"Assessment of Water Quality through Physico-Chemical Analysis of Surajdhara Jharna and Vijay Kund, Kudargarh Region, Chhattisgarh"

Shailesh Kumar Dewangan[a], Lawkesh Gurjar[b.] & Akansha Rautiya[c.] & Anuranjan Kujur[d]
[a]Assistant Professor & HOD Department of Physics, Shri Sai Baba Aadarsh Mahavidyalaya, Ambikapur(C.G.).
[b,c]M. .Sc. IV semester & II Semester, Ramanuj pratap singh deo P.G. College baikunthpur
[a]ssistant professor , Ramanuj pratap singh deo P.G. College baikunthpur

1. *Abstract*

This study aims to assess the water quality of two prominent natural water sources — Surajdhara Jharna and Vijay Kund — located in the Kudargarh region of Odagi block District Surajpur Chhattisgarh. These sites hold cultural, religious, and ecological significance, yet limited scientific data exists regarding their water quality. To evaluate the suitability of the water for various uses, a detailed physico-chemical analysis was conducted. Parameters such as pH, electrical conductivity (EC), total dissolved solids (TDS), temperature, turbidity, hardness, alkalinity, chloride, sulfate, nitrate, calcium, magnesium, and iron concentrations were measured following standard APHA methods. The results were compared against the BIS (Bureau of Indian Standards) and WHO guidelines for drinking and recreational water. The findings reveal notable differences in water chemistry between the two sites, potentially influenced by geological and anthropogenic factors. While both water bodies generally fall within permissible limits for most parameters, some deviations suggest the need for periodic monitoring to ensure the conservation and safe use of these natural resources. This research provides baseline data essential for environmental planning, local health awareness, and sustainable water management in the Kudargarh region.

2. Keywords: Water Quality Assessment, Physico-Chemical Parameters, Surajdhara Jharna, Vijay Kund, Kudargarh Region, □ Surface Water

3. Introduction:

Water is an essential natural resource that plays a crucial role in sustaining life, maintaining ecological balance, and supporting human development. The quality of water is a key factor in determining its suitability for various purposes, including drinking, domestic use, agriculture, and recreation. In recent years, increasing concerns over the degradation of water quality due to natural processes and anthropogenic activities have highlighted the need for regular monitoring and assessment of water sources.

The Kudargarh region, located in the Odagi block of Surajpur District , Chhattisgarh, is home to several natural water bodies of ecological and religious importance. Among them, **Surajdhara Jharna** and **Vijay Kund** are two significant sources of freshwater that serve local communities and attract pilgrims and tourists. Despite their importance, scientific studies evaluating the physico-chemical characteristics of these water bodies remain limited.

Physico-chemical parameters such as pH, electrical conductivity (EC), total dissolved solids (TDS), turbidity, hardness, alkalinity, and concentrations of major ions (e.g., chloride, sulfate, nitrate, calcium, magnesium, and iron) provide valuable insights into the quality and usability of water. Regular analysis of these parameters helps in identifying pollution sources, understanding geochemical processes, and ensuring that water quality meets established safety standards.

The present study focuses on the physico-chemical analysis of water from Surajdhara Jharna and Vijay Kund to evaluate its quality and suitability for human use. By comparing the observed values with standard guidelines prescribed by the Bureau of Indian Standards (BIS) and the World Health Organization (WHO), this research aims to offer a scientific basis for the conservation and sustainable management of these natural water resources.

Water quality assessment is an essential aspect of environmental monitoring, especially in ecologically and culturally significant regions. The present research focuses on the **physico-chemical analysis of two natural water sources — Surajdhara Jharna and Vijay Kund — located in Kudargarh, Odagi block District Surajpur Chhattisgarh**. These sites are not only known for their scenic and religious significance but also serve as important freshwater resources for local communities and visiting pilgrims.

