Geology and the Management of Water Resources in Rajasthan, India

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Abstract
Water is a natural resource that is essential for sustainable development, livelihood, and food security. The globe formerly had enough of clean, potable water, but due to rapid population increase, misuse, excessive exploitation, and poor management of water, it is now becoming a planet with a shortage of water. The only way to save human existence on Earth is through the wise use of water resources. The largest state in India, Rajasthan, experiences a tropical desert environment. The state as a whole relies primarily on groundwater and has minimal surface water supplies. Only 9% of the domestic water needs are satisfied by surface water sources, while 91% of them are fulfilled by groundwater sources and it's depends on the rock type of the area which helps to water passes into the ground. Limited precipitation, low aquifer recharge, and excessive evapotranspiration are all effects of the state's low precipitation. There is a lot of variance in the state's rainfall pattern, and the rainfall is irregular. In the last six decades, the state has frequently experienced hunger and drought. Due to population expansion, the green revolution, industrialization, urbanization, and rising quality of living, water consumption is rising more quickly. In addition to this, Rajasthan's water resources are being overused and are being contaminated with fluoride and nitrate. The focus of the current study was on geology of Rajasthan, diverse uses and their potential effects on Rajasthan's water resources. In this regard, several potential remedies to these issues are also outlined.

Keywords: Geology, Management, Contamination, Hydrogeological, and Evapotranspiration.

Introduction:
Water is a natural resource that is essential for sustainable development, livelihood, and food security. Water is absolutely necessary for all human life-sustaining activities, including drinking, home use, agriculture, industry, and related industries. It also plays a crucial role in the growth of a nation's or region's economy. No life on earth is conceivable without water, and that is not an exaggeration. In the modern world, water shortage is a serious problem that is getting worse very quickly. Since the issue has gotten so bad, several nations' groundwater supplies are nearly completely depleted, forcing residents to rely on outside sources for their water. Water is also one of the resources that we still waste the most. Although it is the focal point of our lives, it is not the focal point of our attention. The globe formerly had plenty of clean, potable water, but due to rapid population expansion, misuse, excessive exploitation, and poor management of water, it is now becoming a planet with scarce water. People used to revere water and make plans for their life around it. On account of water, several civilizations have flourished and collapsed. Today, however, we are aware of the importance of water, but we are still unable to comprehend. As a result, managing water resources is both unavoidably necessary and the sole means of preserving human life on Earth. Planning, developing, allocating, and managing the best use of water resources are all included in the activity of managing water resources. It is a part of managing the water cycle.

This paper focused on the geology of state Rajasthan, numerous uses and their potential effects on Rajasthan's water resources. In this regard, several potential remedies to these issues are also outlined. The purpose of the current study is to highlight the various water resource usage and management activities in Rajasthan, to determine their potential effects on the region's water resources, and to offer some management or mitigation solutions for pollution-related issues.

Methodology:
Secondary data sources have been heavily employed in this research article to achieve its goal. The information was gathered from various governmental organizations, NGOs, and online resources. In order to assess and determine the existing condition of the region's water resources and to forecast some of the effects of various anthropogenic activities, pertinent data has been reviewed.

Study Area:

The largest state in terms of area is Rajasthan, which is situated in the northwest of the nation and extends from 23^0 03' to 30^0 12' North latitude to 69^0 30' to 78^0 17' East longitude. It occupies 342,239 square kilometers, or 10.4%, of India's overall geographic area. It shares a state border with five states: Punjab to the north; Haryana and Uttar Pradesh to the northeast; Madhya Pradesh to the southeast; and Gujarat to the southwest. It also shares an international border with Pakistan. Figure 1 depicts a district's administrative boundary.

Figure 1: Administrative Divisions Map of Rajasthan

Source: CGWB, 2020

The climate of Rajasthan is tropical and arid. It endures the sweltering heat of the sun from March to September while remaining extremely frigid from October to February. Rajasthan experiences drought as a result of its low rainfall. Rajasthan experiences extremely hot summers with temperatures averaging between 32^0 and 46^0C (with a maximum of 49^0C). Rainfall varies constantly throughout Rajasthan, just like the climate. The South-West Monsoon produces the majority of the rain throughout the three-month period from July to September. The state receives 200 to 410 mm of rain on average per year. Rainfall in Rajasthan's south-eastern region can reach 1000mm. There are several areas of western Rajasthan that only get 100 mm of rain annually.

