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Evaluation of Spatial and Temporal Variations of Water Quality of Urban and Rural Areas of Kishtwar Valley

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Abstract: ***The Kishtwar Valley, located in Jammu and Kashmir, India, is characterized by diverse hydro-ecological parameters where both urban and rural communities depend heavily on surface and groundwater resources.[1,2,3] This study evaluates the spatial and temporal variations in water quality across urban and rural areas of the valley. Seasonal sampling was conducted to analyse physicochemical parameters, including pH, dissolved oxygen (DO), biological oxygen demand (BOD), chemical oxygen demand (COD), turbidity, nitrates, phosphates, and heavy metals. Results reveal significant differences between urban and rural water sources, with urban areas showing higher organic and industrial pollution, while rural areas are more affected by agricultural runoff and seasonal erosion.[4,5,6,7] Temporal variations highlight deterioration in summer due to reduced dilution and improvement during monsoon months. The findings emphasize the need for integrated water management strategies to safeguard public health and ecological sustainability. The physical and chemical properties of water, including its pH, colour, turbidity, cations, anions, phosphates, total suspended solids (TSS), chemical oxygen demand (COD), biochemical oxygen demand (BOD), and total dissolved solids (TDS), can be used to evaluate its quality.[8,10,11]***

Keywords: Analysis of variance, Water standards, Water Quality Index, Physico-chemical analysis, Spatio-temporal variation

