iJRASET
International Journal For Research in Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 13 **Issue:** VIII **Month of publication:** August 2025

DOI: https://doi.org/10.22214/ijraset.2025.73595

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International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 13 Issue VIII Aug 2025- Available at www.ijraset.com

Groundwater Crisis in Terai Region of Nepal

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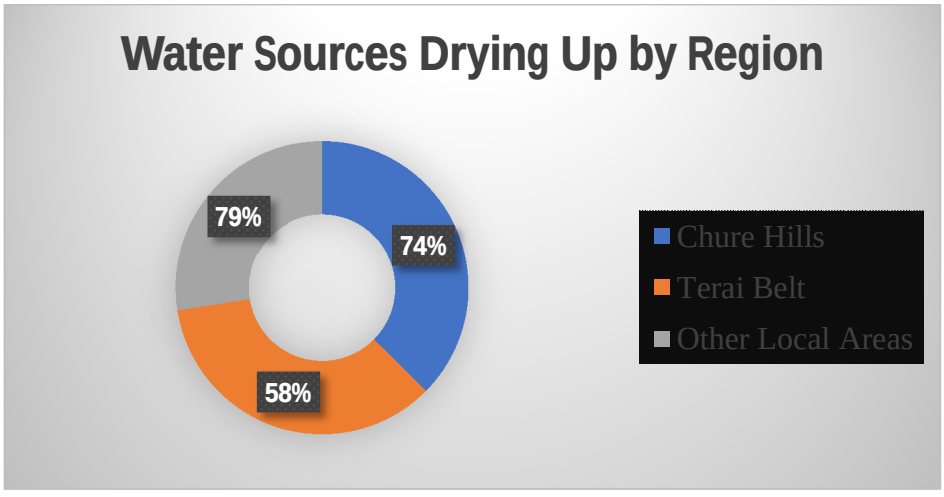
Abstract: ***The Terai Region which lies in the southern part of Nepal which covers approximately 34,019 square kilometers, which is about 17% of Nepal's total land area and 48% of Nepal's population, making it the most densely populated region. Terai region lies just below Chure range which consist of 36 districts nearly covering the area of 800 Km from Ilam in the east to Kanchanpur in the west. This region covers nearly 12.78% of the total land area of Nepal. This region is always known as the "granary" or "Breadbasket" of the country. Majority of the population in this region mainly depended on groundwater as a primary source of drinking water and irrigation. However, over the past few years from 2022 to till now, this region has been experiencing a significant decline in groundwater levels due to over-extraction for irrigation and drinking water, weakened aquifer recharge linked to land degradation, deforestation in the Chure hills, erratic monsoons, and unregulated use of tube wells. This paper investigates the present scenario of groundwater predicament in the Terai part, examining its major root causes, socio-economic and environmental impacts, regional disparities, and potential solutions. Through the field observations and with a government report doing a comparative analysis and highlights the interplay between over-extraction, inadequate infrastructure, policy gaps, and climate variability. Moreover, this research provides practical recommendations for sustainable groundwater management through community engagement, policy reform, and technology-driven solutions.***

Keywords: ***Terai region of Nepal, Chure-Bhabar region, Groundwater crisis, Deep boring, rainwater harvesting, Zai pits, Rajkulo, Stone spouts (Dhunge Dhara)***

I. INTRODUCTION

Nepal is always known as Himalayan country in the world, with 1,47,181 sq.km. covering area, Nepal ranked in 2nd in terms of inland water resources but also ranked 43rd globally in terms of renewable water resources though it is a landlocked country. Water is an essential resource for sustaining life, where the world covers around 71% of water, only 3% of earth water is fresh and less than 1% is used for drinking purposes. Where Nepal covers almost 2.27% out of 1% of drinking water. Beside this, Terai region covers almost half of the population of the country, nowadays facing scarcity of drinking water for a few years, due to various environmental, socio-economic, and political factors. Despite its rich water table, the Terai is facing the quality and safety of drinking water for its inhabitants. Almost 90% of tube well is drought in these years, whereas 60% of farmer depend on the ground water for their irrigation in the field. Just take an example of Birgunj city, where house numbers were more than **47000+** in the year 2022 and the hand pumps was above **30000+,** but in these years both numbers were increased but the ground water table started decreasing.



The time period from 2022 to 2025, the drinking water problem has been increasing, depletion and contamination of groundwater sources, and ineffective management of water supply systems as evident from media reports, research papers, and field surveys conducted in Terai region. The government's participation has been inconsistent and largely insufficient in tackling the root causes of the problem. This research provides an in-depth analysis of the water crisis in the Terai region and proposes practical solutions to mitigate it.

