigate subsurface geology and identify potential water-bearing aquifers for tubewell construction. The ERT survey, spanning 720 meters, provided high-resolution data on subsurface resistivity, revealing distinct zones of fractured bedrock (350-800 ohm-m) indicative of good water-bearing potential, particularly between 310-450 m chainage. Conversely, high resistivity zones (192-310m and 450-500 m) corresponded to impermeable fresh bedrock. Validation through a 220-meter deep tubewell drilling confirmed the presence of a viable aquifer, with pumping tests yielding a discharge of 3.5 L/s and favorable transmissivity (4.02×10^{-5} m²/sec) and permeability (6.71×10^{-5} cm/sec) values. This integrated approach demonstrates the effectiveness of ERT in groundwater exploration and provides critical insights for sustainable water resource management in similar geological settings.

Keywords: ***Electrical Resistivity Tomography (ERT), Groundwater Potential, Aquifer, Fractured Bedrock, Geophysical Survey***

INTRODUCTION

Banepa, a historical town located approximately 26 kilometres east of Kathmandu Valley in central Nepal, is a significant urban centre within the Kavrepalanchok District. Despite its strategic location and growing population, the municipality faces persistent challenges in ensuring an adequate and reliable water supply for its inhabitants. The primary source of water distributed by the Nepal Water Supply Corporation (NWSC) has traditionally been surface water, which has proven insufficient to meet the escalating public demand (Shrestha & Shresth, 2008). Groundwater serves as a primary source of drinking water in many urban areas due to its low capital, operation, and maintenance requirements. In the Kathmandu Valley, groundwater aquifers are typically associated with alluvial deposits and fractured rock zones. While shallow aquifers are often recharged by rain, rivers, and springs, deeper aquifers receive recharge from the higher Himalayas and perennial snow-fed rivers.

The Banepa area, like many other regions in Nepal, experiences chronic water scarcity. Water supply is managed by various user committees and the municipality, with groundwater being the predominant source. To address the increasing demand for water at the community level, the construction of deep tubewells has been proposed. Prior to tubewell construction, geophysical methods are employed to investigate groundwater availability. Electrical methods, specifically Electrical Resistivity Tomography (ERT), have proven to be reliable for groundwater exploration (Cubbage et al., 2017; Gao et al., 2018).

Electrical Resistivity Tomography (ERT), particularly when utilizing the Wenner array, has demonstrated its reliability as a geophysical method for identifying areas with groundwater potential (Cubbage et al., 2017; Gao et al., 2018). The ERT method is particularly effective in hydrogeological studies for identifying water-bearing formations, estimating aquifer depth and thickness, delineating weathered zones, and mapping bedrock. The resistivity of geological formations varies significantly depending on their dry and saturated states, as well as factors such as mineral composition, density, porosity, water content, water quality, and temperature. ERT provides high-resolution data on subsurface structures, making it valuable for identifying aquifers at varying depths and detecting groundwater within them (Takele et al., 2025).

This study aims to investigate the subsurface geology and identify potential water- bearing aquifers suitable for tubewell construction in Magargaon, Banepa Municipality-9, Kavrepalanchowk District. Specifically, this research seeks to characterize the hydrogeological conditions of the study area using ERT, provide recommendations for sustainable groundwater extraction, and assess the consistency between ERT survey results and actual well drilling data to evaluate the reliability of the ERT method for similar applications. Contributes to the understanding of groundwater potential in complex geological settings and provides a practical framework for water resource management in water-stressed regions.

LOCATION AND ACCESSIBILITY

A geophysical investigation was conducted at Magargaon Temple, situated in Ward No. 9 of Banepa Municipality, within Kavrepalanchowk District. This area lies approximately 20 kilometers east of Kathmandu Valley and falls within the mid-hill region of central Nepal. The site is strategically positioned and can be accessed conveniently via the Araniko Highway, making it logistically feasible for field surveys and equipment mobilization. The GPS co-ordinate of the well drilling site is 27°38'38.62"N and 85°31'26.85"E (Figure 1).

