INVESTIGATION OF PHYSIOCHEMICAL PARAMETERS AND ITS POLLUTION IMPLICATIONS IN THENPENNAI RIVER, CUDDALORE, TAMIL NADU.

ABSTRACT:

Water, which nearly makes up the entire Globe, is the most basic natural resource and is necessary for life. Therefore, its quality and distribution play an important role. Riverine system pollution has been a major problem as it has an impact on the aquatic organisms in the rivers and the lives that depends on them. Thenpennai River, is one among them where the soil and water of the river has been polluted due to disposal of waste. The present study aims to analyze the physiochemical parameters of soil and water due to dumping of waste. The study also evaluates the amount of Biodegradable and Non-Biodegradable wastes. Results obtained from the samples of Thenpennai River shows elevated variations than the standard values. The significance t-test was performed. Based on statistical evidence, non-biodegradable waste has been seen as a main cause of pollution that creates a threat to the ecosystem and may have a major impact on human health. It has also been determined that the contamination in soil and water sample is due to organic and inorganic wastes, which results from inappropriate disposal of waste materials. Therefore, the sample site of Thenpennai River is unsuitable for human consumption and for cultivation of fish. Steps should be taken against these activities so that the quality of water can be improved for a better future.

Keywords: Physiochemical, Biodegradable, Non-biodegradable, Thenpennai.

INTRODUCTION:

The most fundamental natural resource and essential component of life is water, which almost covers a huge portion of the planet. Among this, the lakes and rivers represent 0.036 percent of the planet's total water supply [1]. Although water is a necessary natural resource for life, its distribution and quality are less significant than quantity. Pollution of the riverine systems has been a great concern, which affects the lives in the rivers and the lives that depend on the rivers. The lack of adequate surface water quality protection measures and poor sanitation practices have made river body pollution a serious concern. This pollution can move up the food chain and impact lower and higher organisms, potentially resulting in Bioaccumulation [2]. In most cases, precipitation from surface runoff and other sources such as springs, groundwater recharge, and the release of water that has been stored in natural ice and snow packs from glaciers comes into rivers through a drainage basin [3]. The primary causes of pollution in river water are runoff from land-based activities like agriculture and the discharge of industrial and domestic effluents, which include chemicals, heavy metals, and organic pollutants. Rivers frequently lack enough water to dilute industrial effluents and home sewage, thus worsening the issue of water pollution [4]. Even though some pollution comes from natural sources, human activity is mostly to blame for most pollution [5]. Poor disposal of waste can enrich soils with potentially hazardous components. However certain amounts of toxic elements are transferred from the polluted soils to water systems through surface runoff and infiltration processes, which lowers the quality of the water resources. Hossain [6] aimed to determine the loads of both organic and inorganic pollutants in the Surma River, in which water comes from a particular industrial effluent. River pollution disrupts the delicate food web and poses a health risk to humans by first altering the physical and chemical properties of the river and then gradually destroying the community. Increased pollution significantly hinders the varied applications of waterways [7]. Given such circumstances, the deteriorating condition of the water eventually has an impact on human health, either directly or indirectly. Humans usually come into contact with contaminants (or pollutants) through ingestion, skin contact, or the food web. Pollutants cause malfunctioning of cells and organs [8,9]. Studies have shown that improper waste management makes water systems more vulnerable to pollution risks [10].

The sole purpose of the current study is to determine the water quality of the river for the suitability of drinking and fish production purposes. The water quality of the river is defined by physical, chemical and biological characteristics such as color, odor, pH, total dissolved solids in the soil sample collected near the river and also pH, Total suspended solids (TSS), Chemical Oxygen Demand (COD), Biological Oxygen Demand (BOD), Total dissolved solids (TDS), Total Hardness (TH), Calcium (Cl), Magnesium (Mg), Total iron (Fe) and Sulphate (SO_4). In addition, the study evaluates the amount of trash dumped near the river, by calculating the mean and significance value of biodegradable and non-biodegradable waste present, which includes household waste and other effluents. An attempt has been made to study and predict the environmental pollution status along the river.

