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A Review on Hydro Biological and Toxicological Study on Water Bodies of Rajasthan

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Abstract

Hydrobiology is the study of living things and their processes in water. Much of modern hydrobiology is considered a part of ecology, but it also includes other areas like taxonomy, economic biology, industrial biology, and morphology. Recent studies on water bodies in Rajasthan for 2025 and 2026 show that the environment is under a lot of stress because of fast-growing cities, polluted industrial waste, and changes in the climate causing more evaporation. Water is essential for all living creatures, including plants, animals, and humans. It makes up more than 70% of the human body, and no living thing can survive without it. Water is also very important for daily tasks like cooking, cleaning, and transportation. However, the quality of water is getting worse due to the use of harmful chemicals and industrial waste. Things like household trash, dead organic matter, and dangerous chemicals are making clean water sources dirty, which is bad for people's health and the environment. Studies in Rajasthan show that the groundwater has high levels of fluoride, nitrates, chlorides, and total dissolved solids (TDS), which can cause health problems like hydrofluorosis. Surface water, like lakes and ponds, is suffering from eutrophication, which is caused by pollution from sewage and dirt, leading to too many nutrients like phosphates and nitrates, and changing the types of plankton, which harms the whole ecosystem and makes the water unsafe for drinking or farming. Scientists are studying various physical and chemical elements in the water, such as pH, electrical conductivity, BOD, and COD, as well as living things like phytoplankton and zooplankton, to understand the effects and find ways to protect these important, but stressed, water sources in the desert. Checking the physical and chemical features of water regularly is necessary to keep it clean. Parameters like temperature, total hardness, pH, sulfate, phosphorus, nitrogen, chloride, fluoride, dissolved oxygen, BOD, COD, total alkalinity, and TDS must be checked to determine the water quality. This report brings together review on water quality based on these factors, offering useful information for future studies and efforts to protect clean water.

Keywords: *Limnology; Physicochemical characters; Biological parameters; OCPs; Heavy metals; Water bodies Rajasthan.*

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1. Introduction

Water is one of the most important things on Earth, and it's necessary for life. We wouldn't be able to live without it, and it's very important for our health and happiness. However, around 780 million people around the world don't have access to clean and safe drinking water, and about 2.5 billion people face poor sanitation[1]. Because of this, 6 to 8 million people die every year from diseases and problems related to water. Many illnesses, like diarrhea, skin problems, malnutrition, cancer, and half of all child deaths, are linked to drinking polluted water. Having clean water is considered a basic human right. Water is also important for carrying oxygen in our bodies, and not having enough water can cause serious health problems like dehydration, seizures, kidney failure, and even brain swelling.

Water conservation is important, especially in places like Western Rajasthan, even though there's not much rain[2]. Sometimes, there are heavy rains that cause a lot of water to flow away. There are three main sources of water in Western Rajasthan: rainwater, canal water, and groundwater. Many villages there have small water storage systems[1]. The quality and behavior of these water bodies depend on their size, the climate, and how water flows away. To study water bodies, scientists look at two things: the kinds of animals and plants that live there, and the physical and chemical properties of the water[3]. One of the early Indian experts who studied pond life in Punjab created some of the first seasonal reports. Recently, studies have looked at the water quality and physical features of different water sources. Even though there is a lot of research on water in India, not much is known about the water in Rajasthan[4]. Water is a vital resource for everyone's daily needs. The lack of water is often caused by poor usage and pollution. The physical and chemical properties of water determine its quality and help control the variety of living things in it[5]. These properties are influenced by things like rainfall, the type of soil and rocks in the area, erosion, and evaporation. Human activities, like industrial growth, farming with chemicals, and improper land use, also affect the quality of water and the number of animals in water bodies. Water and its surroundings are important resources and ecosystems. They are also important for culture, social life, and beauty. Keeping these water sources clean helps maintain a healthy environment[6].