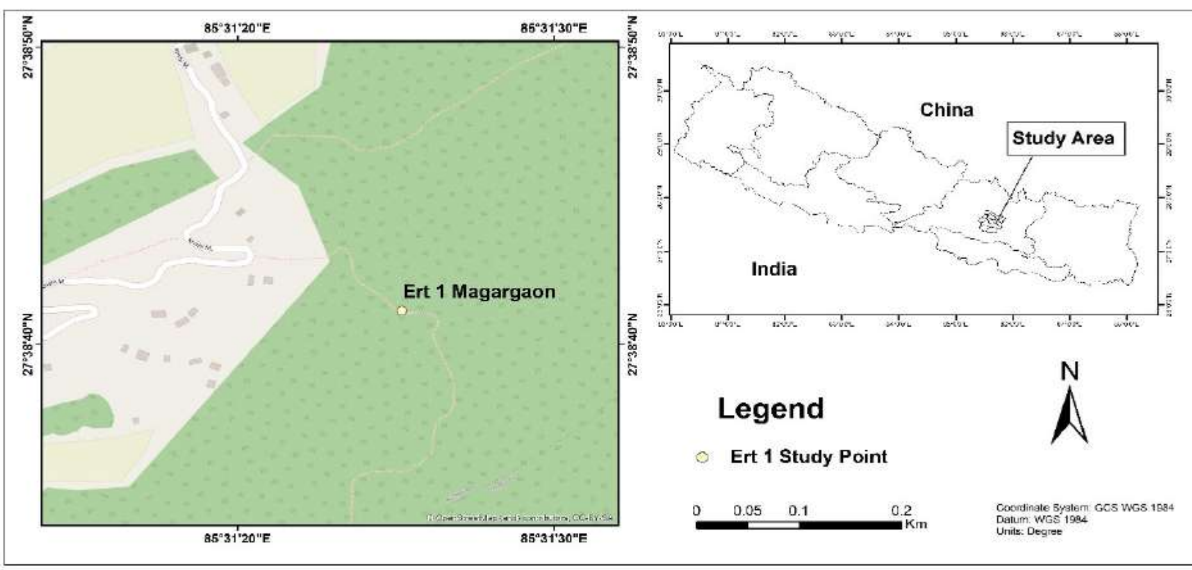

Figure 1: Location map of the Study area

GEOLOGY AND HYDROGEOLOGY OF THE AREA

Geologically, the study area is situated in the Central Nepal, Lesser Himalaya region. The rock succession in this area is broadly categorized into two main units: the Basement rock of the Tistung formation and Quaternary Sediments. Previous geological mapping (Stöcklin and Bhattarai, 1981) indicates that the study area comprises rocks belonging to the Phulchowki Group. These rocks are characterized by low-grade metasandstone and greenish grey phyllite, with the Tistung formation generally considered to be of early Cambrian age. The Quaternary sediments in the region consist of black carbonaceous lacustrine clay deposits and alluvial deposits composed of fine to coarse sand and gravel (Shrestha, 2008).

Field observations in the Thapagaon area revealed the presence of phyllite, often interbedded with thin partings and intercalations of metasandstone. The exposed phyllite was highly weathered and exhibited a greenish to grey colouration. Structural measurements indicated an attitude of N34°W/38°NE.

The hydrogeological characteristics of the Banepa area are significantly influenced by its geological setting. Rivers in Banepa are predominantly seasonal streams rather than perennial, with the Punyamati Khola, for instance, becoming dry in its downstream sections while maintaining flow upstream throughout the year (Shrestha & Shrestha, 2008). Consequently, shallow groundwater, accessed through traditional dug wells, has historically been the primary water source. However, rapid urbanization and industrialization in the area have led to a substantial increase in water demand. This has necessitated the construction of numerous deep tubewells to supply water for industries, hospitals, and drinking purposes.Despite the increased demand, detailed drilling reports for many of these tubewells are often unavailable, and many traditional dug wells and springs have dried up. This escalating water demand underscores the critical need for reliable groundwater exploration, which prompted the Electrical Resistivity Survey in this region to assess the feasibility of groundwater extraction.

METHODS OF STUDY

Principles of the Electrical Resistivity Method

Resistivity values of sediments are controlled by chemical composition of the minerals, density, porosity, water content, water quality and temperature and degree of compaction. The value of formation resistivity also depends on the direction of electrode spread and the nature of the top layer in hard rock areas (Ballukraya et al. 1981). Resistivity varies to a large extent in different rocks. The typical resistivity ranges for various sediments are illustrated in Figure 2 (Telford et al., 1976).

The fundamental objective of an electrical resistivity survey is to measure the electrical resistivity of the subsurface formations. Generally, four electrodes are required to measure the resistivity of subsurface formations (Figure 3). Current (I) is sent through the earth formation through one pair of electrodes (A & B or source and sink) called current electrodes. The potential difference (AV) produced as a result of current flow is measured across a second pair of electrodes (M&N) called potential electrodes. The electrical potential (V) can be expressed as

$$V = \rho I / 2\pi r$$

Where, 'V' is the electrical potential at a distance from a single point electrode placed on the surface of the earth of resistivity 'ρ'. Potential due to two sources can be added algebraically.

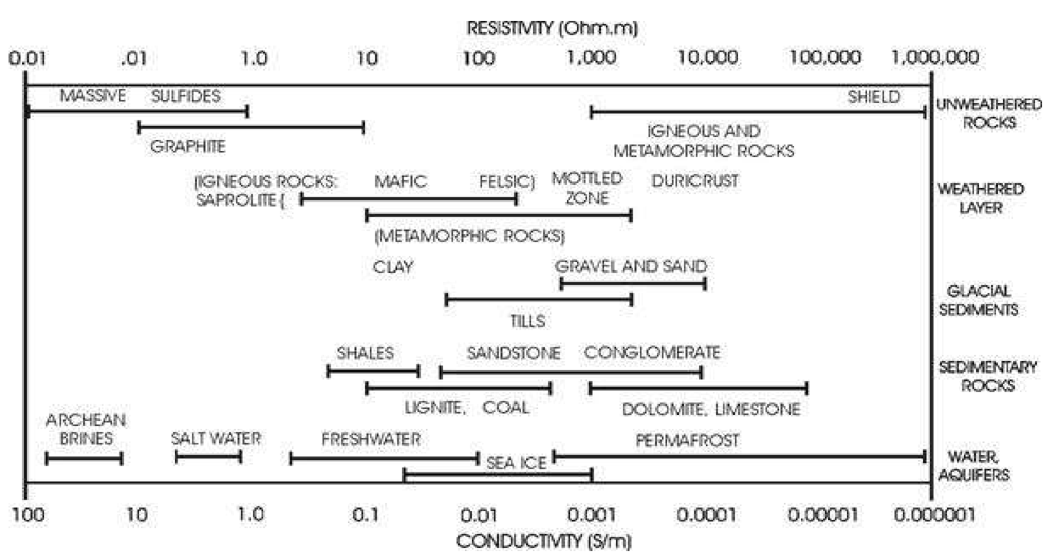

Figure 2. Resistivity of sediments (Telford et al., 1976)