Nine agro-climatic zones and different types of soil in Rajasthan's agricultural economy support the cultivation of crops. According to the Census of 2011, 75% of the State's population lives in rural areas, and 62% rely on agriculture and related industries for a living. It is one of the states in India that produces the most minerals. Rajasthan has a total population of 68,548,437 people, according to the 2011 Indian Census. There are 200 people per square kilometre living in the state. Its population grew by 21.31% between 2001 and 2011 as a whole. The state's literacy rate is 66.11%, and there are 928 females for every 1000 males.

Geology:

In Rajasthan, a variety of rock types are exposed, from the oldest Archaean rocks to sub-Recent alluvium and wind-blown sand. The earliest rocks are covered in a substantial amount of the region, especially in western Rajasthan, by an accumulation of alluvium and wind-blown sands. Table 1 provides a generalized stratigraphic succession of different formations and rock kinds.

The Bhilwara Supergroup, which includes the Banded Gneissic Complex, the oldest meta-sedimentary sequence, and Berach Granite, represents the Archaeans in Rajasthan. The Aravalli Supergroup, which is composed of phyllites, greywackes, quartzites, and dolomites intruded by granites and mafic rocks, unconformably overlies the Archaeans. The majority of these are quartzites, biotite-schist, calc-schist, and marble, and they are exposed in extensive portions of central and northeastern Rajasthan. Vindhyans have been deposited in two different basins on either side of the Aravallis and irregularly overlie Delhis. These include unmetamorphosed, largely undisturbed sandstones, limestones, and shales in the eastern section. They are divided from the Aravallis and Archeans by the Great Boundary Fault. Around Kishangarh, nepheline syenites are uncovered; they date from after Delhi. The main intrusion into the Delhis is Erinpura Granite, which is found near Ajmer and Mount Abu. Around Jodhpur, igneous rocks called the Malani Suit, which are post-Delhi in age and comprise rhyolites and pyroclastic material, are uncovered. Jodhpur Group (mostly sandstone and shale), Bilara Group (primarily limestone and dolomite), and Nagaur Group are the three groups that make up the Lower Palaeozoic Marwar Super Group in the western part of the state (sandstone, siltstone and gypsum). The Badhura Formation, which is composed of sandstones and boulders and is Permo-Carboniferous in age, lies beneath the Marwar Super Group. In the districts of Jaisalmer and Barmer, the Mesozoic era is mostly exposed. Sandstones and limestones make up these. The Deccan Traps are located in the Banswara, Baran, Jhalawar, and Chittorgarh districts of the state's southeast region. These predate the Aravallis, Vindhyans, and the Aravallis. These are uniformly composed and range in composition from basaltic to doleritic. The primary litho-units, which are exposed in the districts of Barmer, Bikaner, and Jaisalmer, include sandstones, bentonitic clay, and Fuller's earth. This category, which is widely distributed throughout the state, consists of alluvium, blown sands, kankar, and evaporates.

Table 1: Geological Succession

Geological Time Unit		**Lithostratigraphic Time Unit**		**Lithology**
Era	**Period**	**Supergroup/Group**		
Recent				Alluvium and blown sand
Cainozoic (Tertiary)	Eocene	Mandai/Akli/Kapurdih/Jogira/ Banda/Khuiala/ Palana		Sandstone, bentonitic clay & fuller's earth
Deccan Traps				Basalt
Mesozoic	Cretaceous	Abur / Fatehgarh		Sandstone, limestone, clay and lignite
	Jurassic	Paruhar/ Bhadesar/ Baisakhi/ Jaisalmer/ Lathi		Limestone, sandstone & shale
Palaeozoic	Permo- Carboniferous		Bhadura	Sandstone & boulders
		Marwar	Nagaur/ Bilara/ Jodhpur	Sandstone, gypsum, siltstone, limestone, dolomite & shale
Upper Proterozoic		Vindhyan	Bhander/ Rewa/ Kaimur/Semri	Sandstone, shale, limestone, conglomerate & basic flows
		Acid,Basic and Ultrabasic Intrusives and Extrusives Malani Volcanics / Plutonics Kishangarh Syenite		
Lower Proterozoic		Delhi	Ajabgarh/ Alwar/ Sirohi/ Punagarh/ Raialo	Lower Proterozoic
		Granite, Basic & Ultrabasic Intrusives		