Today, water has become a scarce resource. It is important for human, social, and economic progress. Without proper access and management of water, development can't happen. Certain chemicals, like fluoride, boron, and nitrate, are harmful to health. The World Health Organization allows up to 1.5 mg per liter of fluoride, 1 mg per liter of boron, and 45 mg per liter of nitrate[6]. In India, 17 out of 32 states have high fluoride levels, putting around 66 million people at risk and 6 million people affected. Rajasthan is the only state where all 32 districts have high fluoride levels, influenced by the local geology and water conditions. Studies have found fluoride levels ranging between 1.01 and 4.78 mg per liter in northern Rajasthan. In Dungarpur, dental and bone problems caused by high fluoride levels have been reported, with levels between 1.2 and 8.9 mg per liter. In Sirohi district, fluoride levels can go as high as 16 mg per liter in groundwater. Drinking this water for a long time causes different forms of fluoride poisoning, from mild dental issues to serious bone problems[4-6].

2. Physicho-chemical Scenario in Rajasthan

Dirty water can make people very sick, especially in places where the Human Development Index is low. Illnesses spread through water that is not clean or has become polluted are a big problem for public health, especially in rural and less developed areas of poorer countries. **Ninama, Y. et.al.(2018)** A study about this problem was done in Rajasthan, India. This is a mountainous region with mostly rural people, and around 80% of them are from tribal communities. The district is one of the least developed areas in the country. In Dungarpur, people get their drinking water from underground sources or through government pipes that bring water from various local water sources. These water sources depend a lot on rain that comes during certain seasons and are supported by small areas that collect water, which causes the water levels and quality to change throughout the year. The main water sources for Dungarpur and nearby areas are Adward Samand and Demia Dam, while Gaip Sagar and Sabela Talab also contribute significantly to the water supply in the region[1].

According to Dhingra, P. et al. (2015) Wastewater from dye and textile factories had very high total dissolved solids. Other factors like pH, dissolved carbon dioxide, dissolved oxygen, biochemical oxygen demand, and chemical oxygen demand were also checked, and they showed a lot of pollution. The study stressed the importance of better water treatment techniques and strong policies to deal with water pollution.[2]

Saxena U. et.al. (2015) studied at the physical and chemical traits of groundwater in Bassi tehsil, which is part of Jaipur district. The pH was between 7.0 and 8.1. The electrical conductivity was from 392 to 5,152 microsiemens per centimeter. The total alkalinity was from 190 to 980 milligrams per liter. Total hardness was from 60 to 2,400 milligrams per liter. Calcium hardness was between 20 and 1,150 milligrams per liter, and magnesium hardness was from 40 to 1,250 milligrams per liter. Chloride levels were between 20 and 2,000 milligrams per liter. Nitrate levels were from 2 to 380 milligrams per liter, and fluoride levels were between 0.3 and 9.6 milligrams per liter. TDS was from 560 to 7,360 milligrams per liter. The study found most of these measurements were above the allowed limits. About 44% of samples had too much fluoride, 14% had high nitrate, 24% had high TDS, and 42% had too much chloride. High fluoride levels caused many cases of dental and skeletal fluorosis in the area. The study said the drinking water in Bassi tehsil isn't safe to drink and urgent steps are needed to stop harmful health effects on the people. [3]

Gauri, N. A. et.al. (2016) A study was done on the quality of water in the Chittorgarh and Nimbahera areas. It was found that all the water quality factors, except for hardness, are within the allowed limits. However, because of the increase in industries in the region, the water in Nimbahera is hard to drink. This has caused health problems like stomach issues and digestive problems for the people living there. The main job in this area is farming, and farmers often use chemical fertilizers to make their crops grow better. In areas near Nimbahera, the water quality is good, with all the physical and chemical features within safe limits. This makes it a good foundation for planning and managing future water storage projects. [4]

Dr. Alok Jain et.al. (2018) I noticed that the water from pumps and wells in the Chittorgarh district has certain physical and chemical characteristics. Some villagers have reported problems with the water's color, taste, smell, and how clear it is. There are factories located close to Chittorgarh and Nimbahera, and their waste is getting into the drinking water, leading to health problems for the people living there. Additionally, farmers in the area use fertilizers to make their crops grow better, which also adds to the pollution in the water. The study shows that there is a need for better environmental practices to solve this problem. [5]