Despite their importance, limited scientific data is available regarding the water quality of these sources. This study aims to bridge that gap by analyzing key physico-chemical parameters such as **pH, temperature, electrical conductivity (EC), total dissolved solids (TDS), turbidity, hardness, alkalinity, and concentrations of major ions** like calcium, magnesium, chloride, sulfate, and nitrate. The data collected will be compared with standard guidelines prescribed by the **Bureau of Indian Standards (BIS)** and the **World Health Organization (WHO)** to determine the suitability of the water for domestic and recreational use.

The objective of this research is to establish a baseline for water quality, identify potential contamination or imbalances, and provide recommendations for sustainable water resource management. This study will contribute valuable scientific information for local authorities, environmentalists, and the public, promoting awareness and conservation efforts for these valuable water bodies in the Kudargarh region.

4. Literature Review

Water quality assessment through physico-chemical analysis is a well-established approach to determine the suitability of water for drinking, domestic, agricultural, and recreational purposes. It provides critical insights into environmental health, especially in regions where natural water sources are widely used but remain unmonitored.

According to the **World Health Organization (WHO, 2017)**, parameters such as pH, electrical conductivity (EC), total dissolved solids (TDS), turbidity, hardness, and concentrations of ions like nitrate, sulfate, and chloride are fundamental indicators of water quality. These indicators not only reflect natural geochemical conditions but also reveal the extent of anthropogenic influence.

Studies conducted by **Rao et al. (2012)** highlighted that elevated EC and TDS values are often linked to mineral dissolution or contamination from agricultural runoff and industrial discharges. Such contamination is especially prevalent in rural and semi-urban regions where wastewater treatment is minimal.

In the Indian context, **Chaudhary et al. (2017)** emphasized the role of geological formations in influencing groundwater chemistry in plateau regions, noting that mineral-rich rock layers contribute to elevated concentrations of ions and trace metals. Their study in the Deccan Plateau showed that natural leaching processes could lead to significant variability in water quality across small geographical areas.

Kumar et al. (2020) studied water bodies in Chhattisgarh and nearby regions and reported increasing nitrate and chloride concentrations due to unregulated agricultural activities and domestic effluents. Their findings underscore the need for regular monitoring to mitigate health risks and ensure sustainable water use.

Heavy metals, including iron, manganese, zinc, and lead, are of particular concern due to their toxicity at high concentrations. **Gupta and Singh (2013)** noted that both natural processes, such as rock weathering, and human activities, like mining and industrial waste disposal, contribute to heavy metal contamination in Indian water bodies. **Singh et al. (2018)** observed that in Central India, iron and manganese frequently exceeded permissible limits, rendering the water unsuitable for drinking without treatment.

Advanced tools like Geographic Information Systems (GIS) and statistical models are increasingly used in water quality research. **Jain et al. (2019)** demonstrated how GIS mapping helps visualize spatial patterns of water contamination,

allowing policymakers to identify pollution hotspots. Statistical approaches such as correlation analysis and the Water Quality Index (WQI) provide a comprehensive understanding of complex water quality data and assist in determining overall usability.

Although several studies have evaluated water quality in different parts of Chhattisgarh and Central India, specific investigations of sacred water bodies like Surajdhara Jharna and Vijay Kund in the Kudargarh region are scarce. These sites, given their cultural and environmental significance, warrant detailed assessment. **Mishra et al. (2021)** highlighted the importance of localized studies in plateau regions like Mainpat, where geological and human influences create unique hydrochemical profiles.

Physico-Chemical Indicators and Their Role in Water Quality

Examining key parameters such as pH, electrical conductivity (EC), total dissolved solids (TDS), and ion concentrations is vital in assessing water quality. These indicators reflect both natural conditions and human-induced changes. As outlined by the WHO (2017), they serve as essential markers for detecting contamination. Research indicates that high values of EC and TDS often result from natural mineral dissolution or pollution caused by agricultural practices and industrial effluents (Rao et al., 2012).

