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Assessment of Physico-Chemical Properties and Metal Concentrations of Water of Koilsagar Reservoir, Telangana, India

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ABSTRACT
The aim of this study was to analysis of water parameters such as pH, temperature, dissolved oxygen, total dissolved solids, turbidity, hardness, alkalinity of Koilsagar Reservoir Mahabubnagar district, Telangana, India with especial reference to determine the concentration of metal during the pre-monsoon and post monsoon season. This study elucidates the reservoir's significance as a primary water source for domestic, agricultural, and industrial needs in the region. Understanding these parameters is essential due to their direct impact on human health and the environment. The finding of the physico-chemical parameters and metal concentration are beyond the permissible limits set by BIS and WHO. The values of DO, BOD, COD and metals (Ca and Mg) concentration was higher during pre-monsoon than post-monsoon in almost all the study sites (RS1, RS2, RS3, RS4, RS5 and RS6). Elevated levels of dissolved solids, turbidity, and metals concentration pose health risks, while fluctuations in temperature and dissolved oxygen disrupt the aquatic ecosystem. Variations in water hardness and alkalinity also have profound implications for agriculture and industry. The findings underline the necessity of effective management strategies to ensure sustainable water use and conservation. By unraveling the intricate dynamics of Koilsagar Reservoir.
Keywords: *Koilsagar Reservoir, Water quality, metal concentrations, health risk, district Mahabubnagar*

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INTRODUCTION

Reservoirs play a crucial role in ecosystems by providing important sources of freshwater for a variety of organisms, including plants, animals, and humans. They serve as important storage units for hydrologic systems, helping to regulate the water supply in a region. Also support a wide range of aquatic ecosystems, including fish, invertebrates, and aquatic plants, these organisms rely significance role in reservoirs for habitat, food, breeding and spawning grounds (for many fish species) and other resources [1, 2, 3, 4].

Furthermore, reservoirs can help to regulate downstream flows, preventing floods during periods of heavy rainfall and maintaining water availability during droughts. They can also help to filter and purify water, improving its quality and providing a source of drinking water for local communities [2, 5, 6]

However, it is important to note that the creation of reservoirs can also have negative impacts on ecosystems. For example, the construction of dams can disrupt natural flow regimes and block the migration of fish species. The impoundment of water can also lead to the loss of habitats and the alteration of riverine landscapes. Therefore, it is important to carefully manage and monitor reservoirs to minimize their negative impacts on ecosystems while maximizing their benefits [7, 8, 9].

The study of physicochemical characteristics of reservoirs is crucial for understanding the impact of these characteristics on the fauna that inhabit them. Physical characteristics, such as water temperature, flow, and depth, can have significant effects on the behavior and distribution of aquatic organisms. Chemical characteristics, such as pH, dissolved oxygen levels, and nutrient concentrations, can also impact the physiology and ecology of aquatic species [10, 11, 12, 13, 14, 15] For example, changes in water temperature can alter the metabolism and reproductive behavior of fish, affecting their growth and survival rates. Fluctuations in dissolved oxygen levels can also impact the distribution and behavior of fish and other aquatic organisms, leading to changes in community structure and biodiversity.

The study of physicochemical characteristics of water of reservoirs, we can better understand the impacts of these characteristics on the fauna that inhabit them. This knowledge can inform management strategies and conservation efforts aimed at protecting and restoring aquatic ecosystems, ultimately benefiting both the fauna and the people who rely on these ecosystems for various ecosystem services, such as food and

freshwater supply. The study's analysis of metals contents may aid in addressing pollution issues by raising public awareness and encouraging people to refrain from producing new pollution of this kind. The local population is able to implement the management program and recommended measures. Additionally, the data produced by the study will be helpful to the media, organizations, scholars, municipalities, water treatment facilities, and those who make policy decisions.

MATERIAL AND METHODS

Study Area

Koilsagar reservoir is a man-made reservoir located in the Mahbubnagar district of the Indian state of Telangana (figure 1). The reservoir was constructed in the 1940s across the Peddavagu and Bheema River, primarily for irrigation purposes. The reservoir spans an area of approximately 23 square kilometers and has a storage capacity of about 1.8 thousand million cubic feet (tmcft). The reservoir and its surrounding area support a diverse array of flora and fauna, including aquatic plants, fish, reptiles, birds, and mammals. The reservoir serves as an important breeding and feeding ground for many resident and migratory bird species.

In recent years, however, there have been concerns about the deteriorating water quality of the reservoir due to various factors, including pollution from agricultural runoff, industrial effluents, and domestic sewage. The increase in nutrient levels in the water has led to the growth of harmful algal blooms, which can deplete oxygen levels in the water and harm aquatic life.