II. OBJECTIVES OF THE STUDY

1) To examine the current status of groundwater levels in Terai (2022-2025)
2) To identify key causes and contributing factors behind the groundwater crisis
3) To assess socio-economic and environmental impacts

III. METHODOLOGY

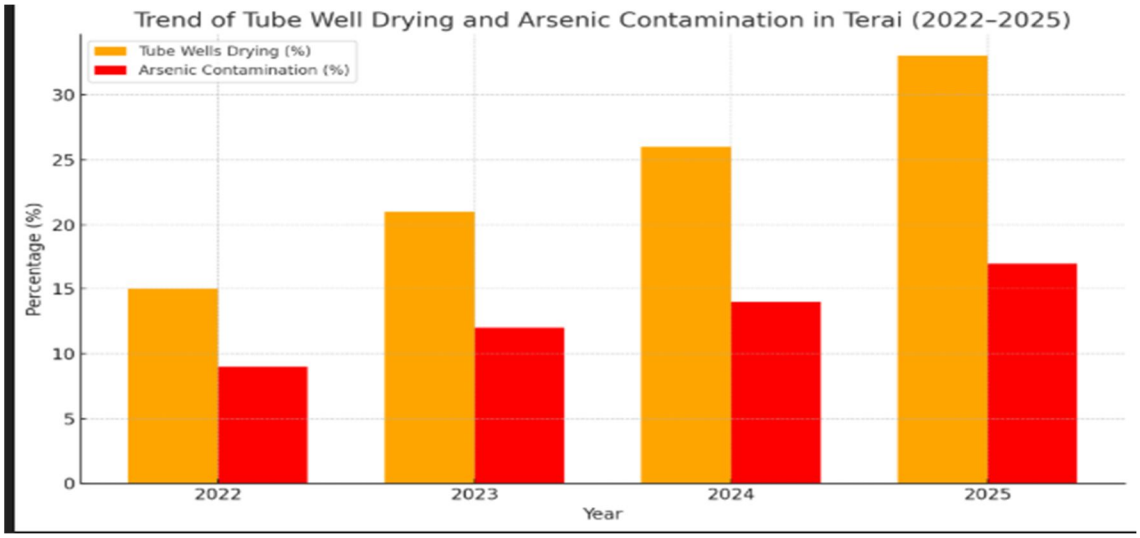
This research employs a mixed-method approach:

1) Field surveys and interviews conducted in the 8 key districts.
2) Secondary data from **DWSSM** (Department of Water Supply and Sewerage Management), **NEA** (Nepal Engineering Association), and academic journals.
3) Use of geospatial tools to analyze declining water levels.
4) Comparative analysis of groundwater data from 2022–2025.

IV. REASONS BEHIND THE WATER CRISIS

A. Groundwater Contamination

The Terai belt people mainly depend on groundwater for drinking purposes. However, their drinking water contains arsenic, iron, and harmful bacteria which is unsafe. Recently field surveying done by Department of Water Supply and Sewerage Management (DWSSM) in 2023, more than 50% of tested tube wells in Terai region they found safe arsenic level of 0.01 mg/L



B. Over-Extraction of Groundwater

Rapid population growth and agricultural expansion in Terai region which led to excessive excavation of groundwater. This led to depleting aquifers faster especially in summer seasons.

C. Climate Change and Irregular Rainfall

In the past few years, the southern part of Terai region has faced uneven rainfall patterns which causes reduced monsoon rains by 1.8 mm/year and rising temperatures increase evapotranspiration, both reducing aquifer recharge and also affecting natural water recharge systems.

D. Inadequate Infrastructure and Governance

Outdated water supply systems, limited government budgets, and lack of skilled manpower hinder effective water distribution. Furthermore, corruption and mismanagement have led to the failure of many water supply projects. Uneven distribution construction of infrastructure, without proper planning and management.

E. Lack of Awareness and Education

In rural Terai, many residents lack awareness about the importance of water purification and safe sanitation practices, leading to health issues and perpetuation of unsafe water usage.

