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Assessment Of Water Quality Parameters "Special Reference To Microplastic Pollution In Kaveri River Basin, Mysuru, Karnataka

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Abstract

A major threat associated with it has emerged, specifically the rising use of plastic and microplastics that seriously jeopardize water and aquatic environments. Rising concerns with respect to its daily consumption are that such substances adversely impact the quality of water. Water samples were collected systematically from 14 locations along the Kaveri River, starting from Talakaveri to Kushalnagara, Chunchanakatte, Belur, Goruru, Konanuru, Hole Narasipura, Chikkayarahalli, Ganjam, Tirumakudalu Narasipura, Kollegala, Manuganahalli, Kattahalli, and Chamarajanagara. The samples were analysed for key physicochemical parameters, such as total hardness, sulphate, chloride, alkalinity, conductivity, turbidity, total dissolved solids (TDS), pH, chemical oxygen demand (COD), and fluoride levels. The study found large plastic accumulation and pollution at particular hotspots, mainly near the waste disposal sites, which are primary contributors to plastic contamination in the river. This study calls for an immediate need for effective waste management strategies and policy interventions to abate the ever-increasing risk of plastic pollution in freshwater ecosystems.

Keywords- *Microplastic, Water parameters, river, pollution, health, hazard*

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1. INTRODUCTION

Plastics are large-scale semi-synthetic and synthetic materials mostly composed of long extendable chain polymers or resins. It is easy to Mold and shape them into a variety of shapes because of their excellent malleability. Despite the advantages of plastics, like their low weight, stability, and affordability, their growing use has led to a global environmental disaster, with 322 billion tons generated annually in 2016. [1]. By 2015, it's expected that 6300 million metric tons of plastic waste would have accumulated [2]. Polystyrene was first produced in large quantities in 1950; synthetic polymers were first developed in the seventeenth century. The European Community currently has a list of about 30,000 plastic waste products. Plastics are useful for various consumer applications due to their stability, durability, affordability, and lightweight. There are over forty-five distinct types of plastic resin, but only a handful of them—polyethylene (PE), polypropene (PP), polyester (PET), polyvinyl chloride (PVC), and polyurethane (PU)—have any real commercial significance [4].

Microplastics are divided into primary and secondary categories based on where they come from. In addition to being directly created, primary microplastics are also found in several cosmetic and personal care items. Secondary microplastics are also created when massive amounts of plastic trash erode under high pressure in environments like sunlight, soil, wind, and water [16]. Microplastic can be found in household items, industrial raw materials, fishing nets, and other worthless plastic waste. It is believed that most microplastics in aquatic environments are secondary ones. Polyethylene (PE), Polypropylene (PP), Polyvinyl chloride (PVC), and Polyethylene terephthalate (PET) are some of the types of Microplastics. Microplastics have been identified in a range of freshwater and marine environments, such as marshes, streams, ponds, lakes, and rivers, across Europe, North America, Asia, Australia, and South America. Using samples from six US states, researchers discovered microplastic pieces in 29 large lakes. These microplastics range in size from 0.355 to 4.75 nm [19]. Freshwater systems exhibit varying microplastic concentrations contingent on human activities, environmental conditions, sampling sites, and sample methodologies. Wastewater treatment facilities continue to be a major source of microplastics even though they may be able to remove a sizable portion of these particles [20]. Microplastics might include harmful bacteria. Microplastic pieces have been found in soil [21], The most common types of microplastics found in potable water are fragments and fibres; there have only been nine studies on the subject.[22] [13]. The presence of microplastics in drinking water poses a risk to human health and serves as a hazard when exposed. The three forms in which microplastics were linked to potential hazards are as follows: plastic particles themselves are a physical hazard; chemicals [24] (preservatives, unbound monomers, and so on are present in nature); and microorganisms can attach to and colonize on small plastic pieces, or MPs, which are known as biofilms [25] [31]. Numerous freshwater animals and invertebrates, such as tadpoles, freshwater mussels, Daphnia magna, water fleas, and various other invertebrate species, have been found to contain microplastics [32].

Microplastic pollution has been on the rise across the world as a result of industrial effluent, river pollution, urban runoff, and inadequate waste management. China has the highest total accumulation, standing at 180,000 tonnes in 2024, primarily resulting from tourism litter and river discharge by significant water bodies such as the Yangtze and Chao Phraya rivers. India, Indonesia, and the Philippines are also highly polluted, with urban runoff, coastal mismanagement, and microfibers being the primary contaminants. This has resulted in ecosystem degradation, coral reef destruction, water pollution, loss of biodiversity, and enhanced flooding threats. The growing role of rivers and tourism waste emphasizes the necessity for improved waste management, increased regulations, and sustainable alternatives to prevent long-term environmental degradation.

Table1: Comparison of plastic pollution year's data (Markus et al., (2024))

Year	**Country**	**Amount of microplastic accumulated (Tonnes)**	**Source**	**Effects**
2015	China	150,000	Industrial discharge, Yangtze River	Ecosystem damage
2016	India	120,000	Gangas river, urban runoff	Contaminated water supplies
2017	India	110,000	Coastal mismanagement, Ciliwung River coral reef damage,	Coral reef damage
2018	Indonesia	120,000	Pasig river	Urban waste impact on mangroves, tourism
2019	Philippines	110,000	Microfibres, tire wear	Pollution in freshwater system
2020	China	170,000	Mekong river	Waste discharge decline in populations
2021	India	140,000	Amazon river, Urban runoff	Urban runoff, loss of biodiversity sediment
2022	Indonesia	130,000	Lagos Harbor, improper waste management	Flooding, Marine
2023	Philippines	115,000	Klang river	Increased microplastic in coastal biodiversity

2024	China	180,000	Chao Phraya River, tourism waste	Tourism waste

Microplastics directly or indirectly become a part of our environment as well as the human body, due to their nondegradable nature it's causing many problems in our lives, they enter into the food chain along with contaminated water and they are consumed by human beings as well as aquatic animals further, those aquatic animals will be consumed by human beings and other wild animals, by that it will enter into the food chain. A schematic representation of how microplastic enters the food chain is shown below.