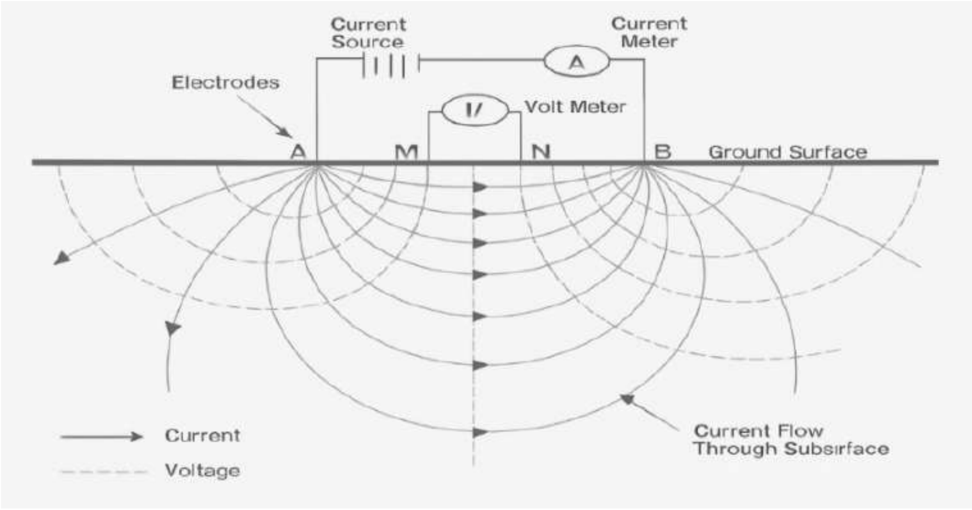

Figure 3. Flow of current through the Subsurface

Electrical Resistivity Tomography (ERT) Survey

For this study, a D Electrical Resistivity Tomography (ERT) survey was conducted to generate a cross-sectional image of the subsurface electrical properties. The survey employed a linear array of 60 electrodes, grounded in a straight line, with an electrode spacing of 12 meters. This configuration extended the profile for a total length of 720 meters. The Wenner configuration, selected for its favorable signal-to-noise ratio and sensitivity to both horizontal and vertical variations, was utilized for data acquisition (Figure 4). The main frame system used for the survey was capable of working with various electrode systems and was configured to send Direct Current (DC) into the ground and measure the resulting voltage changes. The system utilized all 60 electrodes, with four electrodes being used at a time, to collect data at nineteen different levels, covering a depth of up to 120 meters from the ground surface.

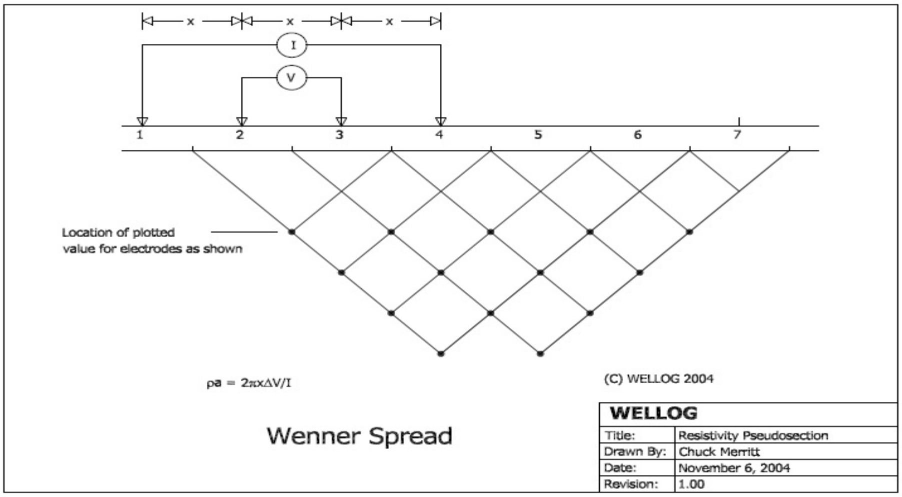

Figure 4: Wenner Configuration in ERT Survey

Data Processing and Interpretation

Raw data from the ERT instrument were downloaded via a USB cable. The data underwent processing to identify and filter out unusual or erroneous readings. Elevation corrections were applied using data obtained from Google Earth. The field data were then analyzed using RES2DINVx64 - 2D RESISTIVITY & IP INVERSION software, developed by Geotomo software, for comprehensive data processing, analysis, and interpretation. This software generates colored resistivity contour sections, which illustrate the distribution of subsurface resistivity in two dimensions (X and Y planes). These resistivity contours are directly correlated with subsurface lithology and moisture content, providing valuable insights into the distribution of subsurface materials.