Physico-chemical Analysis

The extensive physico-chemical analysis conducted at various sites (RS1 to RS6) in Koilsagar Reservoir during both pre-monsoon and post-monsoon seasons has provided valuable insights into the dynamic nature of water quality. The key parameters studied, including pH, temperature, turbidity, TDS, EC, total hardness, alkalinity, BOD, COD, dissolved oxygen, chlorides, fluorides, ammonia, nitrates, nitrite, sulphates, and phosphates, exhibit diverse trends and variations across the different reservoir sites and seasons.

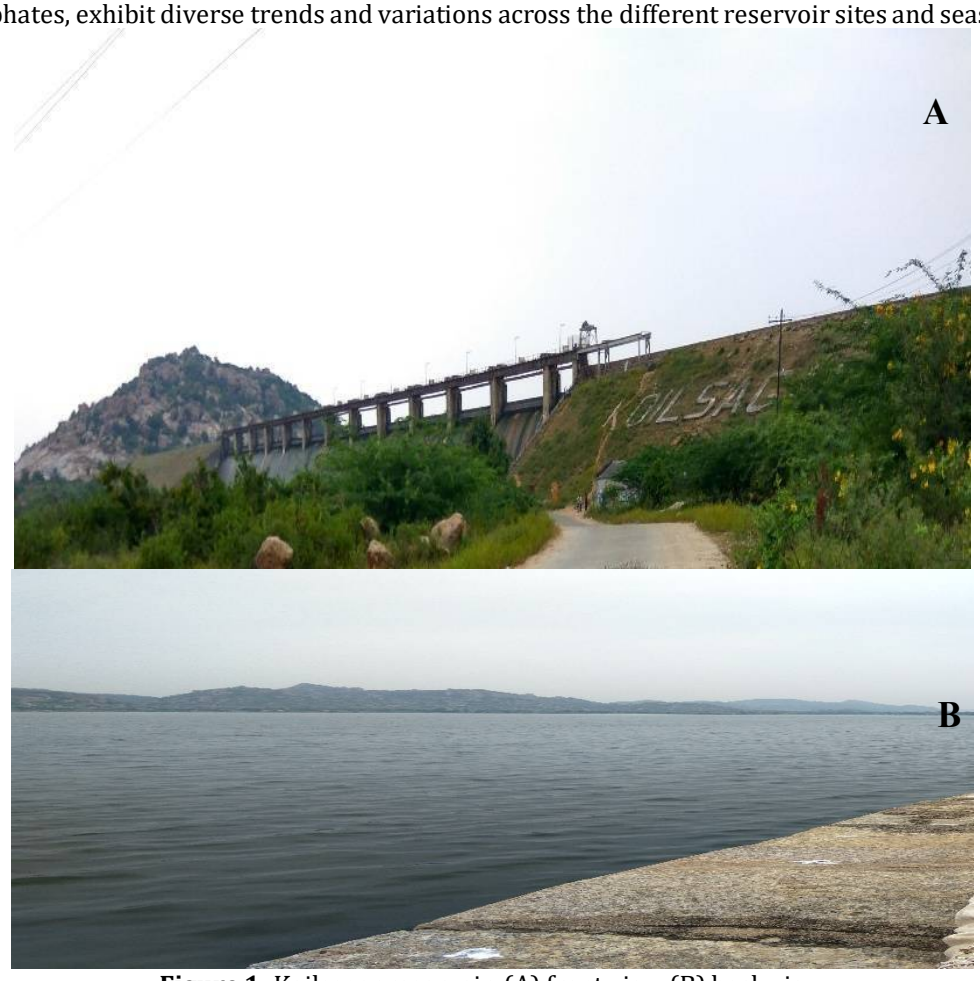

Figure 1: Koilsagar reservoir, (A) front view (B) back view

Sampling and Methodology

In the analysis of the physico-chemical properties of water of Koilsagar reservoir, water samples were collected from different locations of the reservoir, namely RS1, RS2, RS3, RS4, RS5, and RS6 (figure 2) during pre-monsoon and post-monsoon periods. All the water samples collected in sterile containers, and their quality is being maintained by ensuring that the sampling equipment is clean and free from contaminants. The water samples are being transported to the laboratory for analysis, where they are being tested using standard methods and techniques. In laboratory, the collected samples were analyses with stander protocols [16, 17, 18, 19, 20, 21, 22, 23] in different aspects of water quality such as pH, temperature, turbidity, total dissolved solids (TDS), electrical conductivity (EC), total hardness, alkalinity, biological oxygen demand (BOD), chemical oxygen demand (COD), dissolved oxygen (DO), chlorides, fluorides, calcium, magnesium, ammonia, nitrates, nitrites, sulphates, and phosphates.