F. Deforestation

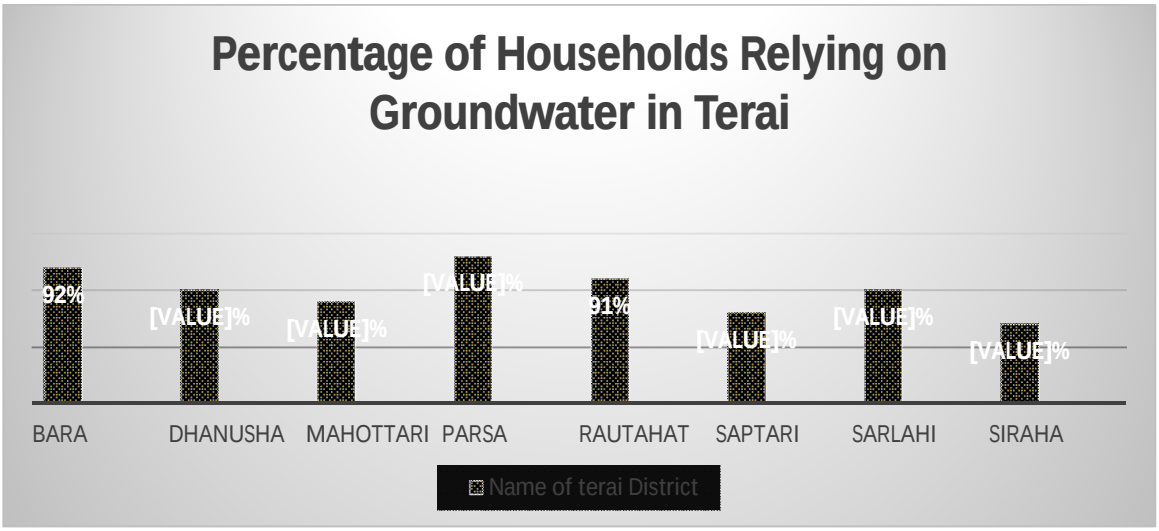
Recently, the government had cut down almost more than 2.8 million of trees in terms of making airports and roadways in Terai belt, without any proper plan and management just for their own personal benefits.

G. Decline of ancient water reservoirs

Government just filling the ponds, lakes and others water reservoirs for their own lucrative.

H. Installation of deep boring

In Terai region, the government is installing deep boring in majority parts without any proper plan and discussion with expertise, that will cause serious predicament in the future.



V. EXAMPLE OF SOME CASE STUDIES

A. Hariwan Municipality (Sarlahi District)

Hydrogeological mapping identified impermeable shallow layers in northern Bhabar and Chure foothill zones, leading to water scarcity in specific localities. The study recommended development of swamp-wells tapping shallow aquifer recharge beneath riverbeds and gravity-fed systems for sustainability.

B. Khutti Khola Watershed (Siraha District)

In Bhabar zones like Ranaha and Simaltoki, studies showed scarcity tied to urbanization and poor hydro governance. The authors proposed artificial recharge ponds as a nature-based solution to improve groundwater availability and community resilience.

C. Bheri Terai (Mid-western Nepal)

A numerical optimization of aquifer parameters—using piezometer and modelling—helped to determine transmissivity and hydraulic conductivity for better planning of sustainable borehole locations.

D. Eastern Terai Quality Assessment

Chemical analysis in some part of Morang, Jhapa, and Sunsari revealed which contains turbidity, ammonia, iron, fluoride and manganese, though most parameters remain within WHO limits except localized contamination risk zones.