		Aravalli	Jharol/ Bari/ Udaipur/ Debari	Quartzite, schist, phyllite, conglomerate, greywacke, metavolcanics & marble
		Granite & Basic Intrusives		
Arachaean		Bhilwara	Ranthamobre/ Rajpura-Dariba /Hindoli	Phyllite, slates, schist, gneiss, granite gneiss & migmatites

Water Resources:

Any water that accumulates on the earth's surface is a surface water resource. This encompasses wetlands, oceans, seas, lakes, rivers, etc. Surface water is maintained by precipitation and lost through evapotranspiration or seepage through the earth. Rajasthan is one of the states with the highest susceptibility to climate change and the lowest capacity for adaptation. Only 1.16 percent of India's total surface water resources, or 21.71 billion cubic metres (BCM) are located in Rajasthan, yet 16.05 BCM of those are still useful economically. The state has built the ability to capture and store 11.29 BCM, or almost 70% of the water that is available. The state contains 11.36 BCM, or 1.72 percent, of the nation's groundwater. 17.88 BCM is distributed through interstate agreements and is dependent on inflows into the rivers, although it is unreliable owing to political pressure from the upper riparian states. On paper, it is possible to increase water use by an additional 30%. Economically useable water, or 21%, represents a more accurate estimate of increased availability. The usage of 79 percent of the 45.09 BCM of total available water is depicted in the figure below.

With the exception of Chambal, all the rivers of Rajasthan are seasonal and only flow when it rains. The creation of a river's catchment areas is influenced by topography and precipitation. The uplands that give rise to the streams and rivers are incredibly fractured, rough, and uneven in character. Catchments have low stream densities since there aren't any deep channels to increase stream density.

The primary water divide in Rajasthan is formed by the Aravalli Range. The only river that flows west of the Aravallis is the Luni. The drainage is internal, the streams only move a short distance from their point of origin, and they eventually disappear in the desert sands in the remainder of western Rajasthan, which makes up around 60% of the state's land area. The Luni itself is a transient stream with a 16-year flood cycle. Rajasthan's western region drains to the west and southwest. The primary drainage lies to the north-east, east of the Aravalli hills. In Rajasthan, it travels around 226 kilometres in a north-easterly direction. The south-eastern portion of Rajasthan is drained by the Chambal and its tributary Banas, which rise in the Aravalli Range.

Yamuna-Ganga in the northeast and Sabarmati and Mahi in the southwest are among the other significant catchments. Barah, Sota, Sahibi, Banganga, and Kantli rivers are inland in eastern Rajasthan's northern and northeastern regions. In Rajasthan, rivers typically have a dendritic drainage pattern. There are a few salt lakes in the desert region; Sambhar Lake, Didwana Lake, Bap, Pokran, Pachpadra, and Rann of Jaisalmer are among the most significant ones. As part of interstate agreements, Rajasthan also receives some water from river basins in other states. Table 2 shows the status of surface water resources and storage built in Rajasthan in 2010.

Table: 2 Status of available surface water and storage created in Rajasthan (2016)

S.No.	**River Basin**	**Basin Area (Sq. Km.)**	**Available Yield (in MCM)**	**Storage Created (in MCM)**
1.	Banas	46902	5,097.26	3639.76
2.	Banganga	9949	754.83	412.26
3.	Chambal	31229	8,702.14	2906.77
4.	Gambhiri	4934	700.89	231.56

5.	Luni	69580	2,269.92	1136.66
6.	Mahi	16598	3,720.25	2726.59
7.	Parvati	1891	427.18	157.28
8.	Ruparail	2550	641.38	101.64
9.	Sabi	4615	348.09	113.65
10.	Sabarmati	4118	732.52	212.09
11.	Shekhawati	9691	562.85	89.72
12.	Sukli	994	137.61	48.00
13.	West Banas	1835	222.14	80
14.	Other Nallah of Jalore	1775	51.42	6
15.	Outside Basin	135603	990.60	9

Source: Water Resource Department, Government of Rajasthan

The Indira Gandhi Nahar Pariyojana (IGNP), the Mahi Bajaj Sagar Project, the Bisalpur Project, the Jakham Irrigation Project, and the Gurgaon Canal Project are significant irrigation projects in Rajasthan. The Ganganagar, Bikaner, Hanumangarh, and Jaisalmer districts of Rajasthan are included in the Indira Gandhi Nahar Pariyojana (IGNP). Its primary goals are to supply drinking water and aid in agricultural endeavours.