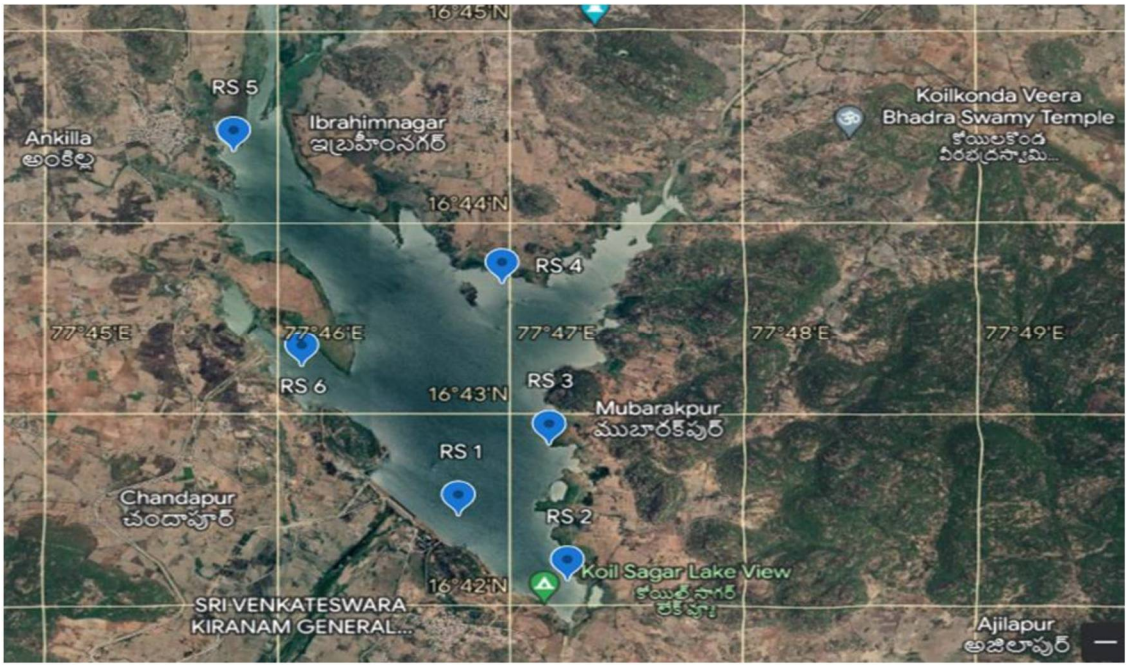

Figure 2: Google image of all the study sites of Koilsagar reservoir (RS1, RS2, RS3, RS4, RS5, and RS6)

RESULTS AND DISCUSSION

Physico-Chemical Analysis of Water in Koilsagar Reservoir: A Comparative Study between *Pre-monsoon and Post-monsoon Seasons*

Reservoir site 1(RS-1): The physico-chemical analysis of water in Koilsagar Reservoir at RS1 reveals notable variations between pre-monsoon and post-monsoon seasons. The pH levels, slightly alkaline at 8.7 in the pre-monsoon, exhibit a marginal decrease to 8.1 post-monsoon, aligning more closely with the permissible range. Temperature witnesses a slight rise from 26°C to 27.4°C post-monsoon. Turbidity, alarming at 27 NTU pre-monsoon, experiences a reduction to 24 NTU post-monsoon, though both values exceed the recommended limit of 1 NTU. Total Dissolved Solids (TDS) remain high, declining from 2433 mg/l to 2258 mg/l post-monsoon but staying beyond the acceptable limit of 500 mg/l. Electrical Conductivity (EC) drops from 3854 µS/cm to 3257 µS/cm post-monsoon. Total Hardness shows a decrease from 1850 mg/l to 1536 mg/l, still above the 300 mg/l limit. Alkalinity remains consistent at 1025 mg/l pre-monsoon and 1024 mg/l post-monsoon.