MATERIALS AND METHODS

Study Area

The water sample were collected from the Thenpennai River located in Cuddalore District, Tamil Nadu, India (Figure 1). The river supports the drinking water system and also irrigates a large area of agricultural fields. It is surrounded by large number of small-scale industries, where the waste from the industries and surrounding localities is directly discarded into the river.

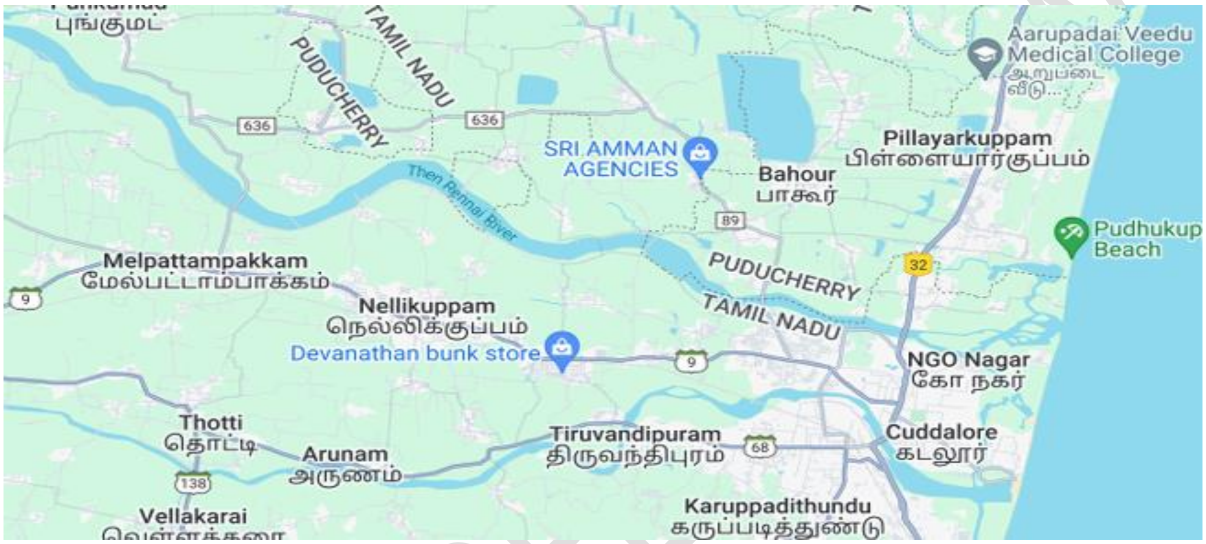

Figure 1: Layout of Thenpennai River

Sampling process and Analysis

The water and soil sample were collected each month on the sampling point (Figure 2). The study was carried out between the period of November 2023 - January 2024. The subsurface water sample was collected near the shore side which is denoted as site 1 of the river where animal and industrial pollution is high (Figure 2) and flowing water was collected from site 2 which was 200 feet away from site 1 using spot sampling procedure. The soil samples were collected from the shore side of the sampling location. Standard procedures were followed for the collection, preservation, and transportation of the water samples to the laboratory by APH regulations [11].

Figure 2: Thenpennai river where water and soil sample were collected.

All Samples were collected in a clean labelled sterile glass bottles of 1 liter's capacity each. The collected samples were stored in refrigerator at 4°C. Physical and initial analysis of the samples such as pH, color, odour was measured onsite using analytical instruments. Whereas the analysis of remaining water and soil parameters was done by following standard analytical technique [11].

In order to determine the amount of pollution near the sampling site, every week we observed, gathered and monitored various types of garbage which were dumped and domestic waste that was discarded within 1000 square feet of the sampling location of the lake area between November 2023 - January 2024. Based on the nature of their degradability, we divided the waste into biodegradable and non-biodegradable waste.

Statistical analysis

The parameters in the water sample and soil samples with their standards were indicated as mean and Standard Deviation. Further, the data were tested for statistical significance by student t-test and $P < 0.05$ was considered.

RESULTS

The collected water and soil samples from the Thenpennai River in the months of November, December and January were analyzed, compared with the permissible limits according to the limits as per IS: 10500 -2012 by calculating their means and Standard deviation for change the values during the study period.