E. Sudurpaschim Rainfall & Extraction Impacts

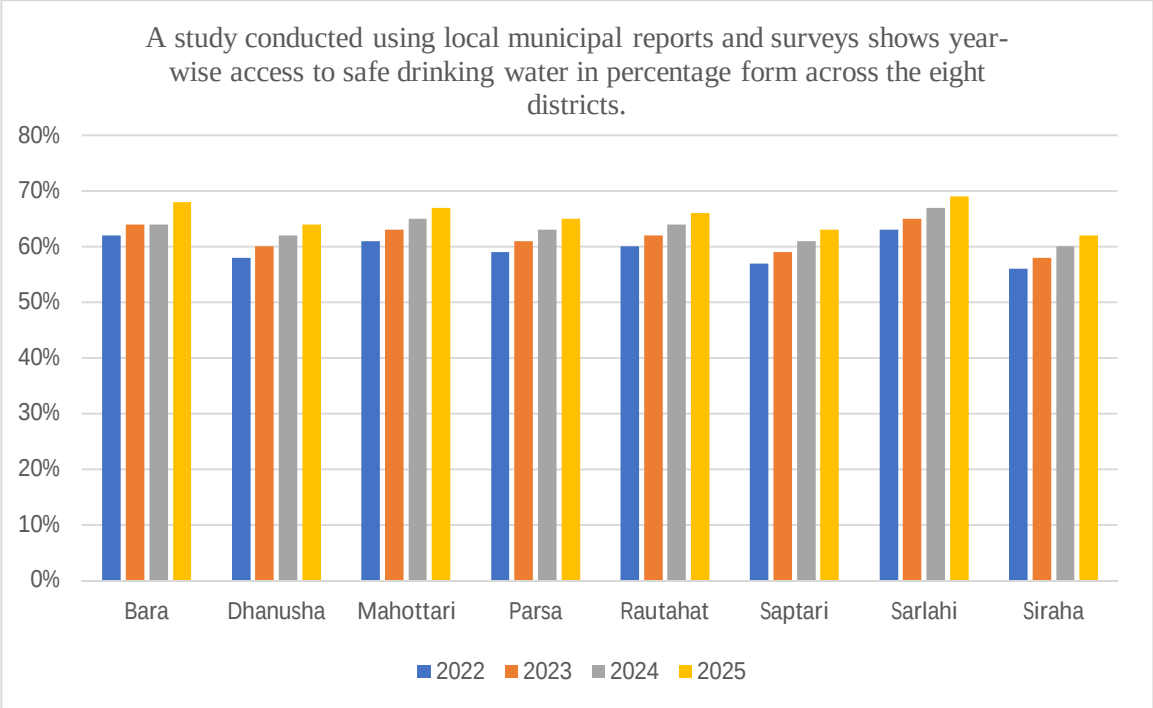
In Kanchanpur and Kailali, four-year drying of borewells forced municipalities to switch to remote sources, drilling deeper or relocating supply, revealing depth now reaching 80–120 ft, which often still fails to yield water.

F. Barahathwa, Madhesh Province

In Barahathwa, a mapping exercise conducted by the International Water Management Institute (IWMI) found that 73% of the 1,136 wells and boreholes used electric pumps. Most of these wells had shallow water tables between 30–60 feet, indicating over-extraction.

G. Drought in 2024

The 2024 drought affected all eight districts along Nepal's fertile Terai belt. Groundwater levels receded, and hand-pumps and wells dried up, leading to an acute shortage of drinking water.



VI. SOLUTIONS AND RECOMMENDATIONS

A. Promotion of Rainwater Harvesting

Generally, Government and institution sector buildings occupied huge area, whereas rooftop rainwater harvesting systems plays major role in serving as backup drinking water sources during the summer season. Along with it, residential and commercial building also have to install rooftop rainwater harvesting which will help groundwater to get recharged and also help in supplement municipal supply. Establishing surface recharge ponds in recharge zone and Bhabar areas that can store runoff and enhance infiltration.

B. Expansion of Municipal Piped Water

Local government should play major role in expansion of municipal pipe, so that only few lands are used for aquifer sources & it is also confirmed arsenic-free which is essential for drinking water. Government funding and international donor support should prioritize these districts. municipal water pipelines also help to reduce leakage and ensure equitable water distribution.

C. Groundwater Regulation and Recharge

Strict rules & regulation of tube well installation should be made and advertisement of recharge ponds and wells that can help in maintaining balance in groundwater. Strict policies must be introduced to monitor and limit private boring.

D. Public Awareness Campaigns

Conducting the campaign on importance of water conservation and also provide Education on arsenic risks on drinking water. Community mobilization through local NGOs and school curriculums helps to promote such programs.

E. Chure Region Conservation

Construct zai pits or surface recharge ponds, especially in upstream region to capture monsoon runoff and replenish aquifers. Conserve Chure foothills through reforestation to restore catchment function. Control illegal logging and gravel mining.

F. Treatment Plants for Industrial Waste

Industries must use their own land for water treatment process rather than leaving their waste water in rivers or agricultural land and there should be mandated to install effluent treatment plants (ETPs) to prevent toxic discharge into natural water bodies.

G. Water-efficient Irrigation & Cropping Changes

People must follow these techniques like drip irrigation, sprinkler systems, the system of rice intensification (SRI), and promoting low-water-footprint crops for irrigation which can reduce groundwater stress while maintaining productivity. Encouraging pupil about the crop rotation with less water-demanding varieties.