Table 1: Pre-monsoon and post-monsoon findings of physico-chemical analysis and metal concentration of water of Koilsagar Reservoir

PREMONSOON RESULTS								
S. No	**Parameter**	**IS 10500**	**RS1**	**RS2**	**RS3**	**RS4**	**RS5**	**RS6**
1	pH	6.5-8.5	8.7	9.2	9	9.1	9.5	9.2
2	Temperature		26	27	25.6	28	26.5	27.2
3	Turbidity (NTU,Max)	1	27	26.5	35.4	28	29.5	37
4	TDS (mg/l)	500	2433	2554	2456	2358	2536	2544
5	EC (µS/cm)	-	3854	3685	3785	3655	3944	3624
6	Total Hardness(mg/l)	300	1850	1965	1752	1854	1965	1842
7	Alkalinity(mg/l)	200	1025	1054	1068	1087	1023	1014
8	BOD (mg/l)	-	25	26	28	31	27	29
9	COD (mg/l)	-	725	865	652	758	832	746
10	Dissolved Oxygen(mg/l)	-	1.9	2.3	1.8	1.7	1.8	1.9
11	Chlorides(mg/l)	250	320	356	416	368	356	410
12	Fluorides(mg/l)	1.9	0.6	0.5	0.62	0.54	0.82	0.65
13	Ammonia(mg/l)	0.5	2.5	3.5	2.9	3.8	4.2	3.7
14	Nitrates(mg/l)	45	26.2	24.5	28.7	29.5	28.4	26.5
15	Nitrite(mg/l)	-	0.3	0.1	0.23	0.19	0.17	0.15
16	Sulphates(mg/l)	200	80.7	96.5	93.2	87.4	92.1	80.5
17	Phosphates(mg/l)	-	1.4	1.5	1.3	1.5	1.6	1.4
Metal Concentrations								
18	Ca Hardness as Ca (mg/l)	75	543	652	563	623	587	596
19	Mg Hardness as Mg(mg/l)	30	62	82.5	73.5	64	73.4	78
POSTMONSOON RESULTS								
S.No	**Parameter**	**IS 10500**	**RS1**	**RS2**	**RS3**	**RS4**	**RS5**	**RS6**
1	pH	6.5-8.5	8.1	8.2	8.4	8.8	8.7	8.5
2	Temperature		27.4	28.2	27.6	27.4	25.8	28.1
3	Turbidity (NTU,Max)	1	24	25.1	26.5	24.3	25.7	26
4	TDS(mg/l)	500	2258	2354	2368	2451	2435	2375
5	EC (µS/cm)	-	3257	3524	3687	3475	3658	3245
6	Total Hardness(mg/l)	300	1536	1547	1638	1756	1857	1532
7	Alkalinity(mg/l)	200	1024	1024	998	1024	1014	1053
8	BOD(mg/l)	-	24	25	25	28	29	27
9	COD(mg/l)	-	658	758	754	658	715	725
10	Dissolved Oxygen(mg/l)	-	2.1	2.3	1.9	1.9	1.8	2
11	Chlorides(mg/l)	250	290	320	315	352	328	315
12	Fluorides(mg/l)	1.9	0.5	0.6	0.54	0.65	0.68	0.45
13	Ammonia(mg/l)	0.5	2.8	2.9	2.8	2.7	3.1	2.7
14	Nitrates(mg/l)	45	25.4	27.5	26.5	24.7	23.8	25.4
15	Nitrite(mg/l)	-	0.2	0.35	0.28	0.19	0.12	0.18
16	Sulphates(mg/l)	200	93.2	87.6	91.5	85.7	85.6	83.2
17	Phosphates(mg/l)	-	1.2	1.4	1.6	1.5	1.4	1.5
Metal Concentrations								
18	Ca Hardness as Ca (mg/l)	75	612	524	584	610	572	542
19	Mg Hardness as Mg(mg/l)	30	58.3	65.2	68.4	64.7	69.1	75.1

Biochemical Oxygen Demand (BOD) and Chemical Oxygen Demand (COD) experience minor reductions, and Dissolved Oxygen (DO) sees an improvement from 1.9 mg/l to 2.1 mg/l post-monsoon. Chlorides decrease from 320 mg/l to 290 mg/l, while Fluorides decrease from 0.6 mg/l to 0.5 mg/l. Ammonia levels increase from 2.5 mg/l to 2.8 mg/l, and Nitrates reduce slightly from 26.2 mg/l to 25.4 mg/l. Nitrite levels show a decrease from 0.3 mg/l to 0.2 mg/l. Sulphates experience a slight increase from 80.7 mg/l to 93.2 mg/l, and Phosphates decrease from 1.4 mg/l to 1.2 mg/l (Table 1). These findings underscore the dynamic nature of water quality in Koilsagar Reservoir, emphasizing the need for ongoing monitoring and remediation efforts to ensure sustainable water resource management.