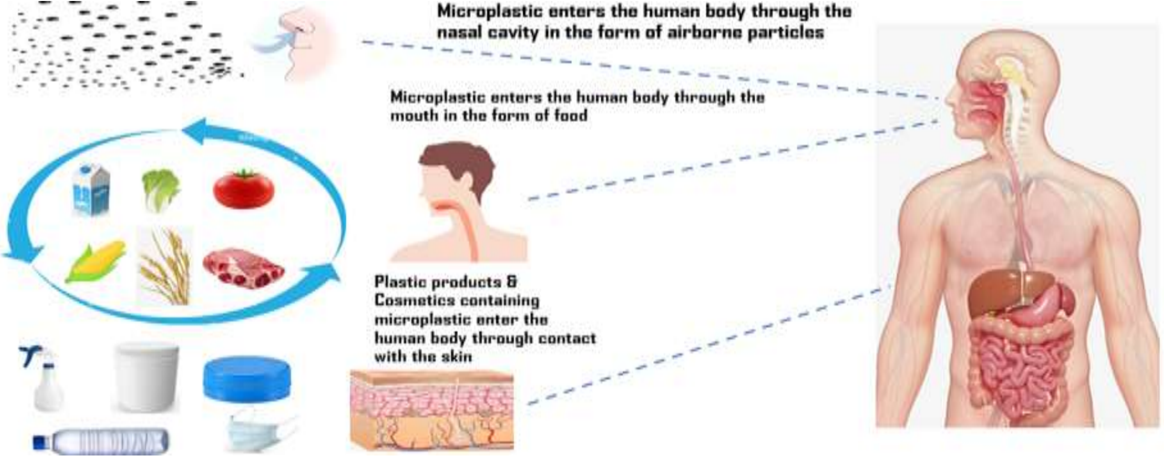
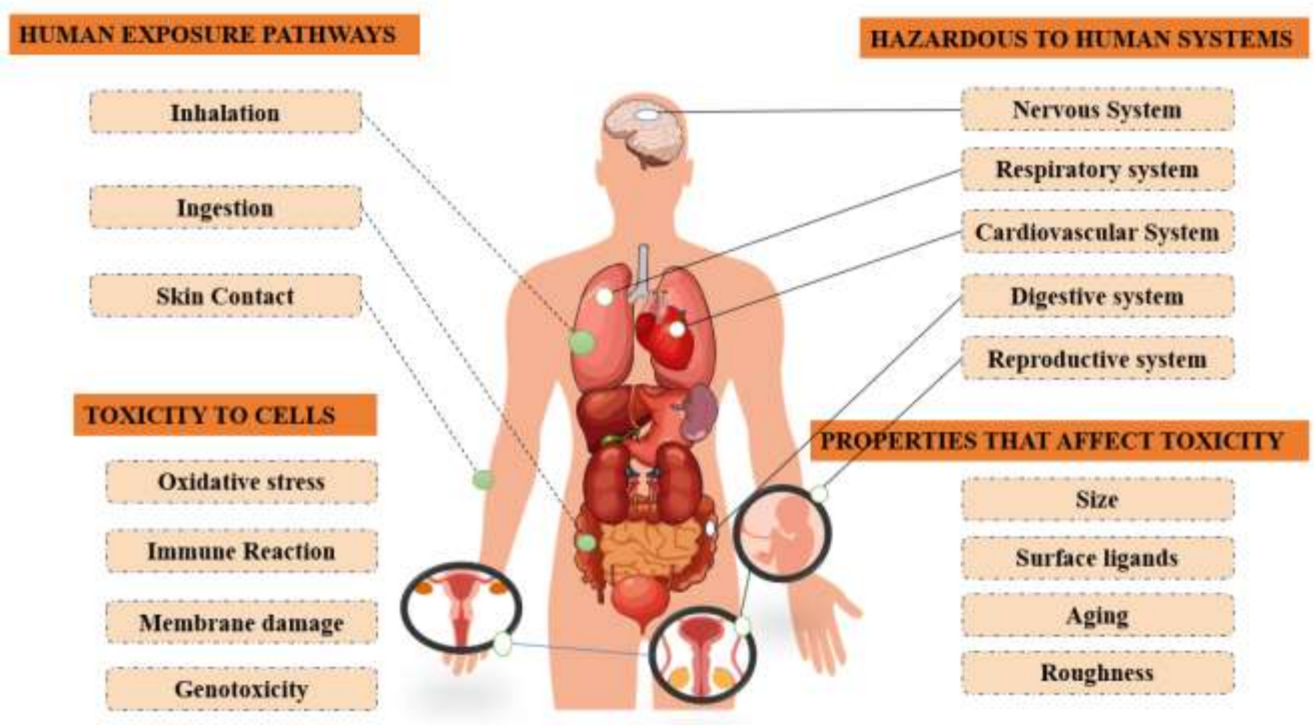


Figure 1: Illustration depicting the process of microplastics entering the food chain

Health Impacts of Microplastic:

Microplastics are a serious threat to human health through various pathways of exposure, such as respiration, ingestion, and dermal contact. Once within the body, the particles can initiate oxidative stress, which causes cellular toxicity. Microplastics induce immune responses, membrane disruption, and genotoxicity, which can interfere with normal cell function. Their unsafe effects also involve crucial systems including the nervous, cardiovascular, gastrointestinal, and reproductive systems, of which inhalation is particularly the risk for lung health. Factors contributing to the toxicity of microplastics involve size, ligands on surfaces, aging, and roughness, which can impact their cell membrane penetration efficiency and potential damages. Knowing about these risks informs efforts towards useful ways of lessening human exposures and their concomitant effects on health.[5]



2. MATERIALS AND METHODS

2.1. **Chemicals required:** Wet Peroxide Oxidation Reagents: 30% Hydrogen Peroxide (H_2O_2) in the presence of 0.05 M Iron solution and Sulfuric Acid (H_2SO_4)

Standard Chemical Reagents: Sodium Chloride (NaCl), Ethylenediaminetetraacetic Acid (EDTA), Ammonia Solution (NH_3), Eriochrome Black T (EBT) Indicator, Barium Chloride ($BaCl_2$), Hydrochloric Acid (HCl), Glycerol Water Quality Analysis Reagents: Potassium Chloride (KCl), SPADNS Reagent, Zirconyl Acid, Methyl Orange Indicator, Phenolphthalein Indicator, Sulfuric Acid (H_2SO_4), Ferric Chloride ($FeCl_3$), Ferrous Ammonium Sulphate (FAS)Precipitation and Titration Reagents: Potassium Chromate (K_2CrO_4), Silver Nitrate ($AgNO_3$), Manganese Sulphate ($MnSO_4$), Mercury Sulphate ($HgSO_4$)

2.2. **Water sample collection:** Water samples were collected from 14 different sites along the Kaveri River to assess variations in physicochemical parameters and microplastic contamination. The sampling sites covered the river's origin at Talakaveri and downstream regions to ensure full spatial coverage. Standard water sampling techniques were used in combination to ensure the integrity and representativeness of the collected samples. Samples were collected in pre-cleaned glass bottles to avoid plastic contamination. To minimize external contamination, a piece of cotton fabric was used in the filter through which plastic waste was passed separately to ensure not to add the plastic particles with the environment; cross-contamination was avoided properly, and cleaning of sampling gear with deionized water occurred before and after each collection. Collected samples were transported to the laboratory in ice-cooled containers and subjected to processing immediately to maintain their chemical and physical properties. Analytical procedures for determining microplastic concentration involved systematic filtration, oxidation, and microscopic examination under controlled conditions. The water sample collected and filtered by what-man filter paper to find the total solid plastic masses in the water sample i.e. The water samples filtered are analyzed through the Wet Peroxide Oxidation (WPO) method to find the organic substances which can be digestible. WPO needs a solution of H2 So4 Fe2+ catalyst along with 30% hydrogen peroxide. Waste plastic in its original form was also taken into consideration for the analysis. To separate the plastic debris, NaCl was added to the WPO solution after density separation. This technique is good for distinguishing frequent microplastics such as polyethylene, polypropylene, polyvinyl chloride, and polystyrene in water. In terms of size, these microplastics range from 5 to 0.3 mm. Their resistance to WPO can identify Microplastics, the ability to float in 5M NaCl, and their ability to be seen under a 40X.