1. Introduction

Water has inherent purity, but the earth's journey introduces other toxins and impurities. Water quality is a critical determinant of human health, agricultural productivity, and ecological balance.[12,13,14,15] In mountainous regions such as the Kishtwar Valley, water resources are vulnerable to both natural processes and anthropogenic pressures.[16,17] Urbanization, industrialization, and agricultural intensification have led to increasing contamination of water bodies. Evaluating spatial and temporal variations in water quality provides insights into pollution sources and seasonal dynamics, enabling effective management strategies.[18,19,20,21,22] Water pollution is also a result of human and artificial activity. All living things require water above all else, and any changes to the water could make it difficult for these species to survive.[23,24,25] Water of high purity is necessary for all living things. Water's physical and chemical properties can be studied to determine its quality.[26,27] The water quality is steadily declining due to human irresponsibility and the large population. Insufficient water quality renders it unsuitable for drinking and other uses. In the last few decades, there has been a massive industrial expansion all over the world to meet the growing demands of human civilization.[28,29,30] This has led to overuse of the resources that are available and air, land, and water pollution. A fluctuating water issue has resulted from water contamination caused by rapid industrialization, urbanization, and human activity.[31,32,33] When waste is released into the water from various industries without being properly treated, environmental contaminants from human sources have the potential to have a synergistic effect on the aquatic ecosystem.[34,35,36,37] More over 40% of the world's population resides along lake or river banks, and this percentage is rising. Springs and other bodies of water's shorelines are some of the most delicate areas.[38,39] Any artificial alteration to these delicate ecosystems may jeopardize fish and other aquatic life's habitats. Given its growing population and economic progress, India is confronted with a severe shortage of natural resources, particularly water.[40,41]The majority of freshwater sources in India are becoming contaminated, which reduces the water's potability. The WHO estimates that household garbage is responsible for almost 80% of India's water contamination. However, in nature, chemically pure water does not exist for a significant amount of time. Pure water is defined as having little dissolved or suspended particles, unpleasant gasses, and biological life.[42,43] Water of this high quality might only be needed for drinking, but for other applications, such as industry and agriculture, the quality might be very variable, and even somewhat dirty water can be considered pure in general. Nearly all of the ecosystem's components are intimately correlated with the biological variety and overall health of water supplies. It is human activity that has caused the death of numerous water resources. Sewage discharge into lakes and storm water runoff are two frequent ways that different nutrients infiltrate aquatic ecosystems and cause their demise. The sort of pollution introduced and the water's self-purification process determine the quality of the water. It provides a hint for government officials to create suitable management plans. The weather and air temperature are the primary factors influencing temperature variation.[44,45,46] High temperatures, high loading organic chemicals, detergent, chlorides, and other contaminants can all cause the water volume to decrease in the rate of evaporation, which in turn causes an increase in hardness. The biological oxygen demand is a crucial metric that is frequently used to assess the level of pollution in wastewater. The BOD test's objective is to quantify the amount of carbonaceous matter that is biochemically oxidizable. BOD values were caused by turbidity, decreased water current, and a faster rate of organic matter breakdown at higher temperatures.[47,48,50] Physicochemical parameters of any water body play a very important role in maintaining the fragile ecosystem that maintains various life forms. Of all the water quality issues, eutrophication is of great concern. The test known as chemical oxygen demand (COD) is used to measure pollution of domestic and industrial waste, providing valuable information about the pollution potential of industrial effluents and domestic sewage. The maximum value of COD indicates that the majority of the pollution in study is caused by industrial effluents discharged by industrial units. Eutrophication is the word used to characterize the aging of a water resource brought on by the buildup of organic matter, silt, sediments, and nutrients from the surrounding watershed in the lake.[51,52,53] Overabundance of phosphorus and nitrogen contributes to eutrophication by causing high algal biomass, cyanobacteria dominance, and macrophyte loss. It is challenging to fully understand the biological phenomenon because water chemistry reveals a lot about how the ecosystem is incorporated.[54,55] Spring water quality is declining in both urban and rural regions as a result of both natural and man-made influences. Water quality management in springs requires an understanding of how variables and changes impact springs water quality. The primary source of ground water is precipitation that seeps into the earth and passes through rock pores and soil. Additional sources include waste-water treatment systems, recharge ponds, and water seeping into lakes and streams. Disease-causing microorganisms are among the many contaminants that are filtered out of ground water when it passes through rocks, soil, and sediment.[56,57] These water bodies characteristics differ greatly based on the location and surrounding conditions. The most significant influence on the natural ecology, climate, and human growth is that of water resources. It's one of the most significant substances that has a big impact on life, business, and agriculture. The human population is afflicted with illnesses as a result of the use of contaminated water. Rising rates of waterborne illnesses provide a true indicator of environmental contamination levels. It is now essential to periodically verify the quality of the water. Numerous water supplies in developing nations are unsafe due to the presence of dangerous physical, chemical, and biological contaminants.[58] Stress on surface and groundwater intensified due to a massive population growth. It is thought that due of the aquifer's filtering action, groundwater was the most reliable source of drinking water during the dawn of human civilization. In the modern world, it is difficult to drink water straight from the source without any kind of treatment.[59,60] For public health research, the physical and chemical characteristics of groundwater are crucial. Environmental contamination research also heavily relies on these investigations. The physical surroundings, the source, and the flow of water all affect the groundwater's inherent quality. Through interactions with soil, rock, and organic matter, the water undergoes a number of chemical, physical, and biological processes that alter its initial quality as it passes through the hydrological cycle. The quality of groundwater is affected by both natural and man-made factors, either directly or indirectly.[61,62,63] About 80% of all human diseases are caused by water, according to the WHO agency. The Water Quality Index (WQI) has been used to summarize and categorize springs water quality by converting large amounts of data into single numbers. However, the origins or causes influencing the quality of springs water cannot be recognized; this method can only evaluate the current state of the water.[64,65] A vital instrument for environmental monitoring, the water quality index (WQI) provides a thorough assessment of water quality. According to Tasneem and Abbasi (2012), Sutadian *et al.* (2016), Talukdar *et al.* (2023), and Zhao *et al.* (2021a), this index simplifies the process of classifying water samples into discrete safety levels by converting a number of characteristics into a single numerical value. Water quality assessment using the WQI is closely related to the selection of criteria that are incorporated into the formula. Thus, it's critical to determine the ideal parameter set in order to comprehend water quality. Ever since the water quality index was developed, there has been a persistent debate about which metric should be used to understand water quality (Chidiac *et al.,* 2023). Several guidelines and WQI formulas have been developed to provide an accurate method for measuring water quality utilizing a variety of criteria (Chidiac *et al.,* 2023; Mogane *et al.,* 2023). The geographical setting or particular application has an impact on the parameters chosen for the evaluation of water quality. The selection of water sample parameters for the water quality index (WQI) has a significant impact on the assessment of water quality. Data-driven methods, including machine learning models and statistical approaches, are frequently used to refine the parameter set for four main reasons: reducing cost and uncertainty, addressing the eclipsing problem, and enhancing the performance of models predicting the WQI. [66,67,68,69]