Reservoir site 2 (RS-2): At RS2, the water quality exhibits discernible variations between pre-monsoon and post-monsoon seasons. The pH levels show a substantial decrease from 9.2 in the pre-monsoon season to 8.2 post-monsoon, aligning more closely with the permissible range. Temperature increases slightly from 27°C to 28.2°C post-monsoon. Turbidity, though elevated in both seasons, experiences a reduction from 26.5 NTU to 25.1 NTU post-monsoon. Total Dissolved Solids (TDS) remain consistently high, with a

decrease from 2554 mg/l to 2354 mg/l post-monsoon. Electrical Conductivity (EC) levels drop from 3685 µS/cm to 3524 µS/cm post-monsoon. Total Hardness exhibits a decrease from 1965 mg/l to 1547 mg/l, still above the recommended limit of 300 mg/l. Alkalinity remains stable at 1054 mg/l pre-monsoon and 1024 mg/l post-monsoon. Biochemical Oxygen Demand (BOD) and Chemical Oxygen Demand (COD) witness marginal reductions, while Dissolved Oxygen (DO) remains unchanged at 2.3 mg/l. Chlorides decrease from 356 mg/l to 320 mg/l, and Fluorides decrease from 0.5 mg/l to 0.6 mg/l (Table 1). Ammonia levels increase from 3.5 mg/l to 2.9 mg/l, and Nitrates show a slight increase from 24.5 mg/l to 27.5 mg/l. Nitrite levels decrease from 0.1 mg/l to 0.35 mg/l. Sulphates experience a slight decrease from 96.5 mg/l to 87.6 mg/l, and Phosphates decrease from 1.5 mg/l to 1.4 mg/l. These findings emphasize the dynamic nature of water quality in Koilsagar Reservoir at RS2, highlighting the importance of ongoing monitoring and management strategies to ensure sustainable water resource utilization.

Reservoir site 3(RS-3): At RS3, the pre-monsoon and post monsoon analyses reveal distinct characteristics of water quality. The pH levels exhibit a decrease from 9 in the pre-monsoon season to 8.4 post-monsoon, showing a tendency towards the permissible range. Temperature experiences a slight increase from 25.6°C to 27.6°C post-monsoon. Turbidity levels, although elevated in both seasons, show a reduction from 35.4 NTU to 26.5 NTU post-monsoon, albeit remaining above the recommended limit of 1 NTU. Total Dissolved Solids (TDS) remain consistently high, decreasing from 2456 mg/l to 2368 mg/l post-monsoon. Electrical Conductivity (EC) levels decrease from 3785 µS/cm to 3687 µS/cm post-monsoon. Total Hardness exhibits a decrease from 1752 mg/l to 1638 mg/l, still above the recommended limit of 300 mg/l. Alkalinity decreases from 1068 mg/l to 998 mg/l post-monsoon. Biochemical Oxygen Demand (BOD) and Chemical Oxygen Demand (COD) witness marginal reductions, while Dissolved Oxygen (DO) remains relatively stable at 1.8 mg/l in the pre-monsoon season and 1.9 mg/l post-monsoon (Table 1). Chlorides decrease from 416 mg/l to 315 mg/l, and Fluorides decrease from 0.62 mg/l to 0.54 mg/l. Ammonia levels decrease from 2.9 mg/l to 2.8 mg/l, and Nitrates show a decrease from 28.7 mg/l to 26.5 mg/l. Nitrite levels decrease from 0.23 mg/l to 0.28 mg/l. Sulphates experience a slight decrease from 93.2 mg/l to 91.5 mg/l, and Phosphates increase from 1.3 mg/l to 1.6 mg/l. These findings underscore the dynamic nature of water quality in Koilsagar Reservoir at RS3, emphasizing the importance of continuous monitoring and effective management strategies to ensure sustainable water resource utilization.