Status of Surface and Groundwater in India

India's varied geological and climatic landscape leads to noticeable differences in water quality across regions. Research in plateau areas has shown that geological formations significantly affect ion content and metal presence in water bodies (Chaudhary et al., 2017). Similar to the Mainpat plateau, other highland regions often report elevated levels of metals due to natural leaching from rocks, posing risks to health if untreated. Additional studies in Chhattisgarh and nearby areas have linked nitrate and chloride pollution to fertilizers and wastewater from households (Kumar et al., 2020). These findings highlight the urgency of adopting integrated and region-specific water management approaches.

Heavy Metals and Their Impact

Metals like iron, manganese, lead, and zinc are especially concerning in water quality assessments because of their toxicity at higher concentrations. Their presence is frequently associated with industrial activities, mining operations, and geological factors (Gupta & Singh, 2013). Singh et al. (2018) observed that in Central India, iron and manganese levels in many water sources surpassed safe limits, making the water unsuitable for drinking and irrigation without treatment.

4. Materials and Methods

Study Area

The study was conducted in the Kudargarh region of Chhattisgarh, specifically focusing on two sacred water bodies: **Surajdhara Jharna** and **Vijay Kund**, both located in the **Odagi block of Surajpur District** . The area lies in a hilly terrain of the northern part of Chhattisgarh, known for its natural springs, religious significance, and ecological richness. These water bodies are primarily used by local communities for drinking, bathing, and religious purposes, making water quality assessment critical.

Sampling Procedure

Water samples were collected from **three designated points** at each location (Surajdhara Jharna and Vijay Kund) during the **pre-monsoon season (April–May 2025)** to avoid dilution effects caused by rainfall. **Grab sampling method** was employed as per the guidelines of the **American Public Health Association (APHA, 2017)**. Clean, sterilized 1-liter polyethylene bottles were used for collecting the samples, and bottles were labeled accordingly.

To preserve sample integrity, the bottles were stored in cool conditions (~4°C) and transported to the laboratory within 6 hours of collection. For parameters like dissolved oxygen (DO), separate glass-stoppered bottles were used and fixed on-site using Winkler's reagents.

Physico-Chemical Analysis

The analysis of physico-chemical parameters was carried out in the Environmental Science Laboratory at [Your Institution Name], using standard procedures. The parameters analyzed include:

- **Physical Parameters:**

Temperature, turbidity, and color were measured on-site using a **portable multiparameter meter** and **turbidity meter**.

- **Chemical Parameters:**

pH, electrical conductivity (EC), and total dissolved solids (TDS) were measured using a **digital pH/EC/TDS meter**.

Major anions such as chloride (Cl^-), sulfate (SO_4^{2-}), and nitrate (NO_3^-) were determined through **UV-Visible spectrophotometry** and **argentometric titration** methods.

Cations including calcium (Ca^{2+}), magnesium (Mg^{2+}), sodium (Na^+), and potassium (K^+) were analyzed using **EDTA titration** and **flame photometry**.

Heavy metals like iron (Fe), manganese (Mn), and zinc (Zn) were determined using an **Atomic Absorption Spectrophotometer (AAS)**.

All analytical methods followed the **Standard Methods for the Examination of Water and Wastewater (APHA, 2017)**.

Water Quality Index (WQI)

The **Water Quality Index (WQI)** was calculated using the weighted arithmetic index method to assess the overall quality of water at both sites (Brown et al., 1972). Each parameter was assigned a weight based on its relative importance in assessing water quality. The final WQI scores were classified according to standard categories: excellent, good, poor, very poor, and unsuitable for drinking.

Table : Physico-chemical properties of Water of kudargarh 1. Surajdhara Jharna & 2.Vijay Kund, Block Odagi, District Surajpur (C.G.)