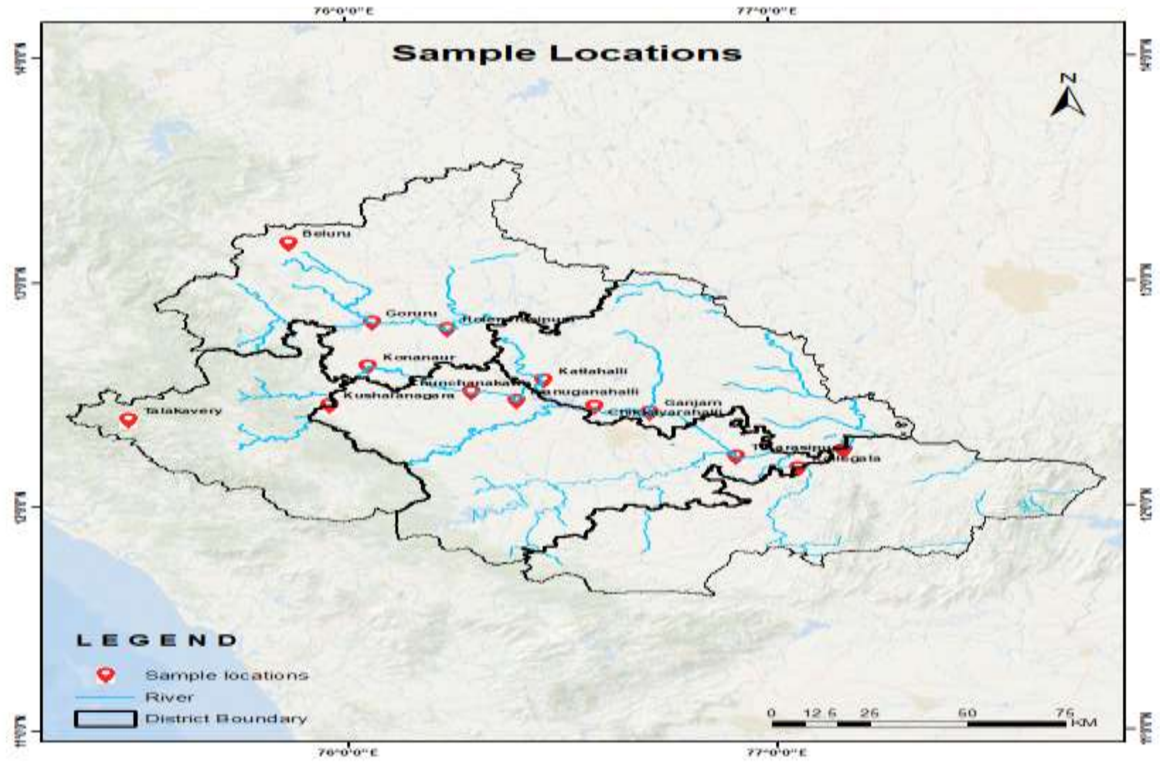


Table 2: Sampling Locations

No.	Sample Location	Latitude	Longitude
S1	Talakaveri	12.385346°	75.49124°
S2	Kushal Nagar	12.451912°	75.961117°
S3	Chunchanakatte	12.507311°	76.289084°
S4	Beluru	13.16922°	75.872077°
S5	Goruru	12.817165°	76.06097°
S6	Konanuru	12.621445°	76.051179°
S7	Hole Narsipura	12.787077°	76.239172°
S8	Chikkayarahalli	12.435057°	76.58077°
S9	Ganjam	12.419362°	76.7104487°
S10	Tirumakudalu Narsipura	12.215467°	76.909494°
S11	Kollegala	12.16745°	77.062444°
S12	Manuganahalli	12.46924°	76.397379°
S13	Kattahalli	12.557582°	76.457074°
S14	Chamarajanagara	12.254125°	77.163597°

3. RESULTS

Water Parameters: Parameters like Sulphate, Chloride, Conductivity, Turbidity, pH meter, Total Dissolved Solids (TDS), Fluoride, Chemical Oxygen Demand, Alkalinity, and Total Hardness have been performed and results and graphs are plotted.

Table 3. Determination of Mass of Total Solids Using Analytical Balance

Sl. No	Water sample	Total solid mass (c) in gm (b – a = c)
1.	S1	0.03
2.	S2	0.03
3.	S3	0.02
4.	S4	0.03
5.	S5	0.01
6.	S6	0.03
7.	S7	0.03
8.	S8	0.02
9.	S9	0.03
10.	S10	0.03
11.	S11	0.02
12.	S12	0.03
13.	S13	0.02
14.	S14	0.02

Alkalinity, turbidity, conductivity, hardness, total dissolved solids, pH, chloride, fluoride, sulphate, and chemical oxygen demand were among the metrics analysed and assessed on water samples sampled from fourteen distinct locations, in this graph the highly affected and polluted areas are also plotted, some samples exceeded the WHO standards, whereas some didn't even meet the standards, Hence the below graph shows the parameters and its results