H. Data-Driven Governance

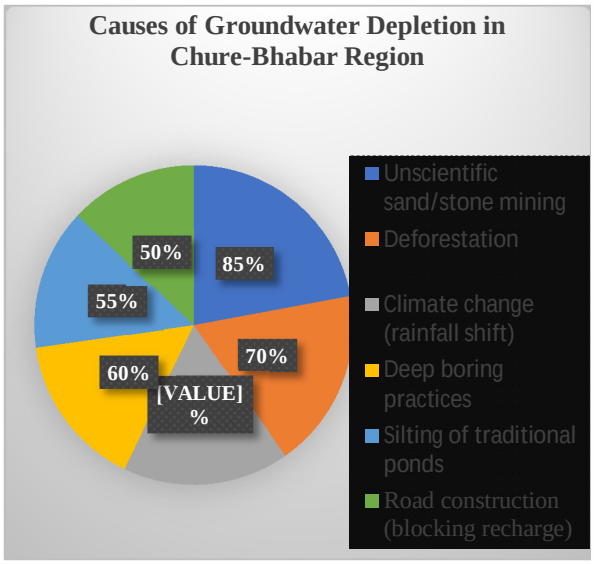
Establish a real-time groundwater monitoring system. Use GIS for mapping water-stressed zones.

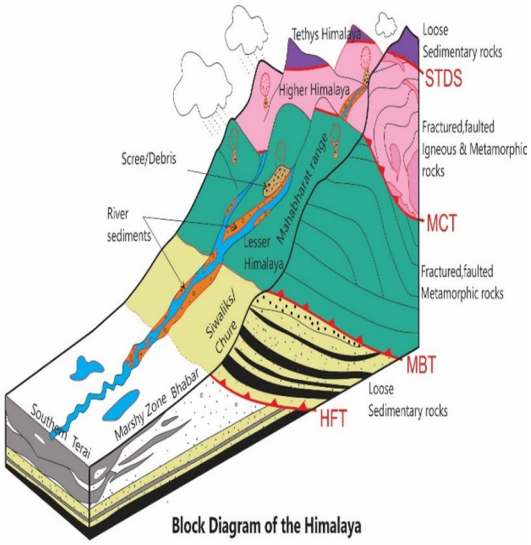
VII. HOW CHURE EXPLOITATION ENDANGERS NEPAL'S GROUNDWATER FUTURE?

Nepal's geographical location and environment support abundant water sources. Nepal has the Himalayas, a reservoir of water, with glaciers and mountains in between, where rain falls regularly. The water recharged and flowing in the mountains flows through springs and waterfalls, and flows through large fields and rivers throughout the year.

Fig: Before Extraction Fig: After Extraction

The forests and wetlands in the Chure-Bhabar region collect water through the floodplain and store it underground. According to the recent report data of the Department of Drinking Water and Sewerage Management mention that 90% of the terai population uses groundwater for household purposes as well as irragtion process. The main source groundwater is the water that collects in the Chure-Bhabar region, where We extract water from the Chure-Bhabar region by building canals and channels, and by drilling wells and boreholes to access the water flowing underground. However, the Chure region is prone to limestone. Due to the excavation of stones and rocks, the land has been eroding for years. Stone mining industries have been excavating and extracting against the standards. Similarly, the excavation of stones and sand in the Chure region has also been affecting the water sources. This is because the stones in the rivers perform an important function. These stones help control the flow of water, and the water flows by being blocked and released. When water flows slowly, the land absorbs more water.





Due to the haphazardly extraction of stones and gravels, it directly affects the water sources that causes natural obstruction in the river's flow in the Chure region. Beacause of this, each year ground water is decreasing and cannot be recharged. The streams and rivers of the Chure hills are drying up. In the Bhabar area, the groundwater level is decreasing rapidly.

A study has shown that 74% of the water sources in Nepal's local levels are drying up and 58% of the sources have shifted. Among them, most of the water sources have dried up in the Chure region.There is a problem of 79% of the water sources drying up in the Chure region. If it continues at this rate, the settlements there are sure to disappear. There has been unscientific and haphazard extraction of gravel, sand, and stones in the Chure Bhabar region.

The Terai region is considered the breadbasket of Nepal, and agriculture is not possible without water. A study has shown that 74% of the water sources in Nepal's local levels are drying up and 58% of the sources have shifted. Among them, most of the water sources have dried up in the Chure region. Chiranjeevi Bhandari, the executive director of the said foundation, states that deforestation, climate change, and floods and landslides are also the main reasons for the drying up of water sources. Besides, traditional ponds silting up, hydroelectric tunnels being dug, and installing deep boring, are some of the reasons for water drying up. Natural reasons include excessive and insufficient rainfall, and the resulting floods, landslides, droughts, and earthquakes. Another main reason is the change in rainfall patterns. However, roads are usually built during this time in our country, which hinders this important process of water recharging.