To study the occurrence and flow of ground water unconsolidated sediments, semi-consolidated sediments, and consolidated rocks are the three hydrogeological units that Rajasthan can be categorized into. Due to their widespread distribution, Quaternary sediments, including both younger and older alluvium, are the most significant unconsolidated formations. The sediments are made up of a mixture of calculus as well as silt, clay, sand, and gravel. In the state's northern, eastern, north-eastern, western, and south-western regions, sand, gravel, and mixtures of these materials constitute possible aquifers. At Anupgarh in the Ganganagar district, the greatest alluvium thickness is 543.51 mbgl. Shale, conglomerate limestone siltstone, clay stone, and sandstone make up the semi-consolidated formations. The primary aquifers in the districts of Barmer, Bikaner, Jaisalmer, and Jodhpur are formed by sandstones and limestones. The most promising aquifers in the districts of Barmer, Jaisalmer, and Jodhpur are Lathi formation sandstones. The consolidated rocks are primarily restricted to the eastern half of Rajasthan and comprise granites, gneiss, schist, marble, phyllites, Vindhyan limestone, sandstones, quartzite, and basaltic flows. Until the well is situated close to main lineaments or any other weak planes, the yield prospect is limited. At deeper levels, the quality of the ground water is typically poor (brackish to saline).

The depth of the water varies greatly throughout the State; shallow water levels have been seen in the canal command areas of the districts of Ganganagar, Bundi, Banswara, and Kota, while deeper water levels have been seen in the western districts, specifically Barmer, Bikaner, Jaisalmer, and Jodhpur. Figure 2 illustrates the depth to water level map of the pre-monsoon (May 2017). In comparison to the west of the Aravallis, the water's depth is noticeably shallower there. In general, the water depth east of the Aravallis ranges from less than 10 to 25 metres, whereas it ranges from 20 to 80 metres to the west. On the eastern side of the Aravallis, the water level slopes east and south-east, whereas to the west, it slopes west and north-west. However, there are frequently regional variances in the direction and flow of ground water. Groundwater levels have significantly decreased as a result of overuse and overexploitation, which may eventually cause aquifers in several parts of the State to dry out.

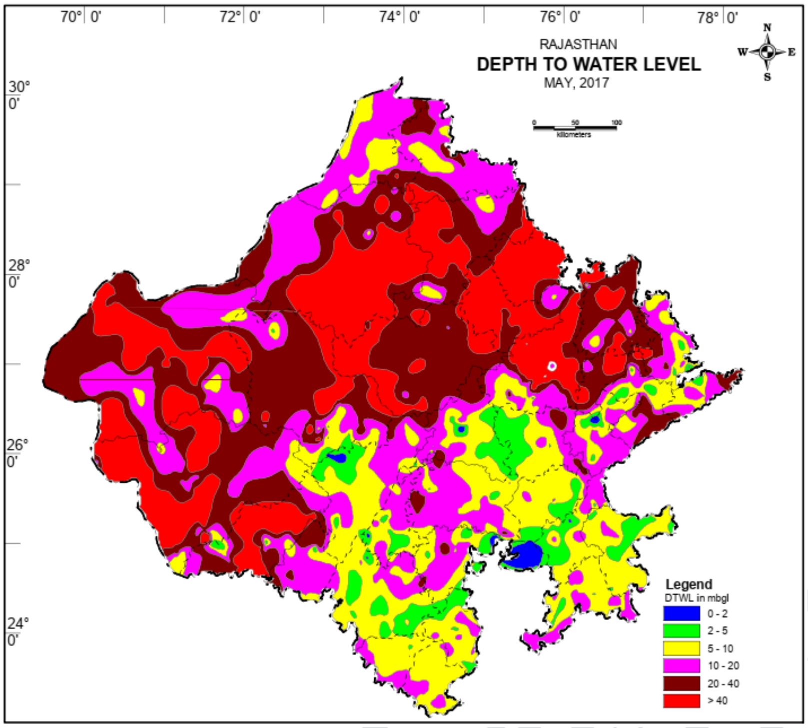

Figure 2: Depth of Water Level

Source: CGWB, 2017-18

Changes in the depth of water levels relative to the pre-monsoon period were investigated to study the impact of the monsoon on the groundwater regime and subsequent use of groundwater for diverse requirements including household, industrial agriculture, etc. According to a water level analysis, the eastern and western parts of the state have seen a significant rise in water levels as a result of monsoon rains, while the western half of the state has seen only a small rise or no change at all.