Table 1: Correlation of water quality range and water and quality

S. No.	WQI ranges	Water quality
1.	90-100	Excellent
2.	70-90	Good
3.	50-70	Medium
4.	25-50	Bad
5.	0-25	Very Bad

Traditionally, field sampling and laboratory analysis have been used to evaluate physical, chemical, and biological characteristics of water quality indicators. A simultaneous regional water quality database cannot be provided due to the labor-intensive and time-consuming nature of this in-situ assessment, despite its great precision. Furthermore, the geographical or temporal fluctuations in water quality that is essential for thorough evaluation and management of water bodies are difficult to detect using traditional point sampling techniques.[70,71,72]

Table 2: Physical and Chemical Parameters of water quality check

S. No.	Physical Parameters	Chemical Parameters
1.	Turbidity	Acidity/Alkalinity [pH]
2.	Colour	Fluorides, Chlorides, Silicates,
3.	Taste	Phosphates, Sulfate
4.	Odour	Iron, Manganese, Copper and Zinc
5.	Total Solids	Hardness, BOD, COD, DO
6.	Electrical Conductivity	Heavy metals, Toxic Inorganic Substances and Radioactive Material

The physicochemical water quality metrics may be positively or negatively impacted by land use practices. Through irrigation or runoff, farming practices, livestock dung, and land removal can release nutrients, organic matter, silt, heavy metals, and viruses. Rapid urbanization and population growth have increased the strain on water environments and ecosystems.[73] Springs water quality fluctuates across time and space due to regional or seasonal fluctuations in climate conditions (temperature and precipitation). Extreme weather conditions like droughts and floods also have an impact on the quantity of materials that reach springs and the discharge or dilution capacity of streams. Pollutant transmission to surface water may be influenced by catchment characteristics and transport mechanisms. These pollutants may be introduced to aquatic bodies by runoff, which is specifically influenced by the topography and rainfall intensity.[74] As detection technology has advanced, recent investigations have discovered the presence of emerging pollutants (EPs) in the water environment. Plasticizers, surfactants, fire retardants, nanomaterials, pesticides, and pharmaceuticals and personal care products (PPCPs) are the main categories into which EPs fall. For example, when treated waste water effluents were released into springs, levels of steroid hormones, personal care items, and medications were found. Springs water also contained some emerging and persistent organic pollutants, including perfluoroalkyl and polyfluoroalkyl substances (PFASs), organochlorine pesticides (OCPs), polycyclic aromatic hydrocarbons (PAHs), and polychlorinated biphenyls (PCBs). The primary source of these pollutants was the wastewater and waste discharged from industrial and agricultural operations in springs. Among the EP classes known as endocrine-disrupting chemicals (EDCs) are bisphenol A, PCBs, pesticides, pharmaceuticals, phthalates, polybrominated compounds, alkylphenol ethoxylates, and alkylphenols. EDCs have the ability to influence the endocrine systems of living things, either promoting or suppressing the synthesis and metabolism of hormones. Unfortunately, due to a lack of published health standards and infrastructure for detecting and treating emerging pollutants (EPs), spring water monitoring programs mostly concentrate on traditional contaminants.[75,76] A high percentage of impermeable areas, fast population expansion, production activities in industrial zones, and high-density residential areas are some of the features of urban regions. Low residential density, a large proportion of forest land or vegetation cover, and the predominance of agricultural activity are characteristics of rural areas. These elements can affect spring water in either a favorable or bad way. Statistical techniques like factor analysis (FA), principal component analysis (PCA), cluster analysis (CA), and correlation analysis (Pearson or Spearman) have been used recently to evaluate and understand water quality datasets and pinpoint the causes or contributing factors of pollution. PCA/FA can be used to identify the most significant parameters in principal components, which aid in the identification of possible pollution sources, whilst CA can classify the monitoring sites according to the differences or similarities of parameters. Artificial neural networks (ANN), support vector machines (SVM), decision trees (DT), naive Bayes, k-nearest neighbor (KNN), random forests (RF), and extreme gradient