Reservoir site 4 (RS-4): At RS4, the pre-monsoon and post-monsoon assessments reveal significant fluctuations in water quality parameters. The pH levels exhibit a decrease from 9.1 in the pre-monsoon season to 8.8 post-monsoon, aligning more closely with the permissible range. Temperature remains relatively stable, with a slight decrease from 28°C to 27.4°C post-monsoon. Turbidity levels, though elevated in both seasons, show a reduction from 28 NTU to 24.3 NTU post-monsoon, yet remain above the recommended limit of 1 NTU. Total Dissolved Solids (TDS) remain consistently high, with a slight decrease from 2358 mg/l to 2451 mg/l post-monsoon. Electrical Conductivity (EC) levels decrease from 3655 µS/cm to 3475 µS/cm post-monsoon. Total Hardness exhibits a decrease from 1854 mg/l to 1756 mg/l, still above the recommended limit of 300 mg/l. Alkalinity shows a decrease from 1087 mg/l to 1024 mg/l post-monsoon. Biochemical Oxygen Demand (BOD) and Chemical Oxygen Demand (COD) witness reductions, while Dissolved Oxygen (DO) remains relatively stable at 1.7 mg/l in the pre-monsoon season and 1.9 mg/l post-monsoon. Chlorides decrease from 368 mg/l to 352 mg/l, and Fluorides decrease from 0.54 mg/l to 0.65 mg/l. Ammonia levels decrease from 3.8 mg/l to 2.7 mg/l, and Nitrates show a decrease from 29.5 mg/l to 24.7 mg/l. Nitrite levels decrease from 0.19 mg/l to 0.19 mg/l. Sulphates experience a decrease from 87.4 mg/l to 85.7 mg/l (Table 1), and Phosphates remain consistent at 1.5 mg/l in both seasons. These findings emphasize the dynamic nature of water quality in Koilsagar Reservoir at RS4, underscoring the need for ongoing monitoring and adaptive management strategies to ensure the sustainability of water resources in the region.

Reservoir site 5 (RS-5): The examination of water quality at RS5 during pre-monsoon and post-monsoon periods reveals distinctive characteristics. The pH levels, initially high at 9.5 during the pre-monsoon season, decrease to 8.7 post-monsoon, aligning more closely with the permissible range. Temperature experiences a decrease from 26.5°C to 25.8°C post-monsoon. Turbidity levels, although elevated in both seasons, exhibit a reduction from 29.5 NTU to 25.7 NTU post-monsoon, though remaining above the recommended limit of 1 NTU. Total Dissolved Solids (TDS) remain consistently high, with a slight decrease from 2536 mg/l to 2435 mg/l post-monsoon. Electrical Conductivity (EC) levels decrease from 3944 µS/cm to 3658 µS/cm post-monsoon. Total Hardness shows a decrease from 1965 mg/l to 1857 mg/l, still above the recommended limit of 300 mg/l. Alkalinity experiences a decrease from 1023 mg/l to 1014 mg/l post-monsoon. Biochemical Oxygen Demand (BOD) and Chemical Oxygen Demand (COD) witness reductions, while Dissolved Oxygen (DO) remains relatively stable at 1.8 mg/l in both seasons. Chlorides decrease from 356 mg/l to 328 mg/l, and Fluorides decrease from 0.82 mg/l to 0.68 mg/l. Ammonia levels decrease from

4.2 mg/l to 3.1 mg/l, and Nitrates show a decrease from 28.4 mg/l to 23.8 mg/l. Nitrite levels decrease from 0.17 mg/l to 0.12 mg/l (Table 1). Sulphates experience a decrease from 92.1 mg/l to 85.6 mg/l, and Phosphates remain consistent at 1.6 mg/l in both seasons. These findings highlight the dynamic nature of water quality in Koilsagar Reservoir at RS5, emphasizing the importance of continuous monitoring and adaptive management strategies to ensure the sustainability of water resources in the region.

Reservoir site 6 (RS-6): The examination of water quality at RS6 during the pre-monsoon and post-monsoon periods unveils noteworthy variations. The pH levels, initially elevated at 9.2 during the pre-monsoon season, decrease to 8.5 post-monsoon, indicating a movement towards the permissible range. Temperature experiences a slight increase from 27.2°C to 28.1°C post-monsoon. Turbidity levels, though elevated in both seasons, show a notable reduction from 37 NTU to 26 NTU post-monsoon, though still surpassing the recommended limit of 1 NTU. Total Dissolved Solids (TDS) remain consistently high, with a decrease from 2544 mg/l to 2375 mg/l post-monsoon. Electrical Conductivity (EC) levels decrease from 3624 µS/cm to 3245 µS/cm post-monsoon. Total Hardness exhibits a decrease from 1842 mg/l to 1532 mg/l, still above the recommended limit of 300 mg/l. Alkalinity experiences a slight decrease from 1014 mg/l to 1053 mg/l post-monsoon. Biochemical Oxygen Demand (BOD) and Chemical Oxygen Demand (COD) witness reductions, while Dissolved Oxygen (DO) remains relatively stable at 1.9 mg/l in both seasons. Chlorides decrease from 410 mg/l to 315 mg/l, and Fluorides decrease from 0.65 mg/l to 0.45 mg/l. Ammonia levels decrease from 3.7 mg/l to 2.7 mg/l, and Nitrates show a decrease from 26.5 mg/l to 25.4 mg/l. Nitrite levels decrease from 0.15 mg/l to 0.18 mg/l. Sulphates experience a slight decrease from 80.5 mg/l to 83.2 mg/l, and Phosphates remain consistent at 1.4 mg/l in both seasons. These findings underscore the dynamic nature of water quality in Koilsagar Reservoir at RS6, emphasizing the importance of continuous monitoring and adaptive management strategies to ensure the sustainability of water resources in the region.