Gothwal, R. et.al. (2019) A study was done on Nakki Lake in Mount Abu, Rajasthan. The water was found to be moderately alkaline with a pH of 7.08 and an alkalinity of 102.16 mg/L. Other measurements included total dissolved solids at 161.83 mg/L, chloride at 109.73 mg/L, hardness at 95.66 mg/L, and dissolved oxygen at 5.75 mg/L. Nitrate levels were 31.19 mg/L, and sulfate levels were 123.73 mg/L. The study showed that Nakki Lake is likely to experience eutrophication. In the case of Pichola Lake, the study measured several parameters like air temperature (19.88-36.88°C), water temperature (18.75-30.90°C), transparency (15.91-72.27 cm), pH (7.20-8.80), dissolved oxygen (4.88-9.43 mg/L), free carbon dioxide (0.00-11.75 mg/L), total alkalinity (145.50-177.25 mg/L), total hardness (144.00-183.50 mg/L), total dissolved solids (187.51-273.51 mg/L), nitrate nitrogen (0.36-0.51 mg/L), and orthophosphate (0.15-0.27 mg/L). The results showed that the water quality is within good limits for fish farming and irrigation, meaning Pichola Lake is suitable for fish growth. [6]

Singh K. et.al. (2020) It was noticed that the water temperature in the Nandeshwar Dam in Udaipur changed between 28 ºC and 30ºC. The lowest temperature was recorded in January at 18.4 degrees Celsius, and the highest was in June at 38.5 ºC. The pH level of the water was between 7.5 and 9.5, which means the water was alkaline because it had a lot of carbonate and bicarbonate ions. The levels of dissolved oxygen were low, ranging from 2 to 4 mg per liter, which suggests that the water might be polluted. The total hardness of the water varied between 206 and 332 mg per liter, with the highest levels seen in May and the lowest in January. The biochemical oxygen demand (BOD) was between 330 mg per liter in May and 704 mg per liter in January. The chemical oxygen demand (COD) ranged from 830 to 1,545 mg per liter, with the highest levels in June. The electrical conductivity of the water was between 7,250 and

17,800 microsiemens per centimeter. The total dissolved solids (TDS) were between 2,754 and 4,220 mg per liter. The chloride levels were between 1,435 and 1,885 mg per liter, and carbon dioxide levels varied between 138 and 349 mg per liter. There was a connection between the air temperature and the water quality parameters in the Nandeshwar Dam. [7]

Shwetanshumala, B. K. et.al.(2020) They noticed that the air temperature reached its highest point in May, hitting 42.10°C, and this went up together with the water temperature, pH, bicarbonate alkalinity, and electrical conductivity. The water temperature was between 16.30°C and 30.60°C. The pH levels were from 7.13 to 8.53, and it was linked to other things like dissolved oxygen, carbonate, bicarbonate, total alkalinity, TDS, and nitrate nitrogen. The water clarity was between 34.47 cm and 63.27 cm, and it also went up with pH and dissolved oxygen. Dissolved oxygen was from 7.07 mg/L to 9.07 mg/L. Carbonate alkalinity was between 26.77 mg/L and 44.23 mg/L. Bicarbonate alkalinity was from 47.83 mg/L to 57.30 mg/L at the surface and 50.43 mg/L to 60.53 mg/L below the surface. Total alkalinity was from 75.13 mg/L to 101.27 mg/L. Electrical conductivity was between 0.133 mS/cm and 0.480 mS/cm. TDS levels were from 85.33 mg/L to 309.33 mg/L. Nitrate nitrogen was from 0.043 mg/L to 0.099 mg/L. [8]

Abhilasha Choudhary et.al.(2022) A study looked at the water quality of small rain-fed water storage areas in Nagaur district, Rajasthan, India. These water bodies are known as Talab and Nadis in the local language. They play an important role in providing water for daily needs in rural areas throughout the year, from July 2020 to June 2021. In the past, there was not much research on the microflora of these ponds. So, it's important to study the water quality to help improve how these stored waters are used. Water samples were collected once a month from four selected ponds near Nagaur city and surrounding villages. The samples were tested for physical and chemical properties like smell, pH, total dissolved solids (TDS), total hardness, carbonate and bicarbonate hardness, and total alkalinity. Organic parameters such as BOD, COD, and organic matter were also checked. These tests were done using standard methods from A.P.H.A. The results were compared with the drinking water standards set by the Bureau of Indian Standards. [9]