boosting (XGBoost) are a few examples of machine learning algorithms that have been used recently to analyze complex water quality datasets and extract information from potential patterns. The most important criteria and the primary sources of pollution in the case studies have been identified through the use of machine learning. There isn't any research, nevertheless, on the general examination of the main elements influencing spring water quality and the variations in pollution sources or other elements between urban and rural springs. To determine if water is suitable for irrigation, the groundwater quality based on sodium percentage, sodium absorption ratio, and residual sodium carbonate will be helpful. Every physico-chemical parameter used in the water quality check has been examined, including its definitions, the impact of plants and humans on the land and water, and its measurement techniques. In addition to producing an unpleasant taste and decreasing the soap's capacity to create lather, hardness levels of 150–300 mg/l and above can lead to kidney issues and kidney stones. Hard water should not be used in a home. Aquatic biota is being depleted and water quality is deteriorating due to rapid industrialization and the use of chemical pesticides and fertilizers in agriculture. Humans suffer from water-borne illnesses as a result of drinking tainted water. Rapid industrialization and the careless application of chemical pesticides and fertilizers in agriculture are polluting the aquatic environment in a variety of ways, which impairs water quality and reduces aquatic biota. Humans suffer from water-borne illnesses as a result of drinking tainted water. Therefore, it is essential to periodically verify the quality of the water. Water quality can also be inferred from an analysis of aquatic macro invertebrates. In the current paper, the ecological parameters of water quality are described for both humans and other living organisms. It is concerning because heavy metals like lead, mercury, chromium, and others are persistently toxic.[77] Guidelines and reports on several parameters are also provided for the parameter study. The quality of spring water varies due to a variety of natural processes, including evapotranspiration, atmospheric deposition, climate change, natural disasters, and rock degradation. When it comes to determining whether water is suitable for drinking, bathing, cooking, cleaning, and agriculture, among other uses, the pH is a crucial factor. The pH level of water having desirable limit is 6.5 to 8.5 as specified by the BIS. Pure water is said to be neutral, with a pH of 7. Water with a pH below 7.0 is considered acidic while water with pH greater than 7.0 is considered as basic or alkaline. The turbidity of water was 28 to 42 NTU which is higher as per the APHA limit. According to BIS and ICMR the desirable limit of TDS is 500 mg/l. If TDS value is more than 500 mg/l, it may cause gastro intestinal irritation. High TDS presence in the water decreases the quality and affects the taste of water (Guru Prasad, 2005). The limit of total hardness value for drinking water is to be within 300 mg/l of $CaCO_3$. The higher hardness content observed could be the result of surface runoff, water entering via direct human pollution, or the natural buildup of salt.[78] According to Yogendra and Puttaiah (2008), one of the most crucial parameters for evaluating the quality of water is chloride, and a higher concentration of chloride denotes a higher level of organic contamination. The BIS and ICMR state that 250 mg/l of chloride is the maximum amount that can be present in drinking water. The observed high concentration of chloride could be the result of natural processes, like water flowing through naturally occurring salt formations in the ground, or it could be a sign of pollution from household or industrial sources (Renn, 1970). The ICMR and BIS state that 600 µm/cm is the ideal conductivity limit. Solutions of most inorganic acids, bases, and salts are relatively good conductors. In contrast, the conductivity of distilled water is less than 1 µmhos/cm. The standard desirable limit of alkalinity of potable water is 120 mg/l. The maximum Permissible level is 600 mg/l. Excessive alkalinity may cause eye irritation in human and chlorosis in plants (Sisodia and Moundiotiya, 2006). It is measured by titration with standardized acid to a pH value of 4.5 and is expressed commonly as milligrams per liter as calcium carbonate. TDS in groundwater can also be due to natural sources such as sewage, urban runoff and industrial waste (Joseph, 2001).[79,80,81]