Metal concentrations

The pre-monsoon water quality analysis at RS1 indicates a significant increase in Ca Hardness, rising from 75 mg/l (complying with IS 10500 standards) to 543 mg/l. Similarly, Mg Hardness also experienced an elevation from 30 mg/l to 62 mg/l. Post-monsoon, Ca Hardness further increased to 612 mg/l, surpassing the permissible limit set by IS 10500, while Mg Hardness slightly decreased to 58.3 mg/l (Table 1). These findings highlight a notable deterioration in water quality at RS1, specifically concerning hardness parameters, during both pre- and post-monsoon periods. Immediate attention and remedial measures may be required to ensure compliance with water quality standards and prevent potential adverse effects on human health and the environment.

The pre-monsoon water quality analysis at RS2 reveals an elevated Ca Hardness of 652 mg/l, surpassing the IS 10500 standard of 75 mg/l. Additionally, Mg Hardness is notably high at 82.5 mg/l, exceeding the permissible limit of 30 mg/l. post-monsoon, there is a significant improvement in water quality, with Ca Hardness decreasing to 524 mg/l, still above the standard but showing a reduction from pre-monsoon levels. Similarly, Mg Hardness drops to 65.2 mg/l post-monsoon. While RS2 continues to exhibit hardness levels beyond acceptable limits, the post-monsoon results suggest a positive trend, and ongoing monitoring and mitigation measures may help bring the water quality within compliance with regulatory standards.

In the pre-monsoon water quality assessment at RS3, Ca Hardness is measured at 563 mg/l, slightly exceeding the IS 10500 standard of 75 mg/l. Mg Hardness is also elevated at 73.5 mg/l, surpassing the permissible limit of 30 mg/l. post-monsoon, there is a marginal increase in Ca Hardness to 584 mg/l, while Mg Hardness decreases to 68.4 mg/l. Although both parameters remain above the recommended levels, the post-monsoon improvements suggest a potential positive trend. Continuous monitoring and appropriate remediation measures may be necessary to ensure long-term compliance with water quality standards at RS3 (Table 1).

In the pre-monsoon analysis at RS4, Ca Hardness is recorded at 623 mg/l, significantly exceeding the IS 10500 standard of 75 mg/l. Mg Hardness is also elevated at 64 mg/l, surpassing the permissible limit of 30 mg/l. post-monsoon, there is a slight reduction in both parameters, with Ca Hardness decreasing to 610 mg/l and Mg Hardness remaining relatively stable at 64.7 mg/l. Despite the modest improvement post-monsoon, the water quality at RS4 remains non-compliant with established standards. Continuous monitoring and targeted interventions are essential to address and mitigate the hardness levels, ensuring the water quality aligns with regulatory requirements.

In the pre-monsoon assessment at RS5, Ca Hardness is measured at 587 mg/l, exceeding the IS 10500 standard of 75 mg/l. Mg Hardness is also elevated at 73.4 mg/l, surpassing the permissible limit of 30 mg/l. post-monsoon, there is a slight improvement, with Ca Hardness decreasing to 572 mg/l, while Mg Hardness decreases to 69.1 mg/l. Although there is a marginal reduction in both parameters post-monsoon, they still

