An Experimental Analysis of Water Quality in Thirumanimutharu River Stretch and Treatment of Wastewater using Phytoremediation Process

S. Monika[1], K. Soundhirarajan[2], D. Roopa[3], P. Siva Kumar[4]

[1]P.G student, Dept. of Civil Engineering, Gnanamani College of Engineering, Namakkal, Tamilnadu, India
[2]Assistant Professor, Dept. of Civil Engineering, Gnanamani College of Technology, Namakkal, Tamilnadu, India
[3]Assistant Professor, Dept. of Civil Engineering, Gnanamani College of Engineering, Namakkal, Tamilnadu, India
[4]Assistant Professor, Dept. of Civil Engineering, Master of Simulation Technology,Thuraiyur, Tamilnadu, India,

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Abstract - *This project is to experimentally analyze and the polluted water in the Thirumanimutharu River and its effects on ground water quality. Since it was highly polluted due to effluents from the industries around the river bed. The samples collected from the Thirumanimutharu River and the ground waters is analyzed. The values analyzed is evaluated in detail and compared with TNPCB standards and WHO standards of water quality to know the quality of the water and major pollutants found. The major source of pollutants are from the industries, municipal and domestic waste water from the nearby areas. As The suitable treatment process to avoid the pollution in thirumanimutharu river, phytoremediation process using microalgae have been chosen to treat the waste water to improve the water quality of thirumanimutharu river and the ground waters and the possibilities of usage of river water for drinking, irrigational and other purpose can be improved.*

Key Words: *water quality, phytoremediation process, microalgae, Waste water treatment, Thirumanimutharu ….*

1. INTRODUCTION

1.1 Water Quality

Water is an invaluable resource and benefits to mankind from proper management of this resource as well as the disastrous consequences of its mismanagement are very well known. Study of the water quality has remained an important pre occupation with the environmentalist both from the practical and the academic viewpoints. The concept of quality, however, raises a number of questions which are often controversial because of wide differences in technological and individual perceptions. The economic and the aesthetic considerations describing water quality also come to blows, technologically, water quality can be catalogued in terms of appropriate physical, chemical and bacteriological parameters. Water entering the catchment is intercepted by the vegetation and subsequently evaporated, or reaches the ground as through fall and stem flow. When there is no vegetation, the precipitation comes to the ground directly, although there may be some interception by surface litter. From the ground water infiltrates into the soil or is retained as surface storage which may move downward as surface runoff or is slowly evaporated. Soil moisture may be lost through evaporation and plant transpiration. Or percolates downward to form the mass of ground water. The ground water is subject to similar losses through plant transpiration and evaporation or through upward flow by capillary action into the unsaturated soil or through base-flow to the river channel. The river also receives contributions from surface runoff, through-flow and inter-flow. The quality of the river water is much different from that of the precipitation water. The major mechanisms influencing water quality evolves through a complex series of interactions with soil, rock and biota of the catchment ecosystem. These interactions are always in delicate balance and a slight modification to the catchment such as alterations in the land use pattern is likely to generate significant changes in water quality.

Water from surface runoff incorporates the soluble materials and entrains sediment particles, making the water turbid. The suspended sediments and likely to absorb ions and other matter. Water infiltrating into the soil will have its quality modified appreciably due to soil water interactions, during dry days, evaporative losses will maximum and the constituents of the sub surface water will be enriched. The exchange reactions and the chemical equilibrium, involving soil and water, have been known to play an important role in determining the water quality.

1.2 River water

Surface runoff and ground water flows together constitute the river water. The contributions to river water includes-

a. Precipitation
b. Materials added on land erosion
c. Solution of chemicals during travel over and through the soil
d. Removal of chemicals by plants or by reaction with soil constituents
e. Addition through human activities, from both point and non-point sources

Surface runoff and ground water outflow widely differs in the physical and chemical characteristics and therefore, their relative proportion determine effectively the river water quality. Normally, after heavy precipitation, the flow may be predominantly surface runoff, but at other times, groundwater will be the Main component. In general surface runoff and interflow, and base-flow or ground water flow form a continuum rather than remaining as discrete sources. Dilution of solute concentrations in stream- flow during floods or heavy precipitation is much less than is expected residence time of subsurface water isimportant in determining quality characteristic of river water.