In Rajasthan, the yearly water table drop ranges from 1 to 3 metres. The state has an estimated 11.2567695 BCM of net groundwater availability. 15.7059976 BCM is the current gross ground water draught for all uses. The amount of water allotted for domestic and industrial use is 2.3151773 BCM, whereas 0.9031139 BCM is needed for irrigation. Statewide, groundwater development is at a stage of 139.52%. According to the several districts of Rajasthan's groundwater development stages, Jhunjhunu has the highest level of groundwater overuse, with a total draught that is equal to 200% of the yearly recharge. In Jaipur, ground water development has reached a degree of 186.6%. Those areas that are surrounded by alluvium, limestone, and semi-consolidated sandstone aquifers have particularly high levels of groundwater usage and exploitation, according to a thorough analysis of ground water development in the state. The risks of overexploitation above a certain degree are unattainable in areas where crystalline rocks are present since there aren't many static groundwater resources there and because over-draft circumstances would cause wells to dry up. The Ganganagar district has groundwater resources that are the least developed, at a stage of development of only 45%. Despite the extremely low potential for fresh groundwater, this occurrence may be caused in part by the presence of canal water. The state of ground water development in each block is depicted in the accompanying figure, 3.

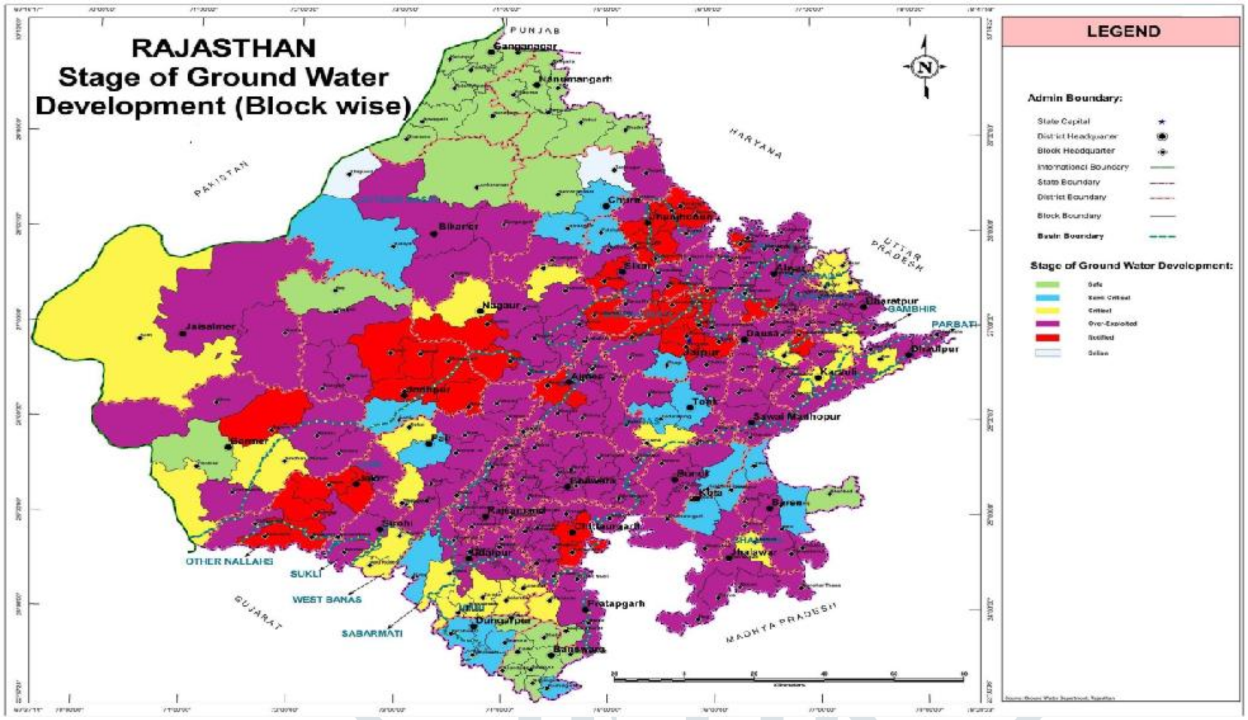

Fig. 3: Stages of Ground Water Development

Source: Hydrogeological Atlas of Rajasthan

Rajasthan's surface water resources are negligible, and the state as a whole relies heavily on groundwater. Only 9% of the domestic water needs are satisfied by surface water sources, while 91% of them are fulfilled by groundwater sources. In the last 60 years, the state has frequently experienced hunger and drought. The majority of the industrial water needs and about 80% of the total demand for agriculture water are entirely met by groundwater resources. Thus, the State's planners' difficult jobs include fulfilling the demands of various sectors and ensuring that people have access to clean water.