VIII. WHY WE SHOULD NOT USE DEEP BORING? WHY?

Modern science is progressing in such a way that we have gained various technologies. However, despite all these technologies being available and with so many sources of water, the problem of water scarcity is increasing every year. To solve this, we are increasing the depth of our boreholes. Until recently, we were digging 100 - 250 feet deep to find water, but now we have gone well below 300 - 400 feet. This depth is going even lower every year. However, increasing the depth of boreholes will not solve the problem; rather, the problem will increase.

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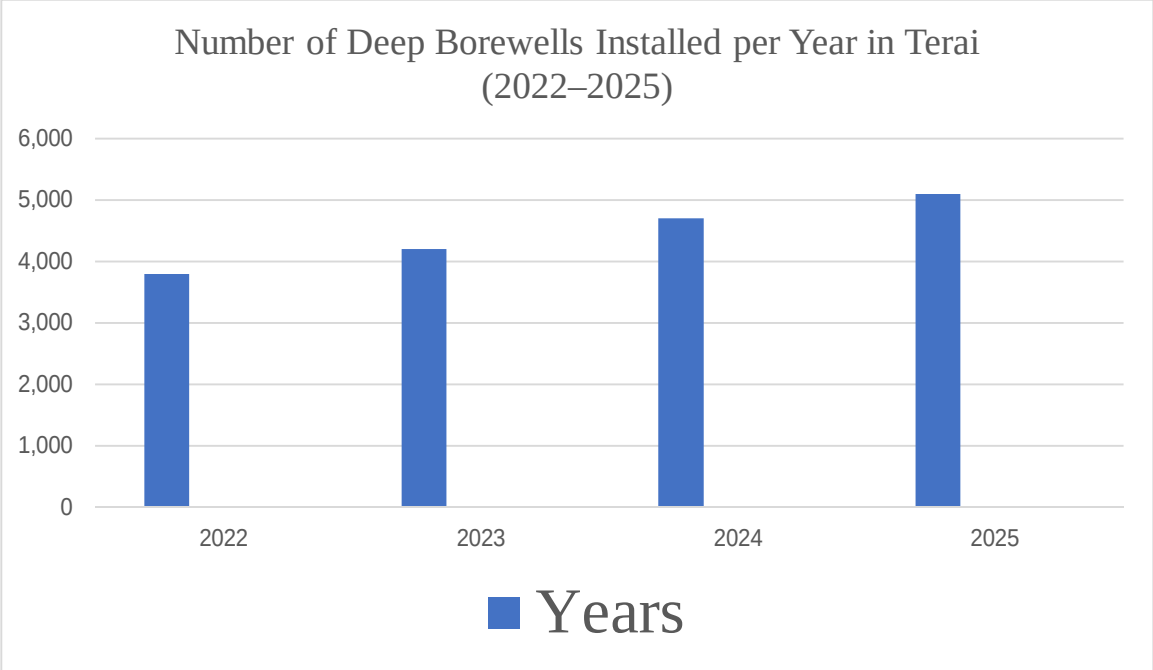

We can take the example of Jakarta and Tehran which are the capital of Indonesia and Iran. In both capitals, so much groundwater is extracted uncontrollably and the wasted groundwater is not recharged which leads to dried the soil and created sinkholes, causing the land to sink. Due to this, in recent years, there have been huge floods and cities have started to sink. Where Jakarta lands sink by up to 25 centimeters each year. Due to this predicament, Indonesia had already announced to shift their capital city from Jakarta to East Kalimantan. Similarly, the cities like Bangkok, Thailand, and Dhaka, the capital of Bangladesh are facing the same problems because of deep boredom. There, due to the problem of land subsidence along with the decrease in water level, they have started to ban the extraction of groundwater. In Bakundol, Lalitpur, some time ago, the land around the under-construction Summit Apartment also subsided. Hydrologist Madhukar Upadhyaya states that one of the main reasons for the land subsidence in the Summit Hotel area is the excessive extraction of underground water. He explains that because the land in the Kathmandu Valley is loose, constructing large structures without caution at great depths can lead to such problems, affecting the land and sources of clean drinking water. He also mentions that it affects the sources of clean drinking water.

IX. SO, WHAT TO DO?

For this, we can look back at our own history. All over the world, according to their local geography and water availability, traditional techniques have been developed from the past. For instance, ponds and Zia pits were built in the hilly settlements of Nepal, and lakes or ponds were also dug in every village of the Terai part. Every stone spout, Rajkulo, well, and canal has its own history. In religious texts and ancient scriptures, water sources are given special importance, and people before us also observed them with great importance. The stone stream is mainly called as dhuga dhara in Nepal, we see it in various places of Kathmandu Valley and other places also which started being built more than 1400 - 1500 years ago. These spouts are built in such a way that water flows continuously from them. Naturally, these spouts were built considering the natural bases for their operation.