1.3 Ground water pollution

Groundwater is a long-term reservoir of the natural water cycle, which originates from rainfall or snow and is dynamic in nature. It is a globally important and valuable renewable resource for human life and economic development. It constitutes a major portion of earth's water circulatory system known as hydrological cycle and occurs in permeable geologic formation known as aquifers i.e. formation shaving structure that can store and transmit water at rates fast enough to supply reasonable amounts to wells. These are affected by factors such as, the expansion of irrigation activities, industrialization and urbanization. Hence, monitoring and conserving this important resource is essential. The quality of water is defined in terms of its physical, chemical and biological parameters. Ascertaining the quality of ground water is crucial before its use. Ground water assessment has been based on laboratory investigation. Ground water pollution may be defined as the artificially induced degradation of natural ground water quality. Pollution can impair the use of water and can create hazards to public health through toxicity or the spread of disease. Most pollution originates from the disposal of waste water which is being used for variety of purposes. In contrast with surface water pollution is difficult to detect and is even more difficult to control, and may persist for decades. With the growing recognition of the importance of underground water resources, efforts are needed to increase to prevent, reduce and eliminate ground water pollution.

1.4 Source of Pollution in the River Stretch

Industries such as Sago units, Textile Dyeing and bleaching units are located along the banks of the River Thirumanimutharu. The Salem Corporation is located along/adjacent to the River Thirumanimutharu and its sewage is discharged into the river. The Salem City Municipal Corporation has established 4 Nos of Sewage Treatment Plants (STPs) with capacity 98 MLD, in which 3 Nos of STPs are yet to put into operation where one of the STP is under operation and the treated sewage is being discharged into the River Thriumanimutharu. The remaining untreated sewage generated is now being discharged into the River Thriumanimutharu.

1.5 Objectives of the study

- To determine the physical, chemical, and biological characteristics of the river water and the ground water.
- To compare the water qualities of river and the ground water to know the effects of polluted river water in ground water.
- To find suitability of water quality for drinking, irrigation or other purpose
- To find the suitable remedies to reduce the contamination of both the river and ground water.

2. LITRATURE REVIEW

N. S. Elangovan et.al, 2011 Groundwater quality in Chennai city along the Coovumm River, during the pre-monsoon (June–July) and post monsoon (Dec–Jan) for three years, from 2009 to 2011, was analyzed. Groundwater samples were collected from 20 bore wells on either side of the river. The analysis focused on the determination of seven specific water quality parameters, namely, pH, EC, TDS, BOD, COD, Na and Pb, using standard procedures. The statistical analysis, like the mean and standard deviation, coefficient of variance, and correlation, and multilinear regression analysis of the obtained data were carried out. The analysis of the collected samples reveals that the stated water quality parameters have not complied with the WHO standards, and the water is not fit for drinking and domestic purposes. The correlation and multilinear regression analyses suggest that the conductivity has a significant correlation with the other six considered water quality parameters.

Nandha Balan et.al, 2012, To assess the groundwater quality using water quality index in Chennai city. Materials and Methods: Chennai city was divided into three zones based on the legislative constituency and from these three zones three locations were randomly selected and nine groundwater samples were collected and analyzed for physiochemical properties. Results: With the exception of few parameters, most of the water quality assessment parameters showed parameters within the accepted standard values of Bureau of Indian Standards (BIS). Except for pH in a single location of zone 1, none of the parameters exceeded the permissible values for water quality assessment as prescribed by the BIS.as mixing water in concrete. EPA has presented suggested guidelines for water reuse. Three configuration alternatives for water reuse systems are presented. One of the sources is the effluent generated by domestic wastewater treatment facilities.