Total Hardness

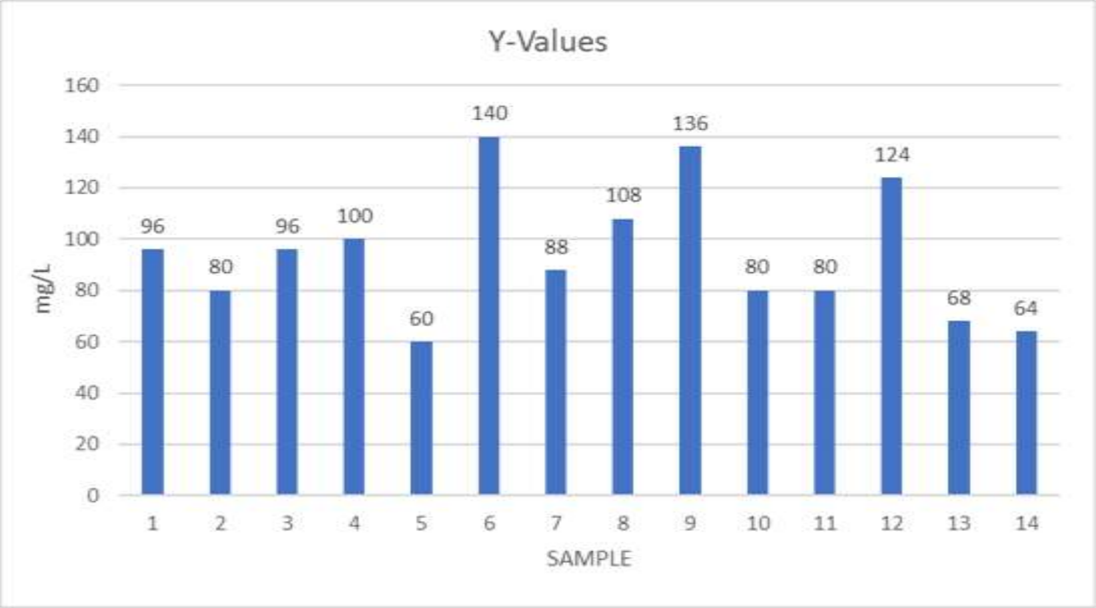
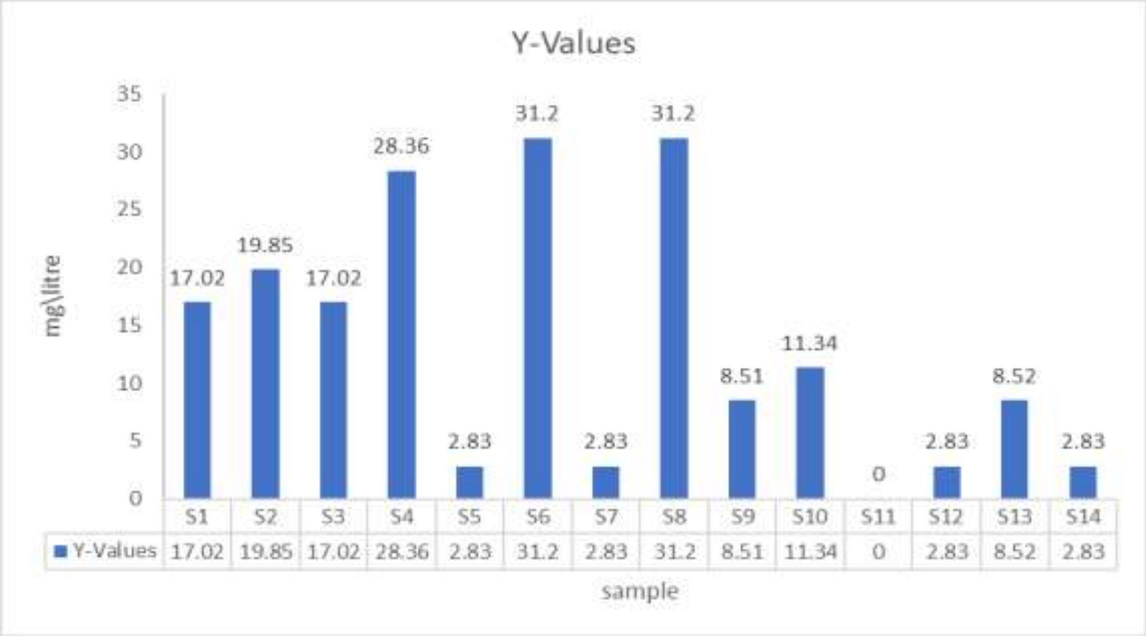


Figure 1: Total Hardness values from S1 to S14

The total hardness values vary greatly among the sampling sites, with the highest values recorded at Sample 6 (140 mg/L) and Sample 9 (136 mg/L), indicating increased mineral content in these areas. These peaks may be because of industrial discharge, agricultural runoff, or natural geological formations that contribute to calcium and magnesium deposits. In contrast, Sample 5 had the lowest hardness level of 60 mg/L, meaning there was relatively lower concentration of dissolved minerals possibly because of lesser anthropogenic influence or lower rates of rock dissolution in that region.

Sulphate



	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11	S12	S13	S14
■ Y-Values	17.02	19.85	17.02	28.36	2.83	31.2	2.83	31.2	8.51	11.34	0	2.83	8.52	2.83

Figure 2: Sulphate values from S1 to S14

Concentrations of sulphate show appreciable variations in the sampling locations. The maximum values are reported in Sample 6 (31.2 mg/L) and Sample 8(31.2 mg/L) with values greater than 30 mg/L, and the lowest concentrations are reported in Sample 11 (0) and Sample 7 (2.83 mg/L). Increased sulphate levels at some points may be due to industrial wastes, sewage inflow, or agricultural fertilizers, whereas lower concentrations in later sampling points might be due to dilution effects or reduced anthropogenic influence in those areas.

Chloride

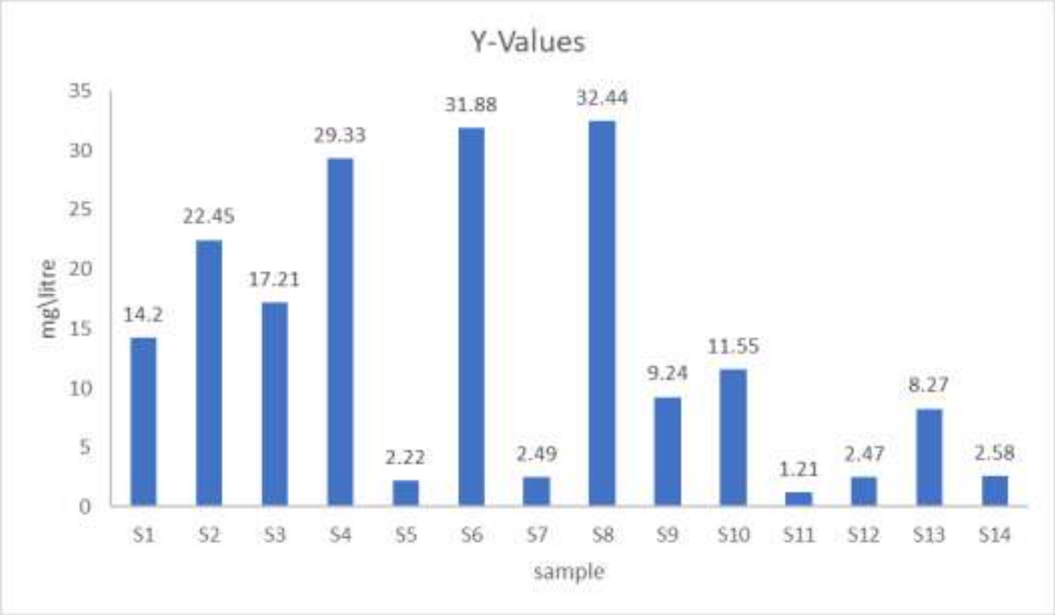


Figure 3: Chloride values from S1 to S14

Concentrations of chloride were also in agreement with sulphate concentrations, showing high peaks at Sample 6 (31.88 mg/L) and Sample 8 (32.44 mg/L), possibly over 30 mg/L, which could be an indicator of contamination by domestic sewage, agricultural runoff, or saline water intrusion. The lowest chloride concentrations occur at Samples 11 (11.21 mg/L), 5 (2.22 mg/L), 7 (2.49 mg/L) and 14 (2.58 mg/L) indicating lower urban or industrial influence and stronger dilution impacts as the river flow continues.