Limitations of Geophysical Study

It is important to acknowledge the inherent limitations of geophysical studies in groundwater exploration. While these methods are effective in identifying probable water-bearing strata, they cannot directly interpret the quality or quantity of the groundwater. Furthermore, the inferred depths of subsurface materials may exhibit minor variations (a few meters) due to mathematical errors inherent in the calculations. Geophysical surveys primarily provide a tentative idea of the aquifer bounding strata rather than detailed lithological information below the subsurface.

Well Drilling: Down The Hole (DTH) Drilling Method

Down The Hole (DTH) drilling is a widely adopted pneumatic technique for penetrating hard formations such as boulders and rock. This method typically achieves a drilling rate of 40 to 100 meters per day, depending on the prevailing ground conditions. The DTH system utilizes a high-capacity compressor to generate air pressure between 18-40 kg/cm². This compressed air drives a hammer located at the bottom of the drill string. The drill bit, attached to the drill rods, rotates and hammers simultaneously, effectively breaking up rock into small fragments. These fragments, along with any water present in the formation, are then lifted to the surface by the compressed air. If the formation is dry, only rock fragments are expelled. Conversely, if groundwater is encountered, it surfaces immediately along with the air and debris. It is important to note that this method does not allow for electrical logging of boreholes since the casing pipe is inserted during drilling. In formations where screens are required, the pipe is simply perforated to allow water intake.

RESULTS AND DISCUSSIONS

Electrical Resistivity Tomography (Ert) Interpretation of Magargaon

The Electrical Resistivity Tomography (ERT) survey conducted in Magargaon aimed to delineate subsurface structures and identify potential groundwater-bearing zones. The ERT profile, spanning 720 meters with 12-meter electrode spacing, was aligned in a North-South direction across the hill slope. The alignment of ERT profile of is shown in google image in Figure 6. The GPS coordinates of the alignment and chainage distances are provided in Table 1.

Table 1: GPS Coordinates of Alignment of ERT Profile of Magargaon

S. No.	Distance (m)	Latitude	Longitude	Elevation (from Google Earth
1	CH-0	27.642285	85.523062	1612
2	CH-120	27.643158	85.523293	1619
3	CH-240	27.643804	85.523969	1632
4	CH-360	27.644562	85.523751	1633
5	CH-480	27.645654	85.523394	1661
6	CH-600	27.646403	85.522613	1673
7	CH-720	27.647165	85.522533	1685

Figure 6: ERT profile alignment in Google Image of Thapagaon, Banepa Municipality-9

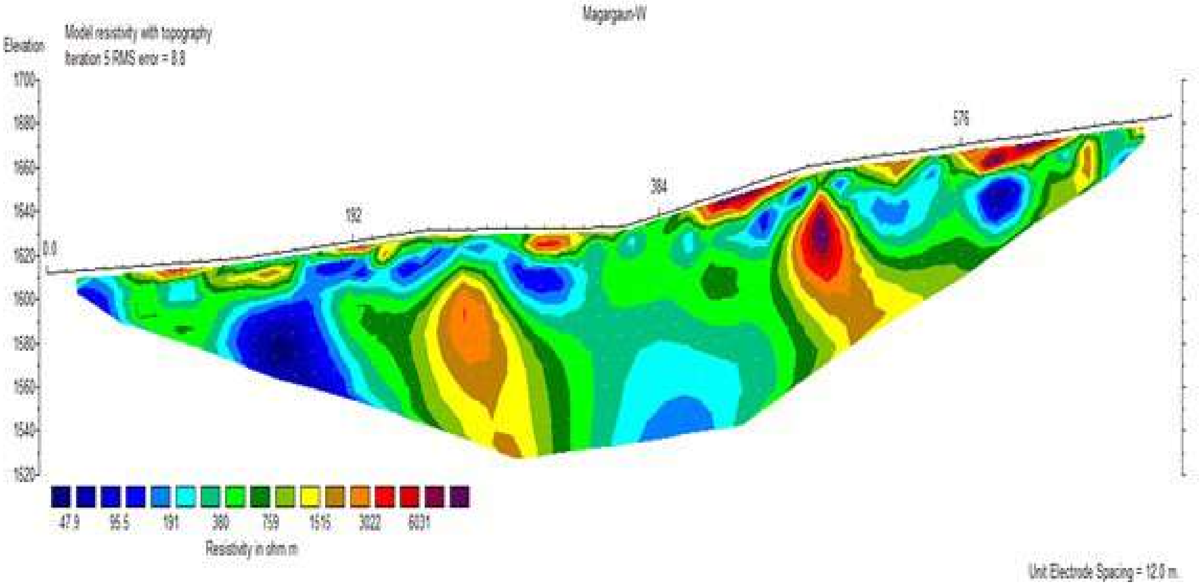

Figure 7: Topographic corrected Inverse Resistivity section of ERT of Magargaon, Banepa-9