Problems:

In majority of the areas of the state, Rajasthan's water resources are being overused and are being contaminated with fluoride and nitrate.

Over Exploitation

Rajasthan's ground water draw has been steadily rising as a result of population growth, urbanisation, and industrialization. The limited distribution and availability of surface water resources places additional strain on groundwater resources, which has led to an overuse of those resources. Out of the 295 total blocks in the state, 184 blocks are classified as over-exploited, 34 blocks as critical, 29 blocks as semi-critical, and 3 blocks as saline according to current estimations of groundwater resources. Due to the poor quality of the groundwater, the deep water levels, or the blocks' location in the canal command area, the remaining 45 blocks that have been classified as safe have restrictions on groundwater development. Due to the poor quality throughout the blocks, the Taranagar Block in Churu, the Khajuwala Block in Bikaner, and the Rawatsar Block in Hanumangarh districts have not been assessed.

Arsenic in ground water:

Rajasthan's groundwater is dangerous to drink since the amount of arsenic in it has above the safe level. Out of the 33 districts in Rajsthan, four (Churu, Sikar, Gangapur, and Hanumangarh) have arsenic contamination over the WHO limit of 10 g/L, according to calculations based on groundwater. Arsenic concentrations have also been found in Rajasthan's mining regions, particularly in the vicinity of the Zawar and Khetri Copper Complex mines in the Jhunjhunu and Udaipur districts, respectively.

Fluoride in ground water:

The only state in India where nearly every district is impacted by elevated fluoride levels is Rajasthan. Out of the 33 districts in the state, 30 are thought to be fluoride-contaminated, according to estimations from the CGWB. According to the data, Rajasthan has 6,589 of the 13,334 habitations in the country that are fluoridated, housing more than 45 lakh people. Consuming water that contains fluoride puts one at risk for the crippling disease fluorosis. The majority of the fluoride-affected area is covered by the Thar Desert. The fluoride concentrations of Ajmer, Nagaur, Pali, Jalore, Jaipur, Jodhpur, and Sirohi districts, which average 2 mg/l, are the highest. Numerous dental and skeletal conditions have been documented in the state as a result of the increased fluoride content in drinking water. The state's fluoride-rich rock system is a favorable feature that contributes to the growth in fluoride levels in ground water. Through the weathering of rocks, precipitation, and impure water, primarily from waste run-off and fertilisers, fluoride penetrates the soil.

Nitrate in groundwater:

Nitrate is another contaminant that is frequently discovered in Rajasthani groundwater. Nitrate poisoning of groundwater has become a threat for the state's environment and public health. The heavy use of nitrogen fertilizers, irrigation with residential wastewater, and manure use all contribute to nitrate pollution. Rainfall has an impact on the amount of nitrate in groundwater. Low rainfall levels reduce the diluting impact, which causes concentration to be higher in those areas. High nitrate concentrations are a concern that affects nearly the whole state of Rajasthan. The districts with the highest nitrate concentrations are Ajmer, Sawai Madhopur, Jaisalmer, Jaipur, Bharatpur, Jalore, Nagaur, Sikar, Sirohi, Barmer, Jodhpur, Churu, Jhalawar, Tonk, and Udaipur. Numerous illnesses, including gastrointestinal malignancies, methaemoglobinemia, Alzheimer's disease, vascular dementia, and multiple sclerosis in people, have been linked to high nitrate levels in drinking water.

Water Logging:

In the state's Outside Basin and Chambal Basin, water logging is a serious issue. The causes are excessive irrigation in the Chambal basin and seepage from canals in the outer basin. The increase in water tables has caused 145,600 hectares to reach a critical level (water table within six meters of land surface). In stage II of the IGNP, a far more serious issue is anticipated. In 25 to 30 years, hundreds of hectares of land, according to experts, would be under water.