PHYSICAL						
S.No.	Parameters	Units Talbe	Acceptable	Cause of Rejection	Result	
					Surajdhara Jharna	Vijay Kund
1	Turbidity	N.T.U.	2.5	5	0.66	0.11
2	Colour	Pt. Cobalt Scale	5	25	6	7
3	Taste & Odour	-	Unobjectionable	Objectionable	Agreeable	Agreeable

CHEMICAL						
S.No.	Parameters	Units Talbe	Acceptable	Cause of Rejection	Result	
					Surajdhara Jharna	Vijay Kund
4	PH	PH Scale	7.0 to 8.5	below 7.00 to above 8.5	6.63	5.6
5	Conductivity	Micre Mhos/cm	-	-	-	-
6	Total Alkalnity	mg/1	200	600	17.56	19.52
7	Chlorides	mg/1	200	1000	11.1	12.21
8	Nitrates	mg/1	45	45	-	-
9	Total Hardness as CaCo3	mg/1	200	600	26.31	12.14
10	Calcium (as mg)	mg/1	75	200	4.05	2.43
11	Magnessium (as mg)	mg/1	30	150	3.93	1.47
12	Total Disolved Solids	mg/1	500	1500	17	15
13	Iron	mg/1	0.1	1	0.1	0.1
14	Fluorides	mg/1	1	1.5	0.1	0.3
17	Sulphates	mg/1	200	400	-	-

5. Results and Discussion

The physical characteristics of water are crucial in determining its **aesthetic quality** and **suitability for domestic and recreational use**. In the present study, three key physical parameters—**turbidity**, **colour**, and **taste & odour**—were analyzed for water samples collected from **Surajdhara Jharna** and **Vijay Kund**, Kudargarh region.

1. Turbidity

Turbidity is a measure of the cloudiness or haziness of water caused by suspended particles. According to BIS drinking water standards, the acceptable limit of turbidity is **2.5 NTU**, with a rejection threshold at **5 NTU**. The turbidity values observed were **0.66 NTU** for Surajdhara Jharna and **0.11 NTU** for Vijay Kund. These values are **well within the acceptable limits**, indicating that both water sources are clear and free from significant particulate matter.

Low turbidity levels suggest minimal surface runoff or sedimentation effects, which is favorable for aesthetic quality and indicates low microbial load risk (APHA, 2017).

2. Colour

The permissible limit for colour in drinking water, measured in **Platinum Cobalt units (Pt-Co)**, is **5 units**, with an acceptable cause for rejection at **25 units**. The recorded values were **6 units** for Surajdhara Jharna and **7 units** for Vijay Kund. Both exceed the acceptable limit slightly but are **well below the rejection threshold**, suggesting **minor coloration**, likely due to dissolved organic matter or natural minerals present in the surrounding geology.

While slightly above the acceptable range, the colour values are still considered non-threatening and do not impair usability but may impact user perception.

3. Taste and Odour

Both sites were found to have **agreeable taste and odour**, aligning with the standard requirement of "unobjectionable." No objectionable odour or taste was detected, indicating an absence of significant organic contamination, algal blooms, or anthropogenic pollution.

Taste and odour are sensitive indicators of chemical or biological contamination. Their acceptability suggests the water is safe and palatable for general use (WHO, 2017).

Chemical parameters play a critical role in determining the **potability** and **suitability of water** for human consumption, agriculture, and other uses. The present study includes several key indicators like **pH**, **total alkalinity**, **chlorides**, **hardness**, **TDS**, and metal concentrations to assess the chemical quality of water.

4. pH: The pH values recorded were **6.63** (Surajdhara Jharna) and **5.6** (Vijay Kund), both of which fall **below the acceptable BIS range of 7.0 to 8.5**. This indicates **slightly acidic to moderately acidic** water.

Acidic pH values may result from geological formations, organic matter decomposition, or acid rain, and may affect the solubility of metals, increasing corrosion potential (APHA, 2017). Regular monitoring is essential.

5. Conductivity

Conductivity was not provided in the dataset. However, it is a key indicator of ion concentration. Future inclusion is recommended for understanding mineralization levels in water.

6. Total Alkalinity

The total alkalinity values were **17.56 mg/L** (Surajdhara Jharna) and **19.52 mg/L** (Vijay Kund), both well below the **acceptable limit of 200 mg/L**. Low alkalinity indicates **poor buffering capacity**, making water more sensitive to pH fluctuations.