Gursimran Singh (2013), Groundwater is one of the most important natural resources. It is a major source of fresh drinking water in both the rural and urban regions. The groundwater quality however in recent times has got deteriorated due to the percolation of polluted water in to the soils from the wastewater drains, polluted rivers and ponds. As a result its quality has not remained portable in many part of the country. Contaminated groundwater of Mettupalayam Taluk in Tamil Nadu, Amravati river basin of karur district, Tamil Nadu, eastern Uttar Pradesh are some example. Therefore, the evaluation of the water quality of rivers, groundwater and impact of polluted groundwater on environment and health has drawn attention of the researchers. The presents also an attempt on such study. The pollution level of budha nallah water and its effect on the groundwater and vicinity area have been studied in this paper. Total eleven ground water samples, seven budha nallah samples and five soil samples were collected from different locations within 6km stretch of budha nullah and its adjoining areas. The samples of the different points were collected from hand pumps and tube walls, the water from which is used for drinking and other purposes. According to irrigation classification values the salinity of groundwater persists at majority of sites. Hence the salinity of water and soil must be permeable with adequate drainage facilities for satisfactory crop growth.

S.D Shinde (2016), The ongoing degradation of the water quality of central Maharashtra's basaltic aquifer is of great concern for different authorities and agencies involved in the water sector in the Maharashtra, India. The Kham river, which is one of the major tributaries of the Godavari river, receives all domestic and industrial waste water from the Aurangabad city. The river, with no natural flow in the dry season, is extensively used for irrigation. In order to evaluate the quality of river and groundwater in the study area, eight river water and forty groundwater samples along right and left bank of the Kham river were collected and analyzed for various parameters. Physical and chemical parameters of the river and groundwater such as pH, TDS, EC, SO4, NO3 and heavy metals like Pb, Cr, Cd, Zn, and Cu were determined. The results show that the river and groundwater of the area is generally unfit for domestic uses. Most of the physico-chemical parameters and heavy metals in the river and groundwater samples have higher value than the World Health Organization (WHO, 2006) and Bureau of Indian Standards (BIS, 2003) guidelines.

3. STUDY AREA

The study area of the project is along Thirumanimutharu river stretch. It is the tributary of river Kaveri, origin from Manjavaadi in Shevaroy Mountain at Salem district. The coordinates of its source lies between 11°46'45"N 78°12'12"E and the elevation is about 1515 meters (4970ft). The river joins to the river Kaveri in Nanjai Edayar at Namakkal district. The coordinates of its mouth lies between 11°05'58"N 78°02'04"E and the elevation is about 121 meters (397ft). The length of the river is 120 kilometers (75 mi). It passes through the places Manjavadi, Yercadu hills, Salem city, Vennandur, Nanjai Edayar. The average rainfall in this area is 1018.5 mm, wettest month is November and driest month is February. The average temperature varies from highly 38.6°c at May to low 29.1°c at December. In Salem District the River flows over a stretch of approximately 55 KM from Manjavadi in Shevaroy Mountain and flows up to Papparapatti. From Papparapatti it enters into the Namakkal District and confluences with River Cauvery at Nanjai Edayar. In Namakkal District the River Thirumanimutharu enters at Mamundi Village, Rasipuram taluk and ends at Koodudurai village, Mohanur Taluk, The total length of River Thirumanimutharu is about 62 KM in Namakkal district. River Thirumanimutharu flows through Acchankuttapati, Kuppanur, Pallipatti, Vallaiyakaranur, Salem Town, Veerapandi, Attayampatti, Papparapatti and Namakkal district. From Papparapatti it enters into Namakkal District and confluences with the River Cauvery at Nanjai Edayar.