Lokesh Kumar et.al.(2024) Water is very important for all living things, like plants, animals, and people. It is a key part of life and makes up more than 70% of the human body. Without water, no living being can survive. Besides drinking, water is needed for many everyday activities. But the quality of water is getting worse because of things like chemicals from pesticides and harmful waste from factories. Things like trash, rotting food, and factory chemicals are making water sources dirty, which is dangerous for people and nature. About 20% of people around the world get sick from water-related illnesses, showing how important it is to have clean water to stay healthy and live better. Checking the physical and chemical qualities of water regularly helps keep it clean and safe. [10]

Jyoti et.al.(2025) Groundwater samples were taken from various parts of the Sri Ganganagar district, using standard methods during four different times of the year—before the monsoon, after the monsoon, during winter, and in spring. The goal of this study was to check the quality of the groundwater and find out how much it was contaminated. To do this, the samples were tested to measure the levels and changes in many chemical factors in the water. These included pH, total dissolved solids (TDS), total alkalinity (TA), total hardness (TH), electrical conductivity (EC), sodium (Na), potassium (K), calcium (Ca), magnesium (Mg), bicarbonate (HCO_3), carbonate (CO_3), fluoride (F), biological oxygen demand (BOD), chemical oxygen demand (COD), dissolved oxygen (DO), chloride (Cl), nitrate (NO_3), sulphate (SO_4), and some heavy metals, using approved methods for water analysis. It was found that the levels of several of these chemicals were higher than the limits allowed for safe drinking water. [11]

3. Hydrobiological And Toxicological Studies Of Rajasthan

Recent studies on water life and harmful effects done from 2024 to early 2026 show that Rajasthan's water sources are facing big problems in their environment. Important results show changes in water quality during different seasons, pollution from heavy metals like lead and chromium, and more algae growth because of waste from industries and farms.

The table below shows 25 major water areas in different parts of Rajasthan, along with the people who studied them and the time periods they were studied, which are the latest data from 2024 to 2026[11-15].

Recent Hydro-Biological & Toxicological Studies in Rajasthan (2024–2026)

Water Body / Area	Author/Researcher(s)	Study Focus / Area	Study Period / Year	Citation
Pushkar Lake (Ajmer)	P. Tak, R. Choudhary, et. al.	Limnological & water quality assessment (WQI)	Study published 2023 (ongoing monitoring relevant to 2024)	18
Rain-fed ponds (Nagaur District)	Abhilasha Choudhary et. al.	Hydro-biological assessment (physico-chemical & phytoplankton)	Water samples Jul 2020–Jun 2021 (results published 2025)	19
Ana Sagar Lake (Ajmer)	NEERI under NGT directions	Environmental/wetland development plan (assessment actions)	2025	20
Menar Wetland (Udaipur)	Dr. Satish Kumar Sharma et. al.	Wetland ecology & Ramsar site designation	Designated as Ramsar site 2025	21
Sambhar Salt Lake (Jaipur/Nagaur/Ajmer)	Wildlife experts (waterbird census)	Water level & migratory bird use monitoring	2025	22
Groundwater -Bikaner City	Leela Kaur, Prem Godara et. al.	Subsurface water quality & heavy metal analysis	2025	23
Groundwater - Sindhari & Siwana (Barmer)	ICAR Soil & Water Quality team	Irrigation suitability (groundwater quality)	2025	24
Comparative Surface & Groundwater (Rawatsar, Hanumangarh)	Leela Kaur et. al.	Surface vs. groundwater physical–chemical comparison	2025	25
Gadisar Lake (Jaisalmer)	Various conservation sources	Historical & present water status reporting	Current status 2025	26
Swaroop Sagar Lake (Udaipur)	Udaipur Lake Conservation Society	Resource use & recharge benefits	Ongoing reports 2025	27
Lake Pichola (Udaipur)	Centre of Advanced Study in Geology	Water quality chemistry study	Earlier research cited in recent water assessments	28
Udai Sagar Lake (Udaipur)	B. K. Das et. al.assessments)	Pollution impact and restoration efforts	Past studies, active management as of 2025	29
Panchana Dam (Karauli)	R. S. Meena et. al.	Physico-chemical water analysis (multiple dam sites)	Published 2025	30
Needar Dam (Karauli)	R. S. Meena et. al.	Water quality comparison among dams	2025	31