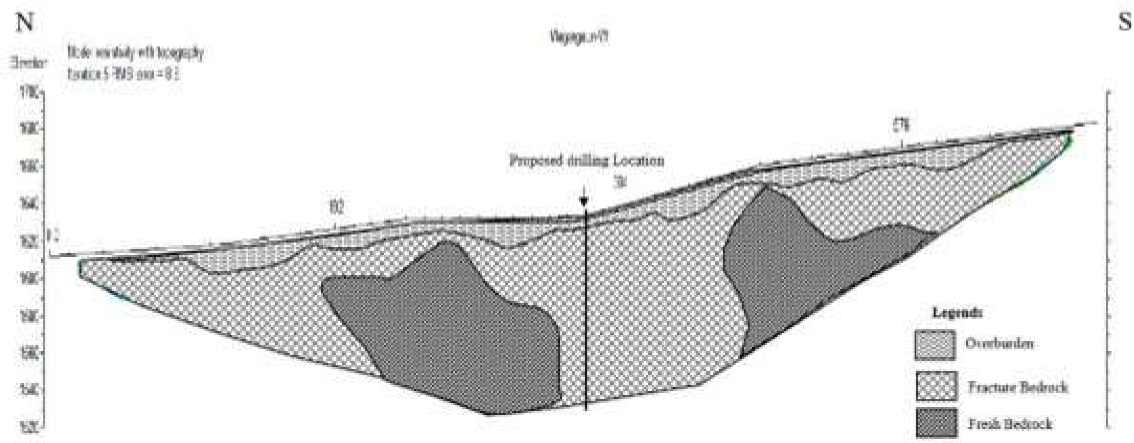

Figure 8: Topographic corrected infered geological section in ERT profile of Magargaon, Banepa-9

The interpretation of the ERT data revealed distinct resistivity zones, indicative of varying subsurface lithologies and water content. The results show an overburden layer approximately 5 meters thick, consisting of residual soil, present throughout the alignment near the surface.Immediately beneath this overburden, a relatively medium resistivity zone, ranging from 350-800 ohm-m, was identified. This zone is interpreted as fractured bedrock and is present within the chainages of 0-192 m, 310-450 m, and 500-700 m. This fractured bedrock is considered a good water-bearing zone, especially in hilly and mountainous regions.

Conversely, high resistivity layers were observed from chainage 192-310 m and 450-500 m, directly beneath the overburden. These high resistivity zones typically correspond to fresh, unfractured bedrock, which acts as an aquitard, neither storing nor transmitting groundwater effectively, thus serving as a barrier to groundwater movement. The inversion model of the ERT data and the inferred geological section for the Magargaon area are visually represented in Figure 7 and Figure 8 of the original report, respectively. These figures clearly illustrate the distribution of overburden, fractured bedrock, and fresh bedrock within the surveyed profile, providing a visual understanding of the subsurface hydrogeological conditions.

The ERT survey results are consistent with the geological observations and provide detailed insights into the subsurface conditions relevant to groundwater exploration. The presence of a fractured bedrock zone, identified by its medium resistivity values (350-800 ohm-m), is a key finding. This zone is located directly beneath the overburden, particularly prominent in the chainage of 310-450 m, which is in close proximity to the proposed drilling location. In mountainous and hilly terrains, fractured bedrock is widely recognized as an excellent water- bearing formation due to its enhanced permeability and storage capacity.

Conversely, the high resistivity zones observed between 192-310 m and 450-500 m chainage correspond to hard, unfractured bedrock. This fresh bedrock acts as an aquitard, impeding both the storage and transmission of groundwater, effectively forming a barrier to its movement. The delineation of these distinct zone of water-bearing fractured bedrock and impermeable fresh bedrock is critical for optimizing tubewell placement and ensuring successful groundwater extraction.

The integration of geological and geophysical data strongly suggests that the saturated fractured rock present at the proposed drilling location holds significant potential for groundwater. The geophysical investigation specifically indicates that the fractured bedrock commences at a shallow depth of approximately 5 meters from the ground level and extends to depths exceeding 150 meters within the 310-450 m chainage in Magargaon. This finding is particularly encouraging as it suggests a substantial volume of water-bearing material.