Figure -1: Map of Salem Rivers

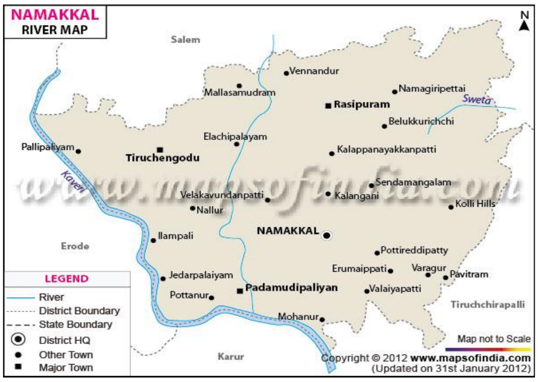

Figure -2: Map of Namakkal Rivers

3.1 Location of sampling source

Water samples were collected from the Thirumanimutharu and its vicinity. For the purpose of water collection site has been classified into 3 parts,

1. Thirumanimutharu
2. Vicinity area of Thirumanimutharu (within 500m perpendicular distance from Thirumanimutharu)
3. Area away from Thirumanimutharu (greater than 500m perpendicular distance from Thirumanimutharu)

3.2 Types of samples

Grabber Catch Samples

The samples collected at particular time can represents only the composition at the time and space however when composite over the extended time or over suspended distance in all direction then the sample may be set at represented an longer time period or both then uptime and place at which it was collected in such circumstance a source may be represent adequate by single grab samples.

Composite Samples

This is a mixture of lab samples taken own period of time with the volume of individual sample usually being proportional to flow at the time sample is taken. This may be obtained manually or mechanically either on the time base or on the time base or on reaching a specified total flow.

This is mostly useful for analysis of average characteristics such as duty based loads.

Continuous Samples

This represents diversion of small fraction of the total flow over some period of toxic, this samples are usually non flow proportional rather they extract the samples are most suitable for instrumental, measurements which can be performed, instantaneously such a temperature dissolved Oxygen, pH etc.,

Representative Samples

This most samples the entire cross section of flow since ash has been noted sewage contain multiple spaces which tend to be segregated same extended. A sampler which cuts across the entire stream is the best method obtaining such specimen. Since it may not be possible to install such a sampler in some location an alternative design for pumping of flow in which sampler can be rotated.

Sample Container

The sampling bottle may be made of either glass or plastic, usually polyethylene. It must be capable of being tightly sealed either by stopper or cap. The bottles should be soaked with 10% HCI for 24 h and then thoroughly cleaned and rinsed with distilled water. Cleaning solution; acid dichromate: Prepare a saturated water solution of potassium dichromate ($K_2Cr_2O_7$). Add 32 mL of this $K_2Cr_2O_7$ solution in 1L of concentrated H_2SO_4 (sp. gr. 1.84).

Transportation of Sample

Sample containing bottles should be placed in a box for transportation to the laboratory. Sturdy, insulated wooden or plastic boxes will protect samples from sunlight, prevent the breakage of bottles and should allow a temperature of 4°C to be maintained during transport.

4. TREATMENT OF WASTE WATER

The most important common problem for the pollution in the river and ground water are the partially treated and untreated waste water from the sewage discharge and the industrial effluent around the area. So it is very important to treat the effluents before discharging it to the river directly.

The various treatment methods are available for the treatment of waste water. The conventional treatment which is already in use for the wastewater treatment can be applied but it is separately for physical characteristics, chemical characteristics and biological characteristics. It is very tedious by applying in practical conditions and also it is time consuming process and uneconomical. So to give an economical treatment our opinion is to apply a ”phytoremediation” treatment technique.

4.1 PHYCOREMEDIATION

Phytoremediation is the use of macro algae or micro algae for the removal or biotransformation of pollutants, including nutrients and xenobiotic from waste water and CO_2 from waste air .a group of aquatic, most primitive photosynthetic organisms ranging from unicellular to multicellular forms and generally possess chlorophyll but lack true roots, stems and leaves characteristic of terrestrial plants.

4.2 MICROALGAE

The green-cell factories of microalgae tackle simultaneously more than one problem, a solution not capable by conventional chemical processes. That is, for example, problems such as PH correction, sludge removal, TDS reduction, BOD removal, etc can be handled simultaneously by micro-algal treatment (phytoremediation), where as in conventional methods, separate methods or stages of treatments are used.