remain above the recommended levels. Ongoing monitoring and targeted measures are crucial to address and manage water hardness at RS5, ensuring long-term compliance with water quality standards.
In the pre-monsoon assessment at RS6, Ca Hardness is recorded at 596 mg/l, exceeding the IS 10500 standard of 75 mg/l. Similarly, Mg Hardness is elevated at 78 mg/l, surpassing the permissible limit of 30 mg/l. post-monsoon, there is a notable improvement, with Ca Hardness decreasing to 542 mg/l, and Mg Hardness reducing to 75.1 mg/l. While both parameters remain above the recommended levels, the post-monsoon results indicate a positive trend towards improved water quality at RS6 (Table 1). Continuous monitoring and targeted interventions may be necessary to further mitigate hardness levels and ensure sustained compliance with water quality standards.
The water quality analysis for multiple sites (RS1 to RS6) before and after the monsoon season reveals variations in hardness parameters, specifically in Ca Hardness and Mg Hardness, with respect to the IS 10500 standards. In the pre-monsoon phase, RS1 exhibited a substantial increase in Ca Hardness, reaching 543 mg/l, and Mg Hardness rose to 62 mg/l. RS2 showed even higher levels, with Ca Hardness at 652 mg/l and Mg Hardness at 82.5 mg/l. RS3 had Ca Hardness at 563 mg/l and Mg Hardness at 73.5 mg/l, indicating non-compliance with the standards. RS4 demonstrated elevated Ca Hardness (623 mg/l) and Mg Hardness (64 mg/l), while RS5 recorded Ca Hardness at 587 mg/l and Mg Hardness at 73.4 mg/l. RS6 displayed Ca Hardness of 596 mg/l and Mg Hardness of 78 mg/l (Table 1).
Post-monsoon results showed some improvements. RS1's Ca Hardness increased to 612 mg/l, while Mg Hardness decreased to 58.3 mg/l. RS2 exhibited a reduction in Ca Hardness to 524 mg/l and a slight decrease in Mg Hardness to 65.2 mg/l. RS3 experienced a marginal increase in both Ca Hardness (584 mg/l) and a decrease in Mg Hardness (68.4 mg/l). RS4 showed a slight decrease in Ca Hardness to 610 mg/l and stable Mg Hardness at 64.7 mg/l. RS5 demonstrated a reduction in both parameters (Ca Hardness: 572 mg/l, Mg Hardness: 69.1 mg/l). RS6 displayed a significant decrease in Ca Hardness to 542 mg/l and Mg Hardness to 75.1 mg/l.
While post-monsoon improvements were observed at most sites, several locations still exhibited hardness levels above the permissible limits. Continuous monitoring and targeted remediation efforts are essential to bring these water quality parameters within the recommended standards and ensure the long-term environmental and human health sustainability of the water sources.

CONCLUSION

The pH levels at all sites generally align with the permissible range, demonstrating the resilience of the water system. Temperature fluctuations, though minor, indicate some variability in thermal conditions. Turbidity levels, exceeding the recommended limit at several sites, underscore potential challenges in sediment management. Total Dissolved Solids (TDS) and Electrical Conductivity (EC) values consistently surpass acceptable thresholds, emphasizing the high mineral content in the water. Total Hardness levels at multiple sites exceed the recommended limit, posing concerns for various applications. Alkalinity levels remain relatively stable across sites, contributing to the water's buffering capacity.
Biochemical Oxygen Demand (BOD) and Chemical Oxygen Demand (COD) show reductions post-monsoon, indicating a positive influence of increased water flow. Dissolved Oxygen (DO) levels generally stabilize or improve post-monsoon, promoting better aquatic health. Chlorides and fluorides exhibit variations, potentially influenced by anthropogenic activities. Ammonia, nitrates, and nitrites display fluctuations, suggesting varying nutrient inputs. Sulphates and phosphates levels, while within permissible limits, show site-specific variations.
The metal concentration of water analysis conducted before and after the monsoon season at multiple sites (RS1 to RS6) highlights significant variations in hardness parameters, particularly Ca Hardness and Mg Hardness, when compared to the IS 10500 standards. The pre-monsoon results indicated elevated hardness levels at several locations, with RS2, RS4, and RS6 demonstrating particularly high concentrations. While post-monsoon improvements were observed across most sites, some locations still exhibited hardness levels exceeding permissible limits.
The water quality analysis in Koilsagar Reservoir reflects a dynamic interplay of natural and anthropogenic factors. While certain parameters meet regulatory standards, elevated levels of others warrant continuous monitoring and strategic interventions for sustainable water resource management. The study underscores the importance of ongoing research, vigilant monitoring, and adaptive management practices to address emerging challenges and ensure the long-term health of Koilsagar Reservoir and its surrounding ecosystem.
Additionally, the findings regarding metal concentrations highlight the dynamic nature of water quality in response to seasonal changes, emphasizing the importance of ongoing monitoring and intervention measures to mitigate hardness levels and ensure compliance with regulatory standards. The observed

improvements post-monsoon at certain sites, such as RS2 and RS6, suggest a positive trend that can be further enhanced with targeted remediation efforts. Overall, this research underscores the need for a proactive and adaptive approach to water quality management, recognizing the intricate interplay between environmental conditions and water quality parameters. Implementing sustainable strategies and continued vigilance will be crucial to safeguarding the health of ecosystems and communities reliant on these water sources.

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