There are very few places in the world where the water has been flowing, Festivals were celebrated to clean water sources like stone spouts, wells, and canals.

According to Madhusudan Shakya, who has been working in the field of climate change impacts, also states that if we do not conserve the traditional water sources and ponds, the problem is certain to become more severe. He mentions that the government has increased investment in large river and reservoir-focused projects, but no one is paying attention to the conservation of small springs that can meet the local water needs. He explains that by adopting traditional concepts and naturally increasing water flow, the example of ending water scarcity through the efforts of India's 'Paani Foundation' can also be seen.

X. PERFECT CASE STUDIES IN GROUNDWATER RECHARGE AND URBAN WATER MANAGEMENT!

Paani Foundation, established by Bollywood actor Aamir Khan in collaboration with his ex-wife Kiran Rao, is working to eliminate water scarcity in about 10,000 villages in Maharashtra by adopting traditional methods. The villagers of those thousands of villages transformed their villages from drought-stricken areas to areas with year-round water supply by working for just 45 days. When rainwater goes into the ground, many water-related problems can be solved automatically.

Another one, a canal was built from the Colorado River in America, and its water was taken to the Phoenix area. The canal passes through the Arizona desert. Due to a dam on one side of the canal, rainwater is collected there and reaches underground. As a result, a forest has grown in that area. And this forest was not intentionally planted, so it is called the 'Accidental Forest'.

Similarly, in Tokyo, after implementing regulatory measures to ban the use of groundwater at the beginning of the 20th century, the groundwater level increased again, and after about 10 years, the land level stopped decreasing.

Singapore is developing its cities as 'sponge cities' where water can easily seep underground from roads and other structures. For this, Singapore uses porous construction materials. Also, in Singapore, priority is given to trees, and even vacant or unused spaces are cleared for tree plantation.

XI. WHY NEPAL FACES A WATER CRISIS DESPITE ABUNDANT RESOURCES?

According to a report published by the World Resources Institute of the United States, Nepal is in the 40th position in the list of countries experiencing an extremely severe water crisis, while India is in the 13th position. Nepali scientists suggest that Nepal can learn from India's water management practices.

Annual Rainfall Variability (in mm) in Chure Region (2022–2025)

Year	Average Rainfall (mm)	Variance from Normal (%)
2022	1,240	-10%
2023	1,110	-18%
2024	1,390	+5%
2025	1,050	-22%

Somanth Poudel, former secretary of the Water and Energy Commission and expert on water resources, says, 'We have long envisioned that Nepal can become wealthy by selling water, but we need to manage that water.' Nepal is not facing a severe water crisis due to lack of water, but due to lack of management. Looking at another example of what Nepal has done in the past, we can look at the Chandra Canal. In 1928, we built Nepal's first modern engineering irrigation canal, the Chandra Canal. This main canal, starting from the Triyuga River and 29 kilometers long, has 10 other auxiliary canals and 257 branch canals, all of which can irrigate more than 9,000 hectares of land in 29 municipalities. Many such canals have been built across Nepal, but we have not paid enough attention to their conservation and management, nor has local participation been emphasized in the conservation and management of these canals, as was done in the past with the construction of wells or canals, or how the 'Paani Foundation' in India involved villagers in water conservation.

Political reasons between Nepal and India have also led to irrigation and water shortages in the Terai regions of Nepal. Two canals, east and west, have been built from the Saptakoshi River. The eastern canal flows through 1 kilometer of Nepal's territory and then into India's territory for irrigation. The western canal irrigates 32 kilometers of Nepal, including the Saptari district. However, India occasionally releases water only towards the eastern canal and blocks the water towards the west.

According to Dr. Komal Thapa researches on “water resources and climate change at the International Water Management Institute”, He mentions that for water conservation, the government should create regulations and guidelines, and implement policy measures such as leaving open spaces in newly built houses and collecting rainwater. He also argues that laws should be enacted to revive the currently dry sources and identify recharge areas.

Hydrologist Padam Sundar Joshi mentions that some local levels have done good work in conserving ponds and stone spouts. He says that some local levels have revived ponds that had almost disappeared, but they feel that this is not enough, and that groundwater can also be conserved by storing rainwater underground. Along with these efforts, the government must also think about multi-purpose management to provide irrigation and water to meet the increasing needs.