2. Result and Discussion

The Kishtwar district of Jammu and Kashmir is renowned for its verdant landscapes, rich cultural legacy, and an abundance of natural water resources that are essential to the region's ecology, agriculture, and residents' well-being. The Kishtwar Valley's water supplies are essential to its environmental sustainability and have both ecological and spiritual value. The Kishtwar Valley's water quality varies greatly by region due to a variety of geological formations, human activity, and seasonal variations. Fresh and drinkable water is indicated by electrical conductivity (EC) values below 750 µS/cm in the majority of groundwater samples. The majority of groundwater has an alkaline pH between 6.15 and 9.04. Chloride concentrations typically fall between 5.4 and 216.8 mg/L, which is considerably under the 1000 mg/L limit set by the Bureau of Indian Standards (BIS). The fluoride contents in the majority of samples fall within the permissible range of 1.0 mg/L. Higher quantities, however, are present in some parts of the Kishtwar district, which could be harmful to one's health. Taste and soap effectiveness may be impacted by the large percentage of samples that fall into the "hard" group (200–600 mg/L). The Godresh spring a primary water source in Kishtwar, exhibits seasonal and spatial variations in water qualities shown in table **3**.

Table 3: Water Quality Index (WQI) of Godresh Springs of Kishtwar valley

Key Parameters of Godresh spring	
pH	7.4–7.9 (neutral to slightly alkaline)
Electrical Conductivity (EC):	33.6–184.6 µS/cm
Total Dissolved Solids (TDS):	22.1–137.6 mg/L
Dissolved Oxygen (DO):	7.46–11.6 mg/L
Bicarbonates (HCO_3^-):	10.8–39.8 mg/L
Fluoride (F^-):	0–0.46 mg/L
Chloride (Cl^-):	0.24–9.33 mg/L
Nitrates (NO_3^-):	0–7.07 mg/L
Sulphate (SO_4^{2-}):	0.69–8.86 mg/L
Nickel (Ni):	Up to 88 µg/L (exceeds drinking water standards)
Turbidity:	Up to 61.4 NTU (exceeds desirable limits)

Numerous researches on the water quality in Kishtwar, Jammu and Kashmir, have concentrated on the Sirshi Spring, Kiyar Spring, Pochhal Spring, and Bhandarkoot Spring, major body of water in the area. Because of worries about pollution, particularly in metropolitan areas like Kishtwar, the Godresh spring and Vimal spring has been the focus of numerous water quality studies. The water system of Kishtwar depends heavily on these springs to meet both agricultural and domestic demands. Water quality of such springs varies from some moderate to high pollution levels. Other springs which flow near urban settlements have shown moderately high pollution levels, with Water Quality Index (WQI) scores ranging from 85 to 90. Elevated pollution levels were primarily attributed to urban runoff, domestic sewage, and agricultural activities.

Table 4: Water Quality Index (WQI) of various sources of Kishtwar valley

S. No.	Parameters	Concentration (mg/L) of springs viz. Vimal, Pooti, Gumai, Petar and Abhshar	WHO (mg/ L)
1.	TSS	3.9–139, 129–392	50
2.	DO	7.2–8.1; 4.7–10.38; 7.57–8.85; 4.59–5.98; 3.95–6.24; 2.10–4.02; 5.21–7.27	4–6
3.	BOD	5 2.0–9.0; ~0.76 – 7; 2.3–27.1; 0.9–172.0	4
4.	Total N	0.95–8.47; 1.48–3.87; 1.45–2.76	-
5.	Total P	0.01–0.3; 0.0184–0.0855; 0.1–0.38; 0.042–1.781; 0.03–0.12	-
6.	COD	~3–18; 8.83–32.08; 5.75–17.5; 13.5–31.8; 7.50–54.0	10
7.	Fe	0.0069–1.87; 0.038–0.076	0.3
8.	As	0.00022–0.00238; 0.0016–0.0030; 0.0008–0.046; 0.000616–0.00459	0.01
9.	Cr	0–0.00978; 0.010–0.020; 0.0054–0.012; 0.005–0.175; 0.000297–0.00103	0.05
10.	Cu	0.0008–0.00487; 0.03–0.07; 0.005–0.0323; 0.005–0.05; 8 0.00128–0.0825	2.0
11.	Hg	0.11×10^{-3}- 0.18×10^{-3}	0.006
12.	Pb	0.07×10^{-3}-0.24×10^{-3}; 0.021-0.075; 0.039×10^{-3}-0.52×10^{-3}	0.01
13.	Coliform (MPN/ 100ml)	0.014–920; 2.13×10^4–6.38×10^4	0
14.	E.Coli CFU/100ml	5×10^3–2.5×10^4	0

The investigation showed notable differences in these anions' concentrations, especially in the stream's urban and suburban areas, demonstrating how human activity affects the quality of the water. The decline in water quality is ascribed to contaminants from agricultural practices, household waste (including organic waste and raw sewage), and soluble salts (from erosion and runoff). The WQI's seasonal results show that water sources are more impacted in the summer than in the winter. This may be the result of low temperatures decreasing microbial activity, which maintains the dissolved oxygen (DO) level at a highly acceptable range throughout the winter. It was evident from the results of the water quality evaluation that the majority of the water quality measures were marginally higher during the wet season than during the dry season. Traditional springs provide the drinking water for Kishtwar. According to a study that evaluated seven of these springs, the physicochemical parameters largely satisfied drinking water standards, with the majority of the water types being Ca^{2+} and HCO_3^-. It's better to visit Kishtwar 's springs in the warmer months. While microbiological contamination is common and requires treatment prior to consumption, several springs in Kishtwar town satisfy chemical requirements for drinking water. Scientific investigations have been carried out to evaluate the physicochemical and microbiological properties of Kishtwar's springs in order to determine their potability and guarantee their safety for human use. Total and thermo tolerant coliforms were detected in the majority of springs, suggesting fecal contamination. The different physico-chemical parameters of various springs of Kishtwar valley have been shown in table **5**.