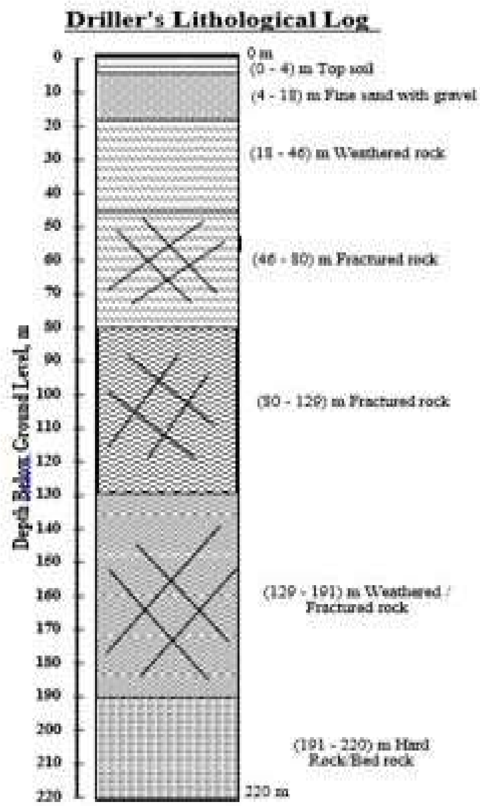

Figure 9: Lithological log of well

Further to the ERT survey, a deep tubewell was successfully drilled at Magargaon, Banepa Municipality- 9, to a total depth of 220 meters using the DTH method. The driller also prepared litholog based on cuttings, nature of well penetration progress (Figure 9). The well has a size of 200/150 mm and a total lowered depth of 220.5 meters, including 0.50 meters above ground level. A total of 60 meters of screen was installed (18 meters of 200 mm and 42 meters of 150 mm). Pumping tests revealed a static water level of 72 meters and a dynamic water level of 113 meters, with a discharge rate of 3.5 liters per second. The calculated transmissivity (T) is 4.02 x 10^{-5} m^2/sec and permeability (K) is 6.71× 10^{-5} cm/sec. These results confirm the good potential for groundwater in the area. It is important to note that while the area shows promising groundwater potential, the construction of successful tubewells in this region can be challenging, requiring careful decision-making during the drilling process. Therefore, it is strongly advised that tubewell construction and development be conducted under the direct supervision of a qualified hydrogeologist or expert to ensure optimal outcomes.

CONCLUSION AND RECOMMENDATION

The integrated analysis of geological data, Electrical Resistivity Tomography (ERT) findings, and field validation via deep tubewell drilling and pumping tests verifies the existence of a viable aquifer system within the fractured bedrock of Magargaon, Banepa Municipality-9. The ERT profile identifies a specific low-resistivity area understood to be saturated fractured rock, positioned at the center of the survey line. This study provides a comprehensive understanding of the subsurface hydrogeological conditions in the study area, demonstrating the effectiveness of ERT as a reliable tool for groundwater exploration in complex geological terrains.

Based on these results, it is advised to construct a tubewell with a diameter of 200/150 mm at a desired depth of meters in the specified area. The Down-The-Hole (DTH) drilling technique is viewed as suitable for penetrating fractured rock layers and guaranteeing optimal aquifer access. The exploratory tubewell, drilled to a depth of meters, produced a discharge of 3.5 L/s. The determined transmissivity (4.02 ×10^{-5} m^2/sec) and permeability (6.71×10^{-5} cm/sec) values reflect advantageous hydraulic characteristics of the aquifer, reinforcing the viability of sustainable groundwater withdrawal for drinking water provision in the area. Future research could focus on long-term monitoring of groundwater levels and quality in the region to ensure sustainable management of this vital resource.

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भूमिगत जल - समस्या तथा समाधान प्रेक्ष्य

(नेपालको परिप्रेक्ष्मा)

प्रतापसिंह तातेड़
भूमिगत जलबिज्ञ

"पानी नै जीवन हो " । प्राचीन काल देखि मानिस को जीवनमा पानी न भई नहुने अपरिहार्य रहेको छ । पानी (भूमिगत जल/सतहजल) बिना मानिस तथा वोट विरुवा लगायत अन्य कार्य समेत बाच्न असम्भव नै हुन्छ भनी हामी सबैलाई अवगत भएकै हो ।

आजको विकाशील युगमा पानी को उचित प्रयोग सबैभन्दा बढ़ी खानेपानी, सिंचाई, उद्योग, कृषि मा भई रहेको सर्वविदित छ । पानी प्राप्त प्रायः सतहजलको रूपमा खोला नाला तथा भूमिगत जूलको रूपमा र मूल पहाड़ वा भित्री उपत्यका आदि सतहीहरुपमा प्राप्त हुन्छ।

सतहजल : सतह जाल आँखाले देखिने र उक्त जल को भण्डार केही हद सम्म राम्ररी मापन गर्न सकिने हुन्छ।

भूमिगत जल : भूमिगत जल जमिन मुनी बिभिन्न तहमा रहेको र उक्त भण्डार को बारेमा धेरैनै अध्ययन को आवश्यकता गर्नु पर्ने हुन्छ। किन भने पानी विभिन्न तहमा विभिन्न किसिमले बगेको वा भएको हुन्छ। नेपालमा भूमिगत जलको अध्ययन अनादिकाल देखि नै भईरहेको हुदा प्रयोग प्राय मूल, कुआ, इनार आदि बाट भएको पाईन्छ। तर विकास को क्रममा सतहजल को जटिलता अप्रर्याप्ताको कारण भूमिगत जल अध्ययन गर्न जरुरी भएकोले नेपाल सरकार ले सन् १९६६/६७ देखि यसको थालनी गरेको बुझिन्छ । अन्वेषणात्मक (Investigation) डीप (गहिरो) भूमिगत जल को सतह पता, लगाउन डीप यूबवेल निर्माण गरी विभिन्न माध्यम बाट पानी निकाली अध्ययन गर्ने कार्य को थालनी बाट संचालन भएको बुझिन्छ।

ती ताका भएको सिमित अध्ययन र अनुसंधान को आधारमा भूमिगत जल सिंचाई तथा खानेपानी मा प्रयोग तथा सिंचाई का लागि अपर्यापता क्षेत्रमा देशभरी नै अध्ययन अनुसन्धान गर्नु पर्ने भएकोले नेपाल सरकारले "भूमिगत जलश्रोत विकास परियोजना" को अबधारणा लिएको देखिन्छ।

उक्त भूमिगत जलश्रोत विकास परियोजना अस्थाई रूपमा रहेको कार्यलय लाई नियम पूर्वक सुचारु रुपले अध्ययन र अनुसन्धान गर्नु पर्ने भएकोले तत्कालिन जलश्रोत मंन्त्रालय अन्तर्गत भूमिगत जलश्रोत बिकास समिती गठन गरी गठन आदेश अनुसार अध्ययन अनुसन्धान तथा भूमिगत जल को विकास सिंचाई को लागि मात्र) गर्ने गरी भूमिगत जलश्रोत विकास परियोजना कार्य संचालन गरियो ।