Alkalinity

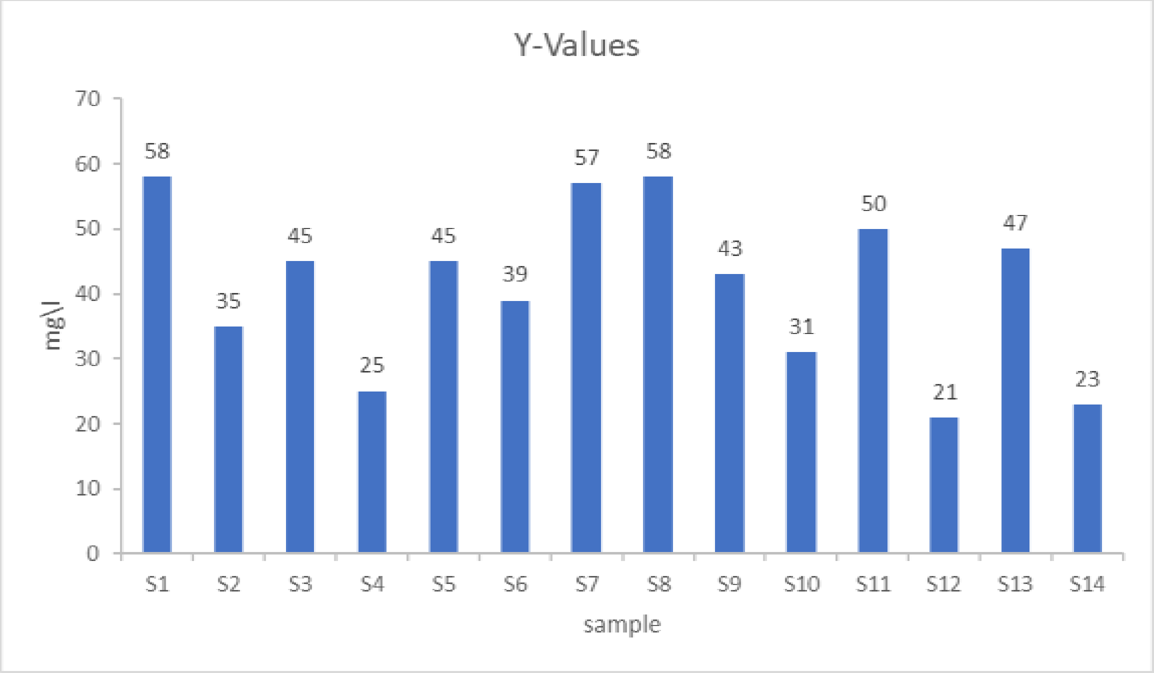


Figure 4: Alkalinity values from S1 to S14

Alkalinity levels fluctuate across the sampling locations, with the highest values recorded at Sample 1 (58 mg/L), Sample 7 (57 mg/L) and Sample 8 (~50-60 mg/L). These peaks might be a result of increased carbonate and bicarbonate ions from industrial activities or agricultural sources. The lowest alkalinity levels are seen in Sample 12 (21 mg/L) and Sample 14 (23 mg/L), indicating a potential reduction in carbonate-rich effluents or dilution effects in the downstream areas.

Conductivity (µS/cm)

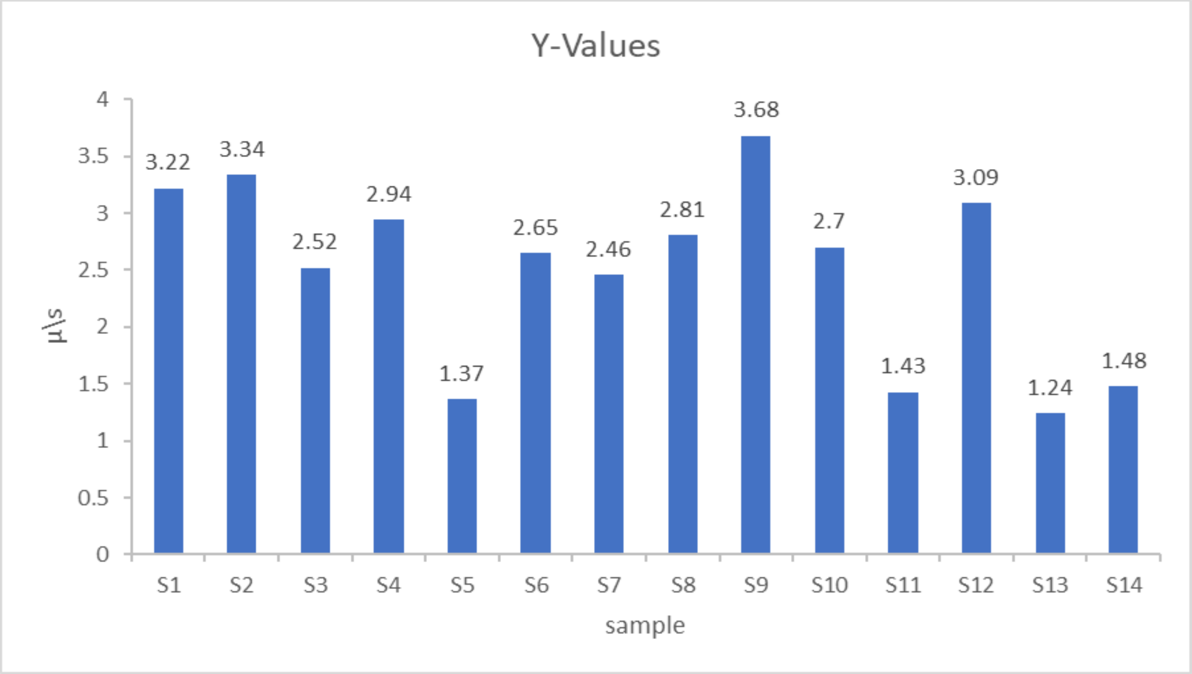


Figure 5: Conductivity values from S1 to S14

There is a strong consistency in conductivity values for most of the sampling sites, suggesting that the river water still contains some level of ionic composition. The highest conductivity values were obtained in Sample 9 and Sample 12, possibly due to increased dissolved salts and pollutants with industrial and agricultural runoff. At the two lowest values, Sample 5 and Sample 13, less contamination could be suggested, alongside significant dilution by tributary inflows.