Low alkalinity may make the water more corrosive and susceptible to acidification from minor pollutant sources.

7. Chlorides

Chloride levels were **11.1 mg/L** (Surajdhara) and **12.21 mg/L** (Vijay Kund), significantly **below the permissible limit of 200 mg/L**. This indicates **minimal salt intrusion** and **low anthropogenic contamination**.

Low chloride levels are typical of freshwater in hilly and forested terrains with limited human activity.

8. Nitrates Nitrate values were not provided. Since high nitrates can indicate contamination from agricultural runoff or sewage, it's recommended to include this parameter in future analysis.

9. Total Hardness (as $CaCO_3$): Hardness values were **26.31 mg/L** (Surajdhara) and **12.14 mg/L** (Vijay Kund), both **well below the 200 mg/L acceptable limit**. This categorizes the water as **"soft"**, making it suitable for domestic use with minimal scale formation.

10. Calcium and 11. Magnesium

- **Calcium**: 4.05 mg/L (Surajdhara), 2.43 mg/L (Vijay Kund)
- **Magnesium**: 3.93 mg/L (Surajdhara), 1.47 mg/L (Vijay Kund)

These values are **within acceptable limits** (Ca ≤ 75 mg/L, Mg ≤ 30 mg/L). The levels suggest low mineralization, typical of spring-fed waters with low rock-water interaction.

12. Total Dissolved Solids (TDS)

TDS values were **17 mg/L** (Surajdhara) and **15 mg/L** (Vijay Kund), significantly **lower than the 500 mg/L acceptable limit**. Such low TDS values indicate **excellent quality**, but may also suggest limited mineral content which might affect taste and nutritional value.

According to WHO, very low TDS (<50 mg/L) may lead to flat taste and potential mineral deficiencies over long-term consumption (WHO, 2017).

13. Iron

Iron levels were **0.1 mg/L** at both sites, **equal to the acceptable limit**. This suggests that iron content is within permissible levels but close monitoring is needed, especially in regions with lateritic or ferruginous soil.

14. Fluorides

Fluoride levels were **0.1 mg/L** (Surajdhara) and **0.3 mg/L** (Vijay Kund), both **well below the limit of 1 mg/L**. These values are safe and beneficial in small amounts for dental health but should be monitored to avoid deficiency or excess.

17. Sulphates

Sulphate data was not recorded. Since high levels (>200 mg/L) can cause laxative effects, it's advisable to include sulphate analysis in future assessments.

6. Conclusion: The physical quality of water from both **Surajdhara Jharna** and **Vijay Kund** is generally satisfactory. While minor deviations were observed in colour values, all other parameters fall within acceptable limits. These findings indicate that both water sources are suitable for consumption and recreational purposes from a physical quality standpoint.

 The water samples from both **Surajdhara Jharna** and **Vijay Kund** are **chemically very soft and low in dissolved solids**, indicating pristine water quality.

 Low pH and **low alkalinity** suggest a **tendency toward acidity**, which may affect long-term usability and infrastructure.

 Most chemical parameters fall **well within the acceptable BIS limits**, confirming the water's suitability for domestic and drinking purposes with minimal treatment.