देशको बिभिन्न तराईका जिल्लाहरु जहाँ जनसंख्या को चाप तथा सिंचाईको लागि जग्गा बढी भएका स्थानमा डीप टयुबवेलको अनुसन्धान कार्य गरी डिप टयुबवेल सिंचाईको कार्यक्रम लागु गर्ने कार्य सुरुवात भयो ।

उक्त समयमा तराई का कही क्षेत्रहरुमा इनार / कुआ बाट सिमित मात्रामा डीजल पमसेट को माध्यम बाट कृषि विकास बैकको ऋण सहुलियतमा स्यालो (कम गहिराई) को टयुबवेल बाट सिंचाई सुविधा को प्रावधान पनि शुरु भएको हो ।

नेपाल सरकारले डीप टयुबवेलको अनुसन्धान तथा अध्ययनको साथ साथै स्यालो टयुबवेलका बढ्दो माग लाई मध्यनजर राखी भूमिगत जलश्रोत विकास परियोजना मार्फत स्यालो भूमिगतको अध्ययन तथा अनुसन्धातक कार्य UNDP का सहयोगमा थालनी गरेको पाईन्छ।

तत्पश्चात स्यालो तथा डीप ट्युबवेल को थालनी भूमिगत जलश्रोत विकास परियोजना तथा विभिन्न कार्यकम मार्फत सुचारु रूपले तराई का जिल्ला तथा भित्री उपत्यकामा संचालन गरेको देखिन्छ।

भूमिगत जलश्रोत विकास परियोजनाको कार्यलय काठमाण्डौं स्थित बबरमहल मा रहेको थियो । उक्त कार्यलयमा जलगुण प्रयोगशाला पनि रहेको हुदा विभिन ठाँउ बाट आउने जलका गुणस्तर पनि जाँच गर्ने गरिएको थियो ।

यसकारण उक्त भूमिगत जलश्रोत विकास परियोजमा भूमिगत जलबिज्ञ (Hydrogeologist/Geologist) तथा जलगुण बिज्ञ (Water Chemist) समेत बिज्ञ दरबन्दी रहेको थियो । त्यो ताका भूमिगत जल सम्बन्धि सम्पूर्ण कार्यहरु तिब्र रुपमा भएको पाईन्छ । यसको साथसाथै उक्त परियोजन ले विभिन्न देशका विज्ञ तथा अनुदान बाट भूमिगत जलको अध्ययन गरेको पाईन्छ । भूमिगत जल सम्बन्धी जे जति अनुसन्धात्मक तथ्याकहरु उपलब्ध छन् ती खबै उक्त परियोजना /कार्यलय तथा ए.जवि. समिती को देन हो ।

"उक्त तथ्याङ्कको आधारमा नै हालसम्म भएका भूमिगत जल सिंचाइ कार्यक्रम तथा आयोजना संचाल्ति भईरहेकाछन जस्ले नेपाल सरकार को कृषि क्षेत्र, खानेपानी क्षेत्र तथा औद्योगिक क्षेत्रमा ठूला आन्दोलन ल्याएको देख्न सकिन्छ ।

समस्याको थालनी

सतहजल को पेचिलो प्रयोग, उपभोग र बढ्दो जनसंख्याले भूमिगत जलमा अत्यधिक निर्भरता भएको पाईयो । तसर्थ भूमिगत जलको अवस्था बुझ्नु जरुरी छ र थियो ।

भूमिगत जलमा आउने तथा उक्त जल बाट हुने समस्या को साथ साथै भूमिगत जल भण्डार बारे बुझ्न हाल आएर भूमिगत जलश्रोत विकास परियोजना का कार्य शुरु गर्न कोशिश गरिरहेको बेला देश को तीन तहको सरकारको भरमा उक्त परियोजना अलपत्र परेका देखिछ हाल आएर नेपाल सरकारले समस्या न बुझी परियोजना लाई खारेज गरेको र तहाँ भएका हाल सम्मका तथ्यांकको कुनै लेखाजोखा नराखी अलपत्र पारेको देखिन्छ ।

भूमिगत जल प्रयोग

भूमिगत जलश्रोत विकास परियोजना का विभिन्न जिल्लामा रहेका कार्यालयहरुलाई सिंचाई विभाग वा प्रदेश सरकार मार्फत राखी सिंचाई को लागि मात्र भूमिगत जल प्रयोग गरेको पाइन्छ ।

त्यसै गरी भूमिगत जल का बिकासको साथ साथै खाने पानी मन्त्रालय अन्तर्गत खानेपानी विभाग/संस्थान ले पनि तराई तथा भित्री उपत्यकाका पूर्ण रूपले भूमिगत जलमा आधारित रहेको पाईन्छ । यसका साथ साथै देशका तराई भूभागमा बढ्दो विभिन्न उद्योगमा जलप्रचुर मात्रामा चाहिने हुदाँ भूमिगत जल प्रयोग भएको पाईन्छ ।