Micro-algae are naturally occurring living organisms and therefore phytoremediation is naturally occurring phenomenon. The microalgae used in phytoremediation are already present in nature and are at work consuming unwanted materials. We come into contact with the daily basis with no ill effects. After phytoremediation is completed, the environment is virtually restored to its pristine condition. The process generally is 70-90% less costly than other technologies as there is virtually little investment in ”capital equipment”. Furthermore, the only energy requirement for the process is solar energy, which is abundantly available in our country. Microalgaes are mainly divided into 4groups based on their colors namely

- Red
- brown
- Green
- Diatoms

Culture and treatment system

Environment differs from place to place the types of system for the cultivation of microalgae for the treatment of waste water shall be selected according to the environmental conditions and economical and the composition of wastewater Microalgae can be used in open pond system or closed photo bioreactor s system. Due to its simplicity and cost effectiveness open ponds systems are commonly used.

Open pond system

Open pond system can be adopted in tropical countries where the sunlight is available in abundant it requires less maintenance and cost effective. It can be such as lakes, lagoons, ponds, artificial ponds and containers usually it’s wider in length and with minimum depth at average of 20cm. however major defect in open pond system poor consumption of sunlight by the cells, evaporation loss, requires more land and difficult to harvest micro algae.

Closed pond system

Microalgaes are cultivated for the waste water treatment n closed pond system such as photo bioreactor and other types. One of the major features of closed pond is such as all the conditions can be controlled like percentage of co2, light utilization and requires less land area. Disadvantage of closed pond is difficult to construct, operate and very costly.

Wastewater Treatment process

Treatment is done by using the natural pond water containing natural algae growth 500ml and glucose as a nutrients to the 4.5litres of sewage water collected nearby Thirumanimutharu River. Initially waste water is allowed to settle down the suspended solids for about 1 day. The change of color from blackish grey to brownish green is observed and the pond water containing algal growth is added with the addition of glucose as a nutrients and placed in the partial sunlight to ensure the no high evaporation loss. The change in color is observed later around 5 to7 days and the water appeared light green at the 15th day with minimal evaporation loss in water.

Figure -3: Wastewater before treatment

Figure -4: Wastewater at 7th day

Figure -4: Wastewater at 14th day

Table -1: Before and after treatment

Water parameters	Before treatment	After treatment
PH	8.1	7.3
BOD	129	45.4
DO	1.5	5.4
TDS	3328	924
CHLORIDE	942	448
MPN	54224	<1

Importance of microalgae treatment process

Treatment of waste water using microalgae requires only simple setup on open pond or raceway treatment process. Sunlight is the only major source of energy for the cultivation of the microalgaes by the photosynthesis process. Microalgae increases the oxygen level in the water and consumes the nutrients contain in the wastewater. It also turns to be good nutritious food for the aquatic animals. After the treatment of the wastewater the microalgae can be used for the production of biogas, fertilizers, pharmaceutical and sometimes also as the food rich in nutrients.

Disadvantages of microalgae in wastewater treatment

It is time consuming process.
It requires large land area.
While treating the wastewater contain harmful pollutants and heavy metals, proper studies to be done to get the effective results. In the treatment of heavy metals and other harmful pollutants in the wastewater the dispose of the microalgae must be done properly to ensure no harmful substance consumed by microalgae can be affects the environment or any living organisms.