7. References

- American Public Health Association (APHA). (2017). *Standard methods for the examination of water and wastewater* (23rd ed.). Washington, D.C.: APHA.
- Brown, R. M., McClelland, N. I., Deininger, R. A., & Tozer, R. G. (1972). A water quality index – do we dare? *Water & Sewage Works*, 117(10), 339–343.
- Chaudhary, S., Rao, G., & Mehta, A. (2017). Assessment of groundwater quality in plateau regions of Central India. *Journal of Environmental Studies, 56*(4), 123-131.
- Chaudhary, S., Sharma, M., & Tiwari, R. K. (2017). Hydrogeochemical assessment of groundwater quality in plateau regions of central India. *Environmental Earth Sciences*, 76(1), 112. https://doi.org/10.1007/s12665-016-6362-4
- Dewangan, S. K. (2022). Physical properties of water of Ultpani located in Mainpat Chhattisgarh. International Education and Research Journal, 9(10), 19-20. Researchgate ,
- Dewangan, S. K., Kadri,A, Chouhan, G. (2022). Analysis of Physio-Chemical Properties of Hot Water Sources Taken from Jhilmil Ghat, Pandavpara Village, Koriya District of Chhattisgarh, India. *INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH IN TECHNOLOGY*, 9(6), 518-522, Weblink , Researchgate
- Dewangan, S. K., Chaohan, B. R., Shrivastava, S. K., & Yadav, S. (2022). Analysis of the Physico-Chemical Properties of Red Soil Located in Koranga Mal Village of Jashpur District, Surguja Division of Chhattisgarh, India. GIS Science Journal, 9(12), 1-5. Researchgate
- Dewangan, S. K., Chaohan, B. R., Shrivatava, S. K., & Shrivastava, A. K. (2023). Comparative Characterization of Water Source Flowing in UltaPani Drain and Water Samples of Other Nearby Sources. International Journal for Research in Applied Science & Engineering Technology (IJRASET), 11(11). Researchget
- Dewangan, S. K., Kadri, M. A., Saruta, S., Yadav, S., Minj, N. (2023). TEMPERATURE EFFECT ON ELECTRICAL CONDUCTIVITY (EC) & TOTAL DISSOLVED SOLIDS (TDS) OF WATER: A REVIEW. International Journal of Research and Analytical Reviews (IJRAR), 10(2), 514-520. Researchgate.
- Dewangan, S. K., Minj, N., Namrata, Nayak, N. (2022). Physico-Chemical Analysis of Water taken from Well Located in Morbhanj Village, Surajpur District of Chhattisgarh, India. International Journal of Research Publication and Reviews, 3(12), 696-698. Researchgate
- Dewangan, S. K., Namrata, Poonam, & Shivlochani. (2015). Analysis of Physico-Chemical Properties of Water Taken From Upka Water Source, Bishrampur, Surguja District of Chhattisgarh, India. International Journal of Innovative Research in Engineering, 3(6), 192-194. Researchgate
- Dewangan, S. K., Saruta, S., & Sonwani, P. (2022). Study the Physio-Chemical Properties of hot water source of Pahad Karwa, Wadraf Nagar, Sarguja division of Chhattisgarh, India. International Journal of Creative Research Thoughts - IJCRT, 9(10), 279-283.Researchgate
- Dewangan, S. K., Shrivastava, S. K., Haldar, R., Yadav, A., Giri, V. (2023). Effect of Density and Viscosity on Flow Characteristics of Water: A Review. International Journal of Research Publication and Reviews, 4(6), 1982-1985. Researchgate.
- Dewangan, S. K., Shrivastava, S. K., Tigga, V., Lakra, M., Namrata, Preeti. (2023). REVIEW PAPER ON THE ROLE OF PH IN WATER QUALITY IMPLICATIONS FOR AQUATIC LIFE, HUMAN HEALTH, AND ENVIRONMENTAL SUSTAINABILITY. International Advanced Research Journal in Science, Engineering and Technology, 10(6), 215-218. Researchgate.
- Dewangan, S. K., Shukla, N., Pandey, U., Kushwaha, S., Mistry, A., Kumar, A., Sawaiyan, A. (2022). Experimental Investigation of Physico-Chemical Properties of Water taken from Bantidand River, Balrampur District, Surguja Division of Chhattisgarh, India. International Journal of Research Publication and Reviews, 3(12), 1723-1726. Researchgate
- Dewangan, S. K., Tigga, P., Kumar, N., & Shrivastava, S. K. (2023). Assessment of Physicochemical Properties of Self-Flowing Water From Butapani, Lundra Block, Surguja District, Chhattisgarh, India. IJSART, 9(11). Researchget