यसरी भूमिगत जल को अत्यन्त बढी मात्रामा प्रयोग, बिना कुनै अध्ययन (निर्देशिका) तथा बिज्ञको आधारमा स्यालो ट्युबवेलका डीप ट्युबवेलको निमार्णले गर्दा आई पर्ने समस्या तथा उक्त समस्याको निराकरण कसले गर्ने ? कुन कार्यालय/संस्था ले गर्ने ? संघीय सरकार, प्रदेश सरकार र स्थानीय सरकार निधो भएको देखिन्छ ।

सांरांश

भूमिगत जल एक किसिमको पानीको खानी हो । बर्षातबाट खोला बाट, हिउपग्लिने बाट र अन्य माध्मबाट भूमिगत सतहमा पानी थपीने हुन्छ ।

तर थपीने भन्दा बढी प्रयोगमा ल्याउने हो भन्ने ठूला समस्या निम्त्याउँछ जस्तै : पानीको सतहजल तल जाने, पानी गुणस्तरमा हृास आउने, पानी भण्डार मा समस्या आउन सकने आदि आदि ।

हामीलाई थाहा छ संसारका सबैदेश हाम्रा छिमेकी मुलुकहरु समेत मा भूमिगत जल को अध्ययन, अनुसन्धान अनुगमन तथा यस सम्बन्धि हुनसक्ने समस्याको अध्ययनका लागि सम्बन्धित बिज्ञ भएको टोली तथा संस्था बिध्यमान छन । भूमिगत जल सम्बन्धि केही बुझ्नु परेमा सम्बन्धित सरकारको उक्त संस्थाको धारण आधिकारीक मान्ने गरीन्छ । तर हाम्रो देश नेपाल ८० प्रतिशत जनसंख्या भूमिगत जलमा निर्भर छन र यस सम्बन्धि कुनै समस्या आई परेमा निराकरणको लागि बुझ्ने संस्था कहाँ छ कसैलाई पनि थाहा छैन ।

"यसको ट्डकोरा उदाहरण अहिलेको घटनाबाट बुझिन्छ । मधेश प्रदेशका आठ जिल्लाका सीमित क्षेत्रहरुमा पानी को सतह तल खसेको वा हाते पम्पबाट पानी नआएका वा पानीको सतह सुकेको साथ साथै पानी धमिलो र रातो आउनेगरेको र आर्सेनिक पानी भएको सम्बन्धित को सबैको हितका समस्या छ्याप छ्याती पत्रपत्रिकामा छापिएको देख्न सकिन्छ ।

यसको साथ साथै राजनैतिक तह मापनि समस्या उठाईरहेको देखिन्छ । देशमा बिध्यमान बिज्ञहरुमा पनि आ-आफनो धारणाहरु न बुझी पनि पस्की रहेको पाईन्छ । बिज्ञहरुको राय बाझ्न सकिन्छ । तर नेपाल सरकारको एउटा पनि संस्था वा कार्यालय छैन जसले आधिकारीक रुपमा यस समस्याका कारण र समाधानको उपाय आम जनता लाई दिने ।

निष्कर्ष

तसर्थ भूमिगत जल समस्या हाल तराई क्षेत्रमा सिमीत देखिएको छ भोली पहाडी क्षेत्रमा पनि यस्तै समस्या आउला भन्न सकिन्न । यस कारण नेपाल सरकारमा एउटा भूमिगत जल सम्बन्धि जुन सुकै नाम राख्न सकिन्छ सम्बन्धित बिज्ञहरु भएका आधिकारीक कार्यलय स्थापना गर्नुपर्ने उचित देखिन्छ।

भूमिगत जल देशकै सम्पति भएकोले केन्द्रमा एउटा (पुरै देशका) को तथ्यांक राख्ने गरि तथा सातै प्रदेशमा एक एक ओटा कार्यालय राख्न उचित देखिन्छ। यसको लागि नजिकका छिमेकी मुलुका संरचना लाई पनि आधार मान्न सकिन्छ।

काठमाण्डौ उपत्यका खानेपानी व्यवस्थापन वोर्डको अनुरोध

- पानी नै जीवन हो यसको महत्व बुझी सदुपयोग गरौं ।
- खानेपानीका श्रोत तथा परम्परागत ढुंगेधाराहरुको संरक्षण गर्ने गरौं ।
- खानेपानीका मुहानहरु प्रदुषण हुनबाट जोगाउँ र मुहान संरक्षण गर्ने गरौं ।
- वर्षातको पानी ढलमा नमिसाई खाल्डो खनी पुनर्भरण गरौं ।
- सबैले वर्षातको पानी संकलन गर्ने प्रविधि जडान गर्ने गरौं ।
- भूमिगत पानीको उपयोग गर्दा अनिवार्य रुपमा यस वोर्डबाट अनुमती पत्र लिने गरौं ।
- खानेपानीको महशुल नियमित रुपमा भुक्तानी गर्ने गरौं र जरिवाना तथा वक्यौताबाट छुटकारा पाउँ ।
- काठमाण्डौ उपत्यका भित्र भूमिगत पानीको दुरुपयोग, भूमिगत श्रोतको अनाधिकृत दोहन आदीको बारेमा थाहा पाएमा यस वोर्डलाई जानकारी गराऔं ।

काठमाण्डौ उपत्यका खानेपानी व्यवस्थापन वोर्ड

सैंबु, भैसेपाटी, ललितपुर

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