Table -2: Water quality parameters value of groundwater samples

sample	place	PH	BOD (mg/l)	DO (mg/l)	COLIFORMBACTERIA MPN/100ml	TDS (mg/l)	Cl (mg/l)
standard	IS11624,IS10500	6.5-8.5	20-30	8-10	<500MPN/100ml	500	250
1	MANJAVADI	7.3	1.5	6.21	<1	542	97.515
2	MANJAVADI	7.2	5.5	7.9	<1	214	141.84
3	KUPPANUR	7.29	0.5	5.4	<1	982	226.944
4	KUPPANUR	7.5	5.8	6.2	<1	621	443.25
5	MOOKANERI	7.9	0.2	6	<1	489	487.575
6	MOOKANERI	7.6	2.4	6.4	3	312	359.91
7	OLDBUSSTAND	7.44	0.8	1.92	2.4	543	859.905
8	OLDBUSSTAND	7.3	0.6	4.4	<1	873	540.765
9	UTHAMASOLAPURAM	8.24	0.5	3.33	<1	956	244.674
10	UTHAMASOLAPURAM	8.1	2.5	4.19	<1	210	351.054
11	VEERAPANDI	8.34	2	4.8	1.2	436	254.321
12	VEERAPANDI	7.31	0.4	4.64	<1	365	877.635
13	PAPARAPATTY	8.64	3.2	1.6	<1	580	391.833
14	PAPARAPATTY	7.29	5	3.84	<1	554	395.87
15	MATHIYAMPATTY	7.4	0.5	2.48	2	321	226.944
16	MATHIYAMPATTY	7.14	3.2	5.4	1.7	339	375.21
17	IDUMBANKULAM	7.9	2.4	2.2	1.6	981	258.858
18	IDUMBANKULAM	7.5	3.3	3.36	<1	672	328.251
19	NANJAIEDAYAR	7.6	6.5	2.6	<1	1241	390.005
20	NANJAIEDAYAR	7.5	6	4.8	<1	698	198.576

Table -3: Water quality parameters value of River water Samples

sample	place	PH	BOD	DO	COLIFORMBACTERIA MPN/100ml	TDS	Cl
standard	IS4764-1973 IS2490-1974	5.5-9.0	3 Mg/l	8-10 Mg/l	<500MPN/100ml	500	600mg/l
1	MANJAVADI	7.7	27	1.25	30	1021	678.45
2	KUPPANUR	7.6	132	NILL	346	1754	875.21
3	MOOKANERI	7.9	140	NILL	$84X10^5$	950	775.43
4	OLDBUSSTAND	8.1	54	NILL	$156X10^9$	2932	1241.32
5	UTHAMASOLAPURAM	8.3	231	NILL	$170X10^8$	3328	982.65
6	VEERAPANDI	8.13	341	0.4	$218X10^7$	1784	1142.14
7	ATTAYAMPATTI	7.4	201	NILL	$1678X10^4$	2641	1365.21
8	MADHIAMPATTI	7.77	31	6.9	$2468X10^6$	2134	1180.12
9	IDUMBANKULAM	7.6	22	NILL	7421650	1651	764.12
10	NANJAIEDAYAR	7.54	62	3.2	1324780	1570	831.65

PH

PH is an important parameter to check the quality of water sample. The various human activities as well as some natural processes are responsible to change in PH of water sample. The PH value of our ground water samples and river water samples are from 7.2 to 8.64 and 7.4 to 8.3 respectively. According to IS standard the normal PH value range from 6 .5 to 8.5.So the contaminant is negligible.

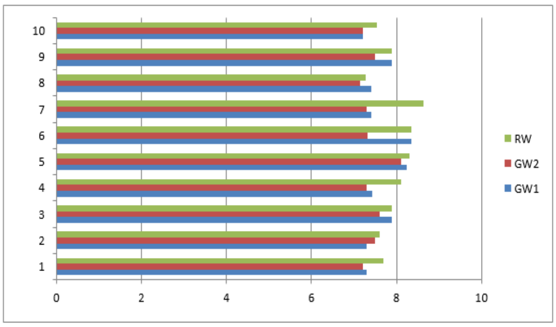

Chart -1: Graph plotted for PH Vs Samples

BOD

Biological oxygen demand is the amount of dissolved oxygen needed by aerobic biological organisms to break down organic material present in the water sample. The minimum BOD value for our water sample is 0.2mg/l in ground water and 22mg/l in river water. The maximum value BOD value for ground water sample is 6.5 and 341 in river water samples. According to the Indian standard the BOD value is about less than 3mg/l. So it is not suitable for public usage.