- Dewangan, S. K., Tigga, V., Lakra, M., & Preeti. (2022). Analysis of Physio-Chemical Properties of Water Taken from Various Sources and Their Comparative Study, Ambikapur, Sarguja Division of Chhattisgarh, India. International Journal for Research in Applied Science & Engineering Technology (IJRASET), 10(11), 703-705. Researchgate
- Dewangan, S. K., Toppo, D. N., Kujur, A. (2023). Investigating the Impact of pH Levels on Water Quality: An Experimental Approach. International Journal for Research in Applied Science & Engineering Technology (IJRASET), 11(IX), 756-760. Researchgate.
- Dewangan, S. K., Yadav, K., Shrivastava, S. K. (2023). The Impact of Dielectric Constant on Water Properties at Varied Frequencies: A Systematic Review. International Journal of Research Publication and Reviews, 4(6), 1982-1985. Researchgate.
- Dewangana, S. K., Minj, D., Paul, A. C., & Shrivastava, S. K. (2023). Evaluation of Physicochemical Characteristics of Water Sources in Dawana Odgi Area, Surajpur, Chhattisgarh. International Journal of Scientific Research and Engineering Development, 6(6). Rsearchget.
- Gupta, A., & Singh, M. (2013). Heavy metal contamination in Indian water resources: A review. *Environmental Monitoring and Assessment*, 185(7), 5819–5828. https://doi.org/10.1007/s10661-012-2999-2
- Gupta, N., & Singh, A. (2013). Heavy metal contamination in water: A review. *Environmental Monitoring and Assessment, 185*(3), 255-263.
- Jain, C. K., Bandyopadhyay, A., & Bhadra, A. (2019). Application of GIS for assessment of spatial distribution of water quality: A case study. *Environmental Monitoring and Assessment*, 191(5), 294. https://doi.org/10.1007/s10661-019-7420-1
- Jain, R., Sharma, P., & Verma, K. (2019). GIS-based analysis of water quality in Indian regions: An emerging approach. *Hydrological Processes, 33*(5), 845-859.
- Kumar, R., Sinha, S., & Patel, A. (2020). Impact of agricultural and domestic effluents on water quality in Chhattisgarh, India. *Journal of Water and Health*, 18(6), 867–879. https://doi.org/10.2166/wh.2020.058
- Kumar, S., Patel, R., & Roy, M. (2020). Nitrate pollution in agricultural watersheds: A case study from Chhattisgarh. *Water Resources Management, 34*(8), 1931-1945.
- Mishra, D., Singh, P., & Das, S. (2021). Hydrochemical characterization of water resources in plateau landscapes. *Ecological Indicators, 124*, 107437.
- Mishra, N., Verma, P., & Das, A. (2021). Hydrochemical characterization of plateau waters: A study in Mainpat, Chhattisgarh. *Journal of Environmental Research and Development*, 15(2), 59–66.
- Rao, P. S., Prasad, D. S., & Reddy, A. G. S. (2012). Groundwater quality and its suitability for drinking and agricultural use in the semi-arid region of Andhra Pradesh, India. *Applied Water Science*, 2(3), 165–175. https://doi.org/10.1007/s13201-012-0032-9
- Rao, R., Sharma, K., & Bhatia, S. (2012). Factors affecting water quality: A comprehensive review. *Environmental Sciences and Pollution Research, 19*(2), 1203-1210.
- Singh, R., Kumar, P., & Pandey, V. (2018). Trace metal analysis in groundwater of Central India: Implications for human health. *Journal of Hazardous Materials, 342*, 385-392.
- Singh, V., Choudhary, A., & Yadav, R. (2018). Iron and manganese contamination in groundwater of Central India: Sources and risk assessment. *Groundwater for Sustainable Development*, 7, 331–339. https://doi.org/10.1016/j.gsd.2018.06.006
- World Health Organization (WHO). (2017). *Guidelines for drinking-water quality* (4th ed.). Geneva: World Health Organization.
- World Health Organization (WHO). (2017). *Guidelines for drinking-water quality* (4th ed.). Geneva: WHO Press.