Turbidity

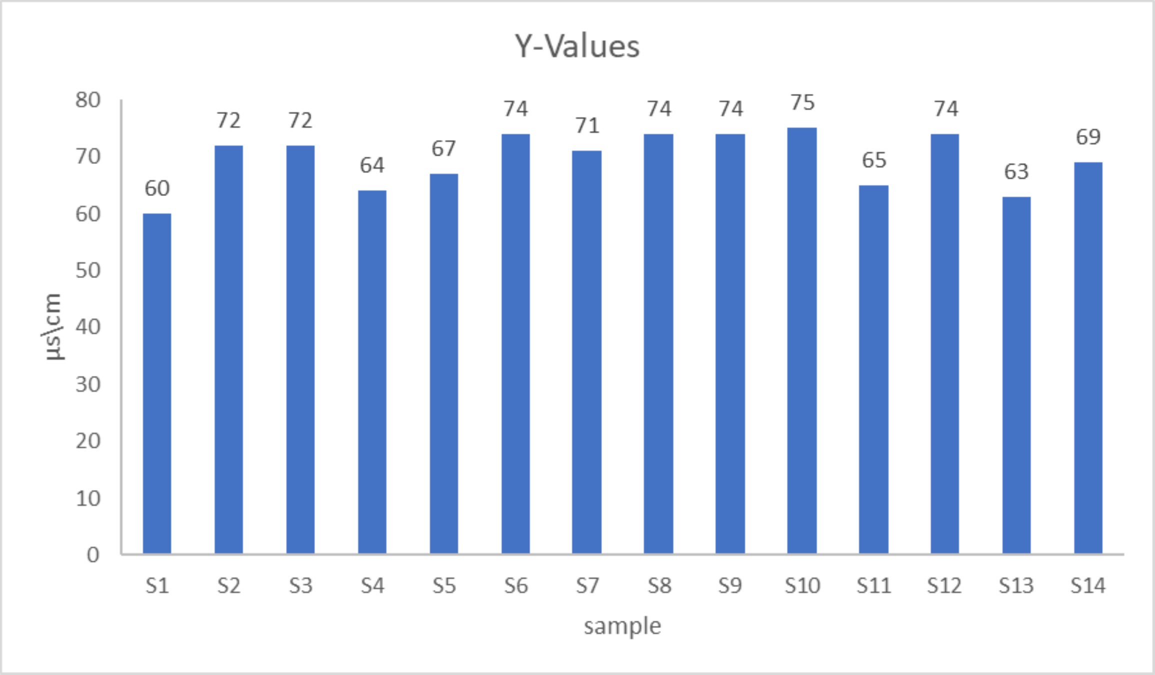


Figure 6: Turbidity values from S1 to S14

The bar chart depicts turbidity levels (in µS/cm) in 14 samples, which can be associated with microplastic water pollution. Increased turbidity readings in S2, S3, S6, S8, S9, S10, and S12 (>70 µS/cm) indicate a greater number of suspended particles, which could be due to microplastics, organic matter, or industrial contaminants. Decreased turbidity in S1, S4, S5, S11, and S13 (<65 µS/cm) might indicate fewer particles or improved water quality. Because microplastics are a cause of water turbidity, such differences may indicate differences in the sources of pollution, plastic degradation, or urban runoff. More analysis is required to validate the microplastic composition of these samples.

Total Dissolved Solids [TDS]

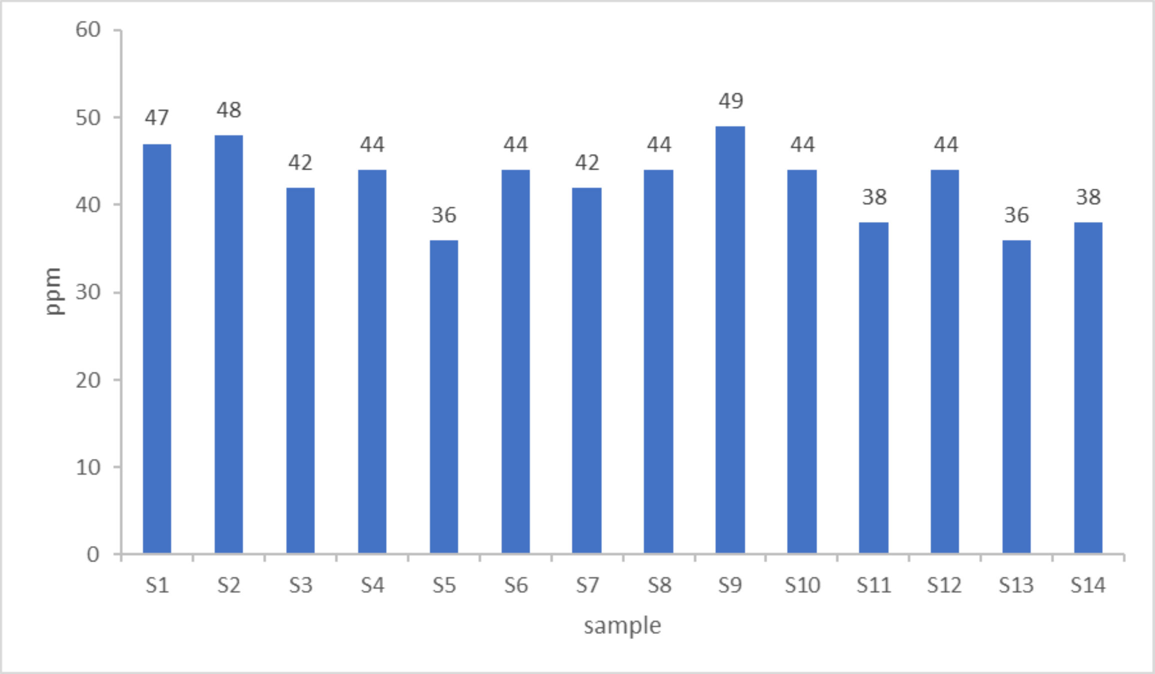


Figure 7: Total Dissolved Solids values from S1 to S14

TDS values vary moderately by the sampling sites. Sample 9 (49ppm) concentration reached a maximum value of ~50 ppm, showing increased dissolved salts and minerals, which may be contributed by urban drainages, industrial effluent inputs, or agricultural surface runoffs. The lowest TDS values are recorded at Samples 5, 13, and 14 (~30 ppm). It may be attributed to dilution effects by natural processes or fewer contamination sources in the downstream locations. Elevated TDS levels can impact aquatic ecosystems as it changes the balance of osmosis and decreases the quality of water for consumption and industrial usage.