Water Sample

The water samples collected from sampling sites 1&2 were highly polluted which led to appearance of black colour along with foul smell in all months of the study. The foul odour strikes the nostril even at 800 meters from the sampling site.

pH is closely associated with other aspects of water quality, and has a considerable effect on aquatic life. The pH of the river shows a mean of 7.0 and 8.0. According to WHO the pH of normal drinking water lies between 6.5-8.5 [12]. The standard deviation was calculated as 0.128582 at site 1 which indicates a variation in pH during the period of study. There was not much variation in site 2 during the study period.

Elevated amount of turbidity was observed in both site 1&2. Ideally, the value of turbidity should be below 1 NTU (Nephelometric Turbidity Units) [13]. There was a major variation in site 1 between the period of time, the SD 1 shows high variation in the sample of site 1. The mean of site 1 and 2 were 8 NTU and 3 NTU which were not considered for human consumption and also for aquatic life.

There was significance difference in TSS and TDS when compared to desirable limits in site 1. The TSS of water sample from site 2 was within the permissible limits. We calculated a mean value of 22.3 at site 1 which was not a desirable value. There was no much variation in TSS during the study period in both sites. High values of TDS were observed in site 2 and very higher values of TDS was seen in site 1. Both sites had values above the permissible limits. There was no much variation in site 2 but there was a huge variation in site 1 during the study period with SD of 333.9.

Worldwide, Chemical Oxygen Demand and Biological Oxygen Demand (BOD and COD) are utilized in water quality parameters for the assessment of organic pollutant in water environments, as well as for wastewater system design, monitoring, and modeling [14,15]. The BOD and COD of site 2 were found to be within the limits. According to WHO the permissible limits for BOD and COD should be below 6mg/ml and 10 ppm for drinking water [12]. The mean values of BOD and COD in site 2 was below the permissible limits. There was no drastic variation observed during the study period in site 2, the SD were 0.4. Elevated values were observed in site 1 for both the parameters which were not within the permissible limits. Very high values were found in site 1 for COD and SD was calculated as 3. The mean value of BOD was 6.3 for site 1 and SD with 0.4, not much variation was found.

Total hardness of a water sample is measured by the amount of bicarbonate, chloride and dissolved sulphate in water sample [16]. Total hardness of both the sites were very high. The mean of site 1 & 2 was 1416 and 866. Calcium content in site 2 was within the permissible limits with a mean of 96.6 and with not much variation. The calcium in site 1 was not acceptable as they were high with mean of 175 and no much variation in values during the study period. Permissible limit for Magnesium in a water sample is 100 mg/l, but here the result shows that the mean value of site 1 (210 mg/l) exceeds the normal range. Total Iron content of both site 1&2 seems to be higher than the acceptable limit. Chloride ion in a water sample should be within a range of 250 – 1000 mg/l. The result shows that both site 1&2 has high amounts of chloride ions. Sulphate present in the water samples from site 1&2 are within the normal range. The values of each parameter are listed below (Table 1).

Soil Sample

Soil samples collected from the sampling location were tested using IS 2720 and EPA method. Soil color, odour, pH and TDS of the soil samples were analyzed. The color of the soil is black and the odour is rotten egg. The optimum range of pH for a fertile soil is between 5.5 to 7. The mean pH value of the soil sample was 8.15 which is higher than the standard value. The TDS (Total Dissolved Solids) value was of the given the soil sample was recorded as 4715 mg/l which indicates higher concentration of inorganic salts and small amounts of organic matter [38].