Salinity:

The largest state in India, Rajasthan, has significant amounts of saline groundwater, particularly in its western regions, which cover an area of about 97673.13 sq.km. and are distributed among 16 districts. The gross drought is 592.75 MCM, but the total amount of usable saline groundwater in the State has been estimated at 3053.38 MCM. Table 02 provides district-by-district information on ground water supplies in saline (Poor Quality) zones.

Table 2:- Ground water resources in saline areas in Rajasthan (2016)

S. No.	Districts	Saline Zone Area (Sq.km.)
1.	Alwar	376.40
2.	Bharatpur	1339.00
3.	Barmer	15441.09
4.	Bikaner	16779.24
5.	Churu	8601.21
6.	Ganganagar	10058.00
7.	Hanumangarh	8301.10
8.	Jaipur	340.06
9.	Jaisalmer	26054.96
10.	Jalor	2023.43

11.	Jhunjhunun	119.78
12.	Jodhpur	3321.80
13.	Nagaur	1339.75
14.	Pali	3188.85
15.	Sikar	93.46
16.	Tonk	295.00
	Total	97673.13

Source: CGWB, 2016

Conclusion and Suggestions:

The country's water resources, particularly those in arid and semi-arid regions, are being negatively impacted by variety of factors, including climate change, population growth that is occurring quickly, changes in people's lifestyles, urbanization, industrialization, and environmental degradation. Along with water scarcity, the country's water quality has declined, leading to an unhygienic situation. As a result, by adopting the best method for waste water treatment and making the best use of treated waste water, you can lessen the unhygienic and improper management of the country's water resources.

Water is a precious resource that is absolutely necessary for plant and other organism survival. It is impossible to envision human life without water. As the population grows and moves, demand for this finite resource rises, necessitating effective management. For water to be maintained and developed sustainably, its management depends on accurate information about the quantity, quality, and uses of the water that is available. The following conclusions have been drawn from the current study:

- Low rainfall, low aquifer recharge, high evapotranspiration are the causes of the state's water-related problems. There is a lot of variance in the state's rainfall pattern, and the rainfall is irregular.
- The single most reliable and dependable source for the sustaining of life in the state is its groundwater resources, notwithstanding their poor quality and limited availability.
- Due to population expansion, the green revolution, industrialization, urbanization, and rising quality of living, water consumption is rising more quickly.
- Rajasthan's ground water draw has been steadily rising as a result of population growth, urbanization, and industrialization. The scenario of falling water levels and deteriorating water quality in some regions will be made worse by any further increase in the draught.
- Since a bigger portion of Rajasthan falls under the category of overexploitation, the state urgently needs to implement groundwater regulation, control, and management strategies.
- Both alluvial and hard rock locations are experience drops in ground water levels. Therefore, in order to ensure sustainability and the protection of the ground water reservoir, the ground water development in such places needs to be controlled by appropriate means.
- Planning for the management and development of ground water in any location must take into account variables such the scarcity of ground water, low rainfall, salinity, arid conditions, and deep water levels in the majority of the state's western regions.
- Wastewater from cities should be reused and recycled. Use recycled water for industrial and agricultural irrigation.
- Water logging issues have been escalating quickly in the canal command regions of the IGNP, Mahi, Chambal, and other surface irrigation systems. In these places, it is necessary to improve irrigation techniques, adjust crop patterns, and control water release from canals.
- Growing amounts of nitrates in ground water have been seen in some cases as a result of improper waste disposal, notably faecal disposal in urban areas. To lessen these risks, it is imperative to educate people about maintaining good hygiene and installing a well-organized sewer system.

- To prevent water waste, restrictions must be placed on the development and exploitation of privately owned buildings for household and drinking purposes.
- The most important necessity to safeguard resources against further quality degradation and ensure quality assurance is education and participation of people in water management methods, including conservation, protection, development, and augmentation.
- The fluoride threat can be addressed through a community-based fluoride removal facility. There are numerous methods for removing fluoride. The nalgounda method is quite efficient.
- The earliest possible implementation of workable rainwater collection and artificial recharge systems in overexploited areas is recommended.
- Planning and implementation for water security should be closely adhered to at the village, district, and state levels.
- Encouragement of drip and sprinkler irrigation systems in locations with limited water resources.
- Due to the distinct seasonality and fluctuation of rainfall, the construction of water reservoirs like dams, tanks, and ponds becomes necessary to store some of the rainfall water to meet agricultural and drinking water requirements all year long.

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