pH

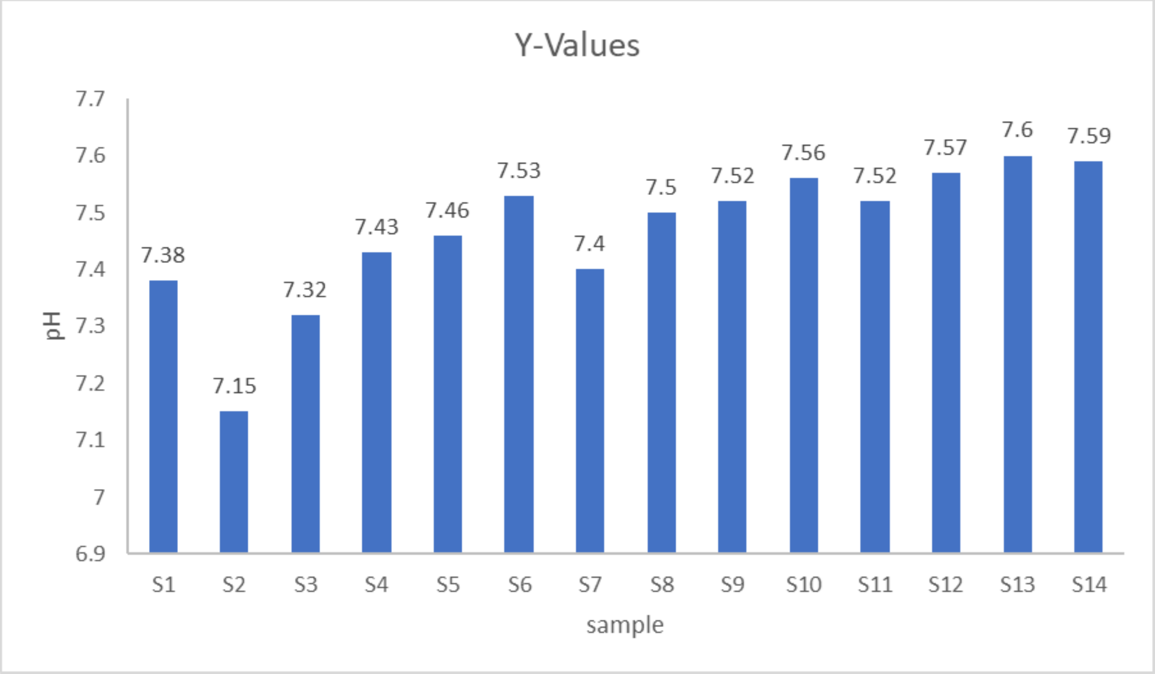


Figure 8: pH values from S1 to S14

The pH values show a gradual increasing trend across the sampling sites from approximately 7.15 in Sample 2 to 7.32 in Sample 3. The lower initial pH values suggest slightly more acidic conditions, possibly due to higher organic matter content or industrial discharge in the upstream areas. The pH values for Samples 12, 13, and 14 are relatively high, suggesting alkaline conditions, which might be due to lower contamination levels, natural buffering by carbonate-rich sediments, or lower degradation of organic matter. This minor increase in slight alkalinity might increase the rate of self-purification processes of water but might also alter the solubility of nutrients and metals in the ecosystem.

Chemical Oxygen Demand

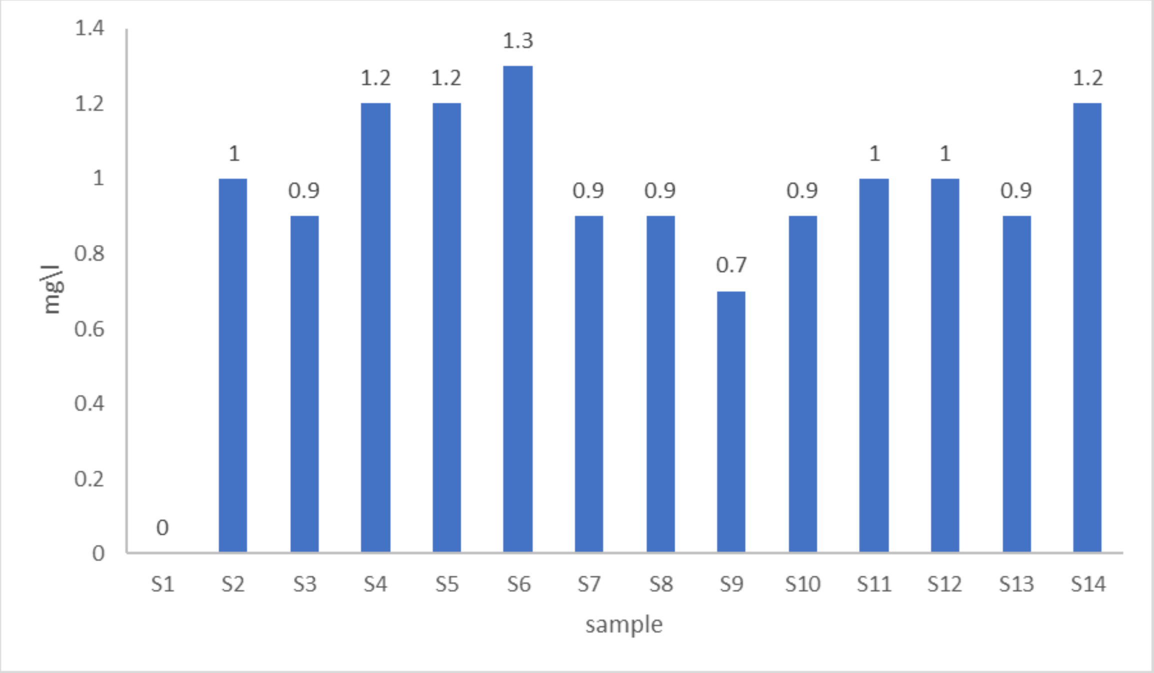


Figure 9: Chemical Oxygen Demand values from S1 to S14

The COD concentration varies significantly through the sampling point, which seems to indicate shifts in organic contaminant levels in the water streams. The two highest COD peaks were ~1.3 to 1.4 mg/L at Sample 5 and Sample 7, with increased contamination suspected from sewage discharges, industry waste, and agricultural runoff water. Lowered COD values show a reduced load of organic, such as for Sample 10 (~0.8 mg/L) and Sample 11. High COD levels signify greater oxygen demand for microbial degradation of pollutants, which can lead to oxygen depletion and affect aquatic life.