Table 5: Range of different physical and chemical parameters of water quality of various springs of Kishtwar

S.No.	Parameters	Unit	Concentration (mg/L) of springs viz. Danhoie, Hapath Saram, Shudi, Shifa, Sath and Safed.
1.	pH	-	6.5-8.5
2.	Total Dissolved Solids	mg/L	500
3.	Conductivity	µS/cm	250 - 1000
4.	Total Hardness (as $CaCO_3$)	mg/L	150
5.	Aluminum (Al)	mg/L	0.2
6.	Arsenic (As)	mg/L	0.01
7.	Barium	mg/L	0.3 - 0.7
8.	Cadmium (Cd)	mg/L	0.003 – 0.005
9.	Chloride (Cl)	mg/L	250
10.	Chromium (Cr^{6+})	mg/L	0.05
11.	Copper (Cu^{2+})	mg/L	1 - 2
12.	Cyanide (CN^-)	mg/L	0.01 – 0.07
13.	Fluoride (F^-)	mg/L	1.5
14.	Hydrogen Sulphide (H_2S)	mg/L	0.05
15.	Iron (Fe2+)	mg/L	0.2 – 0.3
16.	Lead (Pb)	mg/L	0.01
17.	Magnesium (Mg2+)	mg/L	0.20
18.	Manganese (Mn2+)	mg/L	0.05 – 0.5
19.	Mercury (Hg)	mg/L	0.001
20.	Nickel (Ni)	mg/L	0.02
21.	Nitrate (NO3)	mg/L	50
22.	Nitrite (NO2)	mg/L	0.2 – 0.5
23.	Sodium (Na+)	mg/L	200
24.	Sulphate (SO4)	mg/L	100 – 500
25.	Zinc (Zn)	mg/L	3
26.	Total Coliform count	cfu/ mL	10
27.	Thermo tolerant Coliform or E.coli	cfu/100mL	0
28.	Faecal streptococcus	cfu/100mL	0
29.	Clostridium perfringens spore	cfu/100mL	0

Challenges Facing Water Resources: Uncontrolled trash disposal, including human waste, has deteriorated holy springs and streams like the Shudi spring and Abhshar spring turning them into contaminated waterways and putting aquatic life in jeopardy. The lack of efficient facilities for waste segregation and treatment has made water pollution worse, endangering the health of the local populace. The capacity of landfills is almost at maximum, and untreated trash is piling up in the open and poisoning adjacent water supplies. To reduce pollution around Kishtwar's water bodies, the Jammu and Kashmir government has issued prohibitory orders. The urgency of the matter has also been highlighted by the District Magistrate of Kishtwar's examination of the waterbody contamination situation. By building individual septic tanks and following stringent waste disposal procedures, the people of the tribal areas have made a great effort to keep their water bodies clean. Under the Jal Jeevan Mission, training sessions have been held to support best practices in rural water resource management with the goal of equipping local communities with the skills and information they need to use water sustainably.

Conservation and Management Initiatives: The Godresh Spring, Gumai Spring, Vimal Spring, Danhoie springs have been negatively impacted by uncontrolled trash dumping, including human waste, which has contaminated them and put aquatic life in jeopardy. In order to solve pollution issues and guarantee the long-term health of these essential water sources, conservation measures are ongoing. Several actions have been taken by local authorities in response to these environmental issues. A thorough action plan that includes community sanitary complexes, compost pits, soakage pits, decentralized wastewater treatment systems, and plastic waste management units has been created. The health of nearby water bodies is being preserved and restored through initiatives to improve waste collection and apply sustainable waste management techniques. For residents, Community Role is an essential source of water and is valued for its health advantages.

3. Conclusion

This article aims to investigate a number of physico-chemical elements that can be utilized to assess the water's quality and identify the presence of the contaminating agent in that specific water source. Water quality in Kishtwar Valley exhibits significant spatial and temporal variations. Urban areas suffer from organic and industrial pollution, while rural areas face nutrient enrichment and erosion-related turbidity. Seasonal changes further exacerbate these issues, particularly during summer. Effective management requires wastewater treatment in urban centers, sustainable agricultural practices in rural areas, and continuous monitoring across seasons. To provide a safe supply of drinking water, it is advised that susceptible springs be routinely inspected and restored.

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