Jaggar Dam (Karauli)	R. S. Meena et. al.	Seasonal physico-chemical analysis	2025	32
Sagar Dam (Karauli)	R. S. Meena et. al.	Water quality comparative analysis	2025	33
Kalisil Dam (Karauli)	R. S. Meena et. al.	Physico-chemical parameter assessment	2025	34
Groundwater -Tonk District	A. K. Bairwa et al.	Groundwater physico-chemical assessment	Published 2024	35
Groundwater - Kishangarh Marble Area	R. Kumar, M. Kumar et al.	Fluoride & nitrate contamination	Published 2025	36
Anasagar Lake (Ajmer)	M. Parihar et. al.	Diatom diversity (hydrobiology)	Sampled 2023–2024 (published 2025)	37
Luni River (western Rajasthan)	SC panel pollution assessments	River pollution by industrial/untreated effluent	2025	38
Bandi River (Balotra/Nagaur)	SC panel pollution assessment	Assessment of untreated sewage impacts	2025	39
Jojari River (Balotra)	SC panel pollution assessment	Industrial effluent evaluation	2025	40
Keoladeo Ghana Wetland (Bharatpur)	Ramsar site monitoring bodies	Biodiversity & hydrology monitoring	Ramsar site (ongoing)	41
Khichan Wetland (Phalodi)	Local biodiversity assessments	Ramsar site designation & bird use	2025	42
Nakki Lake (Mount Abu)	Regional water tourism and ecology sources	Water body use & tourism/ecology status	Continuous monitoring, general reports	43
Gajner Lake (Bikaner region)	Local and regional reports	Water body status (tourism & resource)	Ongoing interest - general context	-

Hydrobiological Status (2025–2026)

Right now, most freshwater lakes in Rajasthan are getting more polluted with nutrients because of sewage and farm runoff.

Biological Indicators:

Phytoplankton & Zooplankton: A lot of rotifers, like Brachionus and Keratella, have been found in lakes such as Foy Sagar (Ajmer), showing that there is moderate to heavy pollution from organic matter[4-6].

Ecosystem Health: In Sant-Sarover Pond (Mount Abu) and Kot Dam, the plankton communities are diverse but stressed. More algae are seen, which happens when people dump waste into the water[15].

Physico-Chemical Characteristics:

Temperature & Evaporation: During warm months in 2025–2026, there is more chloride and Total Dissolved Solids (TDS) in the water, especially in Pushkar Lake and Foy Sagar, because of higher evaporation rates[16].

Nutrient Levels: Nitrate and phosphate levels are often too high in lakes near cities like Jal Mahal (Man Sagar Lake), which causes the water quality to get worse quickly.

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Toxicological Assessment (2025–2026)

Studies have found high levels of heavy metals and chemicals in both surface and groundwater[17].

Heavy Metal Contamination:

Zinc and Iron levels are very high in lakes near Jaipur, like Jal Mahal and Amer Lake. A 2025 study of Rajasthan's industrial areas found that 40% of the samples had heavy metal levels that are not safe[12-14].

Industrial Toxicity:

The Jojari River is still getting polluted from untreated chemicals from steel and textile factories, which harms the health of over 50 nearby villages[15].

Fluoride and Nitrate: Rajasthan is a big problem for nitrate pollution, with more than 40% of water samples having levels that are too high. This is mainly because of fertilizers used in farming.

River Health Monitoring: The Central Water Commission (CWC) checks nine different metals, including Arsenic, Lead, and Mercury[6].

They say that human activities and industrial waste are the main causes of river pollution in the state.

Groundwater Crisis (2026 Update)

As of 2026, groundwater in Rajasthan is being taken out faster than it can be replaced.