Fluoride

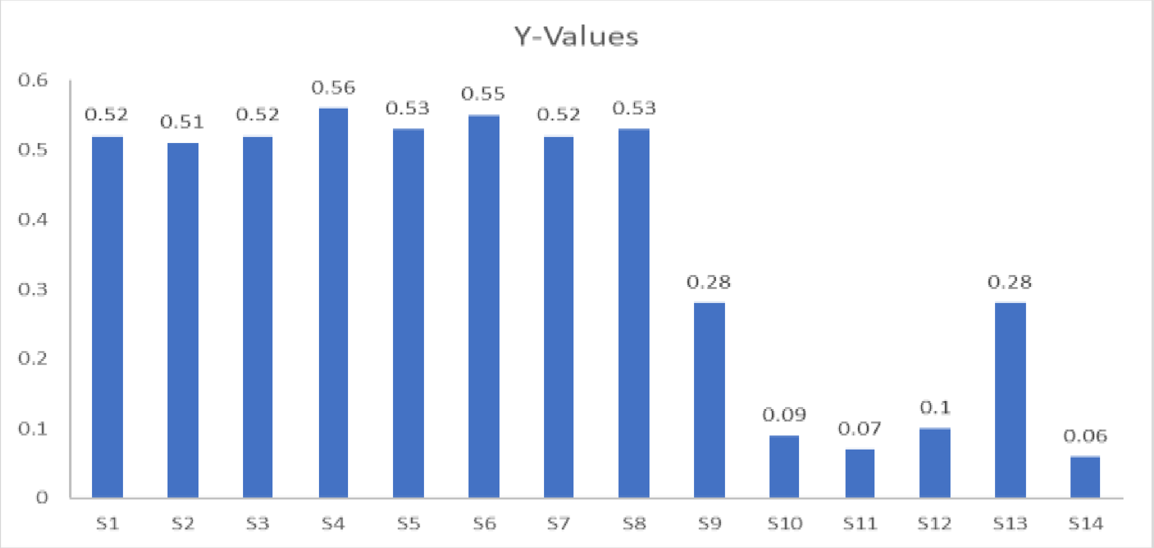


Figure 10: fluoride values from S1 to S14

Fluoride levels are significantly reduced in the later sampling sites. The highest values (~0.55-0.6 mg/L) are observed at Samples 1-8, suggesting potential contamination from industrial discharge, geological sources, or wastewater effluents. However, there is a sharp drop in fluoride concentrations at Samples 10-14 (~0.1 mg/L or lower), which may indicate dilution effects, reduced contamination sources, or natural absorption by sediments. Fluoride is essential in small quantities but can become toxic at higher concentrations, leading to health risks such as fluorosis and bone disorders.

Table4: Results of water quality parameters

parameter	pH	EC	TH	TDS	SO_4^{2-}	Cl^-	COD	F-	HCO_3^-	T
Unit		μs/cm	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	μs/cm
S1	7.38	3.22	96	47	0.10	17.2	0	0.52	47	60
S2	7.15	3.34	80	48	0.08	17.0	1	0.51	58	72
S3	7.32	2.52	96	42	0.15	19.8	0.9	0.52	35	72
S4	7.43	2.94	100	44	0.13	17.2	1.2	0.56	45	64
S5	7.46	1.37	60	36	0.03	28.3	1.2	0.53	25	67
S6	7.53	2.65	140	44	0.04	2.83	1.3	0.55	45	74
S7	7.40	2.46	88	42	0.07	31.2	0.9	0.52	39	71
S8	7.50	2.81	108	44	0.09	2.83	0.9	0.52	57	74
S9	7.52	3.68	136	49	0.03	31.2	0.7	0.53	58	74
S10	7.56	2.70	80	44	0.05	8.51	0.9	0.28	43	75
S11	7.52	1.43	80	38	0.01	11.3	1	0.09	31	65
S12	7.57	3.09	124	44	0.04	0	1	0.07	50	74
S13	7.60	1.24	68	36	0.03	7.28	0.9	0.10	21	63
S14	7.59	1.48	64	38	0.00	2.83	1.2	0.06	23	69

Microscope examination

Samples have been observed under the Microscope:

 S1	 S2	 S3	 S4
			
			

DISCUSSION

Water quality has to be tested in order to identify its usefulness for different applications like industrial, agricultural, and drinking purposes. Important physical characteristics like temperature, pH, turbidity, and colour are vital primary indicators of water quality. Among them, pH plays an important role in water's applicability in terms of different industries [37] Microplastic pollution has become a serious environmental issue, with these tiny plastic particles now found ubiquitously in soils, water bodies, and even within living organisms. Scarily, recent research has established the occurrence of microplastics within the human body, highlighting probable ecological and health risks [39]. These contaminants are mainly sourced from the breakdown of plastic refuse, industrial discharges, and urban runoff, threatening both ecosystems and human health significantly [38]. In the Mysuru region, despite stringent regulations mandating the disposal of plastic waste in designated areas, plastic pollution remains a persistent issue [40]. The Kaveri River, a vital water source for the area, has been significantly impacted by the accumulation of plastic waste. Notably, large quantities of plastic have been directly discarded into the river near Belur, Kollegala, and Hole Narsipura, exacerbating pollution levels [41]. The detection of microplastics in the Kaveri River raises concerns about contamination of drinking water resources, aquatic biodiversity, and the overall health of the ecosystem [42]. Studies from the Indian Institute of Science highlight that microplastic pollution in the Cauvery River may cause growth defects in fish, including skeletal deformities [42].

However, Mysuru has demonstrated commendable efforts in plastic waste management and recycling. The city is renowned for its innovative recycling initiatives, such as converting non-recyclable plastic waste into interlocking tiles for footpaths, contributing to sustainable urban infrastructure [43]. Additionally, local organizations have partnered with companies to promote the upcycling of plastic waste into useful products, thereby addressing plastic pollution effectively [40]. Community-driven campaigns have also played a pivotal role in combating plastic pollution. Educational institutions and environmental groups actively engage residents in understanding the long-term impacts of single-use plastics, advocating for sustainable alternatives, and encouraging proper waste disposal practices [44]. For instance, student-led initiatives have focused on creating eco-bricks and promoting urban greenery to raise awareness about environmental conservation [44]. To reduce microplastic pollution in Mysuru, it is necessary to impose waste management measures strictly, reinforce public awareness, and invest in plastic waste recycling and filtration systems technology [45]. Through embracement of environmentally friendly practices, Mysuru can successfully restrict microplastic pollution and conserve its precious water resources, mainly the Kaveri River, from further decline. Failure to implement these precautions may result in long-term ecological and health difficulties arising from untamed microplastic pollution [39].

CONCLUSION

This study offers a critical review of the sources, destiny, and impacts of microplastics (MPs) and related pollutants in freshwater ecosystems, highlighting the need for standardized detection and quantification protocols. As it stands, the absence of a common approach leads to great differences in reported results, preventing a clear perception of microplastic pollution. To overcome this, sophisticated sample separation, identification, and quantification methods must be established to provide reliable MP pollution assessments. Monitoring the level of microplastics in river water regularly is necessary to protect freshwater habitats and preserve the quality of the water resource for future generations. The Kaveri River, being an important water body that collects runoff from Mysuru, serves as a conveyor of contaminants from urban activities and poor waste disposal. This rising microplastic pollution is a significant threat to aquatic life, human health, and the stability of the ecosystem. Thus, it calls for a multi-pronged approach to counter this problem through efficient disposal methods of waste, tighter pollution control policies, and mass public awareness programs. By adopting sustainable waste management and promoting community involvement, Mysuru can play an active part in preventing microplastic pollution. Increasing regulations, improving recycling activities, and stimulating research into new filtration and remediation methods are steps in the right direction toward maintaining the Kaveri River and other water bodies' health. Taking steps now to address this emerging issue will provide clean sources of water, healthier ecosystems, and a future that is sustainable for generations to come.

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