S. NO	PARAMETER	NOVEMBER2023		DECEMBER 2023		JANUARY 2024	
		SITE 1	SITE 2	SITE 1	SITE 2	SITE 1	SITE2

1.	**pH**	8	7	8.5	6.96	8	7.2
2.	**Turbidity (NTU)**	8.0	3	9.1	3.4	7	3
3.	**Total suspended solids (mg/l)**	22	17	23	17	22	17
4.	**Total dissolved solids (mg/l)**	1946	574	1310	580	1422	576
5.	**Biological oxygen demand (mg/l)**	6	0.9	6.8	1	6.1	1
7.	**Chemical oxygen demand (mg/l)**	58	5	64	5.3	63	5.2
8.	**Total Hardness (mg/l)**	1450	860	1500	850	1300	890
9.	**Calcium (mg/l)**	175	95	175.4	98	175	96
10.	**Magnesium (mg/l)**	210	80	210.7	82	210	80.4
11.	**Total Iron (mg/l)**	1.53	0.6	1.55	0.63	1.5	0.6
12.	**Chloride (mg/l)**	3615.9	1986	3615.6	1986.5	3615.9	1986
13.	**Sulphate (mg/l)**	340	250	342	254	341	251

TABLE 1: ***Physiochemical parameters of Thenpennai River for site 1 & 2 between November 2023 to December 2024.***

Bio degradable and Non-biodegradable wastes

The waste which was observed were calculated and their means and standard deviations are presented in table 2 and 3. By comparison, the non-biodegradable waste was significantly higher than the biodegradable waste. By t- test the P value of biodegradable waste was P = 0.078 which accepts the null hypothesis and for non-biodegradable waste the P value was P= 0.036. The P value is lower than the significant value for non-biodegradable waste which rejects the null hypothesis and accepts the opposite hypothesis.

NON-BIODEGRADABLE WASTE	MEAN	STANDARD DEVIATION
Plastic Water Bottles	174.7	33.45
Disposable Polythene Bags	230	67.53
Disposable Plastic Covers	293	48.41
Plastic Boxes	158.9	58.15
Wax Coated Cups	44.3	19.33
Tin Containers	13	8.87
Baby Diapers and Napkins	9	5.04
Plastic Toys	0.7	1.05
Iron Containers	4.8	4.62
Rubber Materials	2.6	1.38
Metal Containers	2.6	2.27
Glass Containers	23.9	12.28
Electronic Gadgets	3.0	3.7

TABLE 2: ***Mean and standard deviation of Non-Non-biodegradable wastes.***

BIO DEGRADABLE WASTE	MEAN	STANDARD DEVIATION
Paper Wastes	201.75	58.96
Cardboards	16.4	11.48
Human And Animal Wastes	42	1.69
Remains of The Dead	1.5	1.51
Clothes	7.4	7.69
Wood Wastes	39	3.16

TABLE 3: ***Mean and standard deviation of biodegradable wastes.***

DISCUSSION:

The results of our study on the water and soil sample of Thenpennai river at cuddalore, Tamil Nadu based on physiochemical parameters affected by domestic waste shows that how organic and inorganic waste from household and industries impacts the quality of river. It shows that the foul odour strikes the nostril even at 800 meters from the sampling site which may be due to the accumulation of numerous amounts of organic and inorganic waste leads to possible presence of harmful bacteria which causes dark colour change in the soil and water. Microbial decomposition of organic and inorganic matter in the water body results in increase of pH value [17]. Elevated amount of turbidity is observed in the test sample which lead to growth of harmful pathogens [18]. The results showed turbidity above 2 NTU which proves there is high risk of increase in chlorine which reduces the efficiency of chlorination. This shows that the river is contaminated and is dangerous for human consumption, agriculture, and aquatic life. This is due to improper disposal of sewage, surface runoff and wastewater [19]. Worldwide, Chemical Oxygen Demand and Biological Oxygen Demand (BOD and COD) are utilized in water quality parameters for the assessment of organic pollutant in water environments, as well as for wastewater system design, monitoring, and modeling [14,15]. The high value of BOD was caused due to human activities such as domestic waste disposal in the river. This could lead to increases the levels of dissolved organic matter, which may lead to reduction of Dissolved oxygen and also water degradation [20], the increased amount of organic matter in river water further bring rise to production of aerobic bacteria in the water. These microbes require oxygen to oxidize organic materials, synthesis cells, and oxidize cells, which raises the Biological Oxygen Demand (BOD) value. As results of this, aquatic and other organism die due to insufficient amount of oxygen which is required to support biological activities such as oxygen absorption and other chemical processes in the river [21]. Higher COD/BOD ratios could be a sign of more anthropogenic organic pollutants and other non-biodegradable organic pollutants invading rivers and lakes. Additionally, the variations in COD and BOD represent the concentrations of inorganic pollutants in water, which are associated with a subset of organic materials that degrade biologically and those which are non-biodegradable [22]. The Total Dissolved Solids (TDS) value of the river water exceeds than the maximum permissible limit for drinking water and irrigation purpose. The higher elevation of TDS results high degree of eutrophication [23]. TDS is often not regarded as an essential pollutant; rather, it is utilized as an aggregate indicator of the presence of an array of chemical pollutants as well as an indicator of the aesthetic qualities of drinking water. Total Suspended Solids (TSS) of water is directly related to the turbidity of water. Since the rainfalls dilution occurs in the river which decreases the TSS value [24]. There is significance difference in TSS and TDS. The untreated discharge of municipal and domestic waste in water bodies increases the amount of organic content. Therefore, the microbes present in water require more amount of oxygen for its degradation. The discharge water in turn reduces the oxygen content of the final water bodies and hence adversely affects aquatic fauna [25]. The increase in hardness is an indicative of domestic or organic pollution which is discharged in the river [26,27]. Hard waters possess the ability to reduce the effects of heavy metals like iron and zinc, which can be hazardous to fish [28]. The elevated amount of Total hardness to due to the high presence of magnesium and calcium which are observed. The results show that a reasonable number of calcium-bound ions were released from the domestic waste which were disposed in the river. High values of magnesium may lead to increase in alkalinity which may affect the irrigation [29]. The presence of chloride iron has elevated values. Excessive presence of chloride may inhibit the development of plants, delayed reproduction and act as a adversary to aquatic life. it as contributes to corrosion of metals. High amount of chloride leads to salinity of river water [30]. The mean value of iron was more than the permissible limits which may increase the growth of iron bacteria in river water [31]. Consumption of water that contains iron more than the permissible limits have a adheres effect to human health, which may cause polycythemia [32]. The mean value of sulphate shows higher concentrations in the sample which is not suitable for agricultural purpose and also for drinking water. Sulphate compounds can be produced by wastewater discharges as well as the breakdown of organic molecules and debris in the soil [33]. It provides osmotic stress to aquatic organism and also causes specific ion toxicity in aquatic system [34]. The pH of the given soil sample is higher than the standard value which states that the soil is infertile for agricultural purpose. The statistical evidence from the waste disposed in the river shows that non-biodegradable waste has influenced most on the water and soil quality. The landfills will have a long-term ecological effect on the flora and fauna and also throughout the marine ecosystem [35]. Different processing and disposal methods could harm air, water, and land pollution. Untreated or improper disposal of garbage can seriously affect the health of the populations living near the disposal zone. Emissions of PTEs (Polyethylene Terephthalates) and

POPs (Persistent Organic Pollutants) from waste leaks can pollute air and contaminate soils and water streams, creating a long-term threat to health [36]. Environmental pollution caused by trash disposal has been linked to long-term health problems. In addition to causing environmental degradation, the gases released from waste are linked to a range of cancer-related problems [37].

CONCLUSION:

The goal of the study was to examine the amount of waste disposal and the quality of water and soil for drinking and aquatic purpose in Thenpennai river. The river water is not suitable for fish production since physiochemical parameters were not within the desirable limits. The foul odor of the water can be due to the presence of Hydrogen sulphide gas (H_2S) which is produced by certain sulfur bacteria. The non-biodegradable waste was the major source of pollution which leads to ecological threat and can cause serious health effects like cancer, nervous system damage, hormone disruption and fertility issues to the human population. Water bodies can become contaminated by chemicals from non-biodegradable waste, disturbing the delicate balance of aquatic ecosystems. Aquatic species are susceptible to long-term health difficulties and even population losses due to the accumulation of heavy metals and persistent organic contaminants in their tissues. Plastics containing endocrine disrupting chemicals are especially being concerned because they can interfere with the reproductive, immunological, and nervous systems of the organisms. The physiochemical parameter states that the quality of water is very poor and it can cause serious problems in near future if not controlled properly.

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