- Depletion: In 2024, the state used 17.05 BCM of groundwater, but only 11.37 BCM was added back[8].
- Safe Zones: The number of areas with safe groundwater has dropped from 203 in 1984 to just 37 in 2024. The situation for 2025–2026 is expected to keep getting worse in different parts of the state[14].

Study site

The study sites are in the northwest part of Rajasthan. The area includes Sriganganagar and Hanumangarh districts, which are located between 28.4 ºC to 30.3ºC north and 72.3 ºC to 75.3 ºC east, at an altitude of 175.6 meters above sea level. This area is part of the irrigated northwestern plain zone of Rajasthan. The zone is bounded by the international border with Pakistan in the west, the states of Punjab and Haryana in the north, and the districts of Bikaner and Churu in the south and east, respectively. The total area of the zone is 2.63 million hectares[16]. Out of this, 1.61 million hectares are cultivated and 0.85 million hectares are irrigated. The main sources of irrigation are the Indira Gandhi, Bhakra, and Gang canals. Because there is not enough canal water, farmers use water from tube wells for both farming and drinking. Popular crops grown in this area include American cotton-wheat, desi cotton-wheat, and guar-wheat. The climate is semi-arid with temperatures ranging from 0.1 to 48 degrees Celsius, and extreme heat. Rainfall begins at the end of June or the first week of July and ends by the end of September. The amount of rainfall varies between 250 and 350 millimeters. The soils in this region are sandy, loamy sand, and sandy loam[17].

4. Material And Methods

From 2024 to January 2026, different researchers studied the work of others who collected samples and checked the season for their study on the physical and chemical properties and phytoplankton in the water.A study has found that the quality of groundwater in Rajasthan, a desert state in India, is affected by both man-made pollutants and naturally occurring harmful minerals.It was found that more than three-quarters of the wells, which provide drinking water without any treatment, have harmful levels of fluoride, nitrate, and uranium. These levels are higher than the standard limits set by both the Indian government and the World Health Organisation (WHO). Researchers warn that this polluted groundwater is unsafe to drink unless it is treated.Water samples were collected from all the sampling sites using wide-mouth glass bottles with stoppers.The study measured several physical and chemical parameters such as temperature, pH, total dissolved solids (TDS), fluoride, nitrate, chloride, total alkalinity, total hardness, carbonate, bicarbonate, and organic parameters like dissolved oxygen (DO), biochemical oxygen demand (BOD), and chemical oxygen demand (COD). These were measured using standard methods from A.P.H.A. Some parameters like pH and temperature were tested on-site using a lab pH meter and a mercury glass thermometer.The samples were then taken to the laboratory for further analysis of other physical and chemical properties. Parameters such as pH, water temperature, and total dissolved solids were measured in the field using a HANNA Hi 98,129 multimeter. Total hardness was measured using a titrant called ethylenediaminetetraacetic acid (EDTA) in a buffer solution made from ammonium chloride and ammonium hydroxide, with erichrome black T as the indicator.

5. Conclusion

Hydrobiological studies in Rajasthan look at the water quality, types of plankton, and how healthy the water bodies are, especially the Talabs (ponds) and Nadis (reservoirs) in the semi-arid area. These studies show problems like pollution from sewage, such as in Man Sagar Lake, and high levels of minerals. The rapid growth of industrialization and urbanization has greatly contributed to the pollution of nearby water sources. Waste from households and industries flows into water bodies, degrading their quality. To protect these vital resources, it is crucial to manage urbanization and deforestation. Effective wastewater treatment can be accomplished through physical, chemical, and biological methods. By conserving water and using proper treatment techniques, we can prevent pollution, reduce

global warming, and protect human health from waterborne diseases like diarrhea, cholera, typhoid, and skin infections. On the other hand, the village ponds had good water quality during the rainy season and winter, but in the summer, the water quality dropped and there was a risk of pollution because of less water and more concentration of dissolved substances. Certain types of cyanobacteria grow best in temperatures between 25 and 35 degrees Celsius and can produce harmful toxins. The presence of many Closterium and Cosmarium species in Jada Talab shows that the water has a lot of calcium and nutrients. But in the other village ponds, the lower number of desmid species suggests that high pH levels and low nutrient content in the water reduce biodiversity.

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