XII. FUTURE PREDICTIONS

1) Groundwater table may decline by 2–3 meters by 2030.
2) Majority of districts will be face drinking water predicament during summer seasons.
3) Agricultural land drought could be rise by 20% in most vulnerable areas.
4) Migration will be happening from terai region in search of better drinking water.

XIII. CONCULSION

The Terai region of Nepal is facing a drinking water crisis day these, which has rose from 38% in 2022 to 46% in 2025. Despite its natural water resource potential, it is suffering critical situation. The crisis is not just from environmental but also major role played by politics, which cause a serious threat to public health, agriculture, and socio-economic stability.

Addressing this challenge, there must be involvement government bodies, NGOs, and local communities to come out from such crisis. Solutions must include modern technologies, nature-based recharge methods, infrastructure development, community engagement, and strong regulatory frameworks

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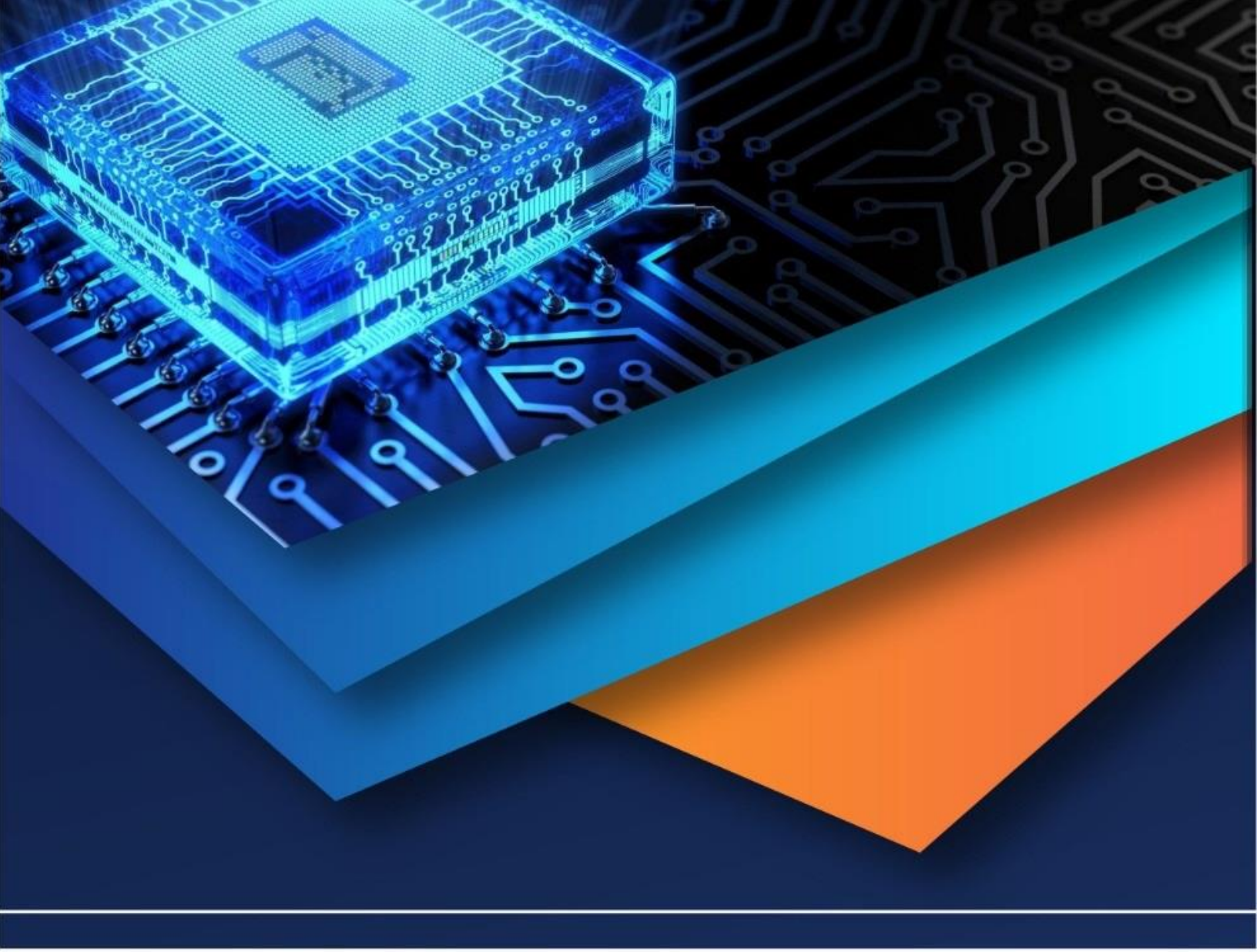

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