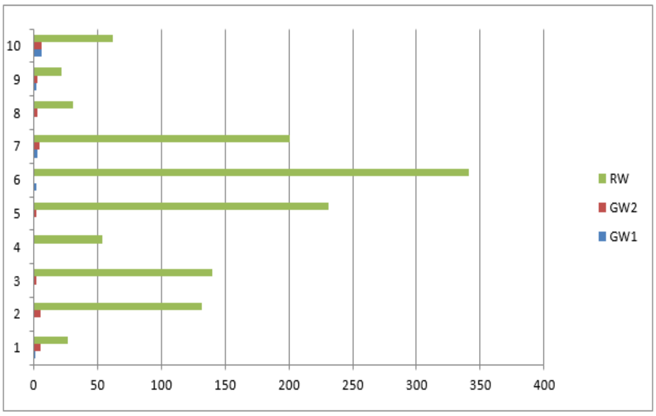

Chart -2: Graph plotted for BOD Vs Samples

DO

Do is the oxygen present in dissolved state in waste water which prevents noxious odors. The minimum DO for our ground water sample is 1.6mg/l and in river water sample is nil. The maximum value in ground water sample is 7.9 and in river water sample is 341 According to the Indian standards do should be within 8-10mg/l. so it is not suitable.

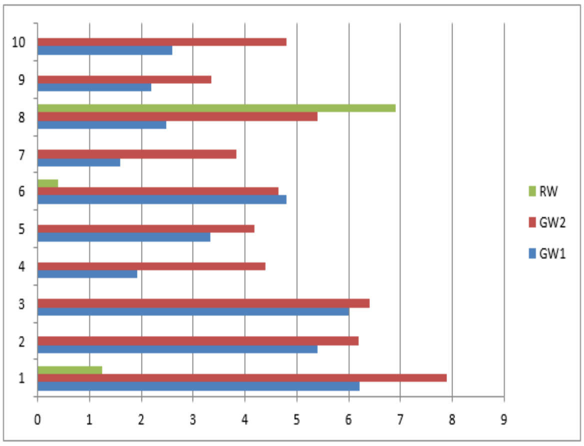

Chart -3: Graph plotted for DO Vs Samples

TOTAL DISSOLVED SOLIDS

Total dissolved solids is one of an important parameter in water quality analysis. If it exceeds, the permissible limits it is unsafe for public usage. The minimum TDS value of our ground water and river water sample is 210mg/l and 950mg/l respectively. The maximum TDS value of ground and river water sample is 1241mg/l and 3328mg/l respectively.

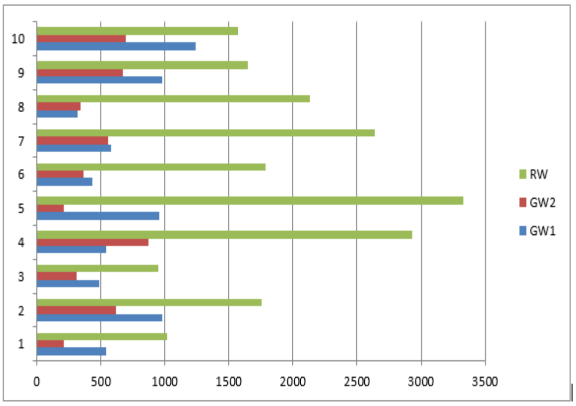

Chart -4: Graph plotted for TDS Vs Samples

CHLORIDE

Cholride is the important parameter in water sample analysis. Due to the effluents from industries and sewage water , chloride is found in excess concentration in river water and ground water. By the observation recorded the minimum value of our ground water and river water samples are 97.515mg/l and 678.45mg/l respectively. The maximum value of ground water and river water are 877.635mg/l and 1365.21mg/l respectively. According to the Indian standards the normal chloride value is about 250mg/l. hence the chloride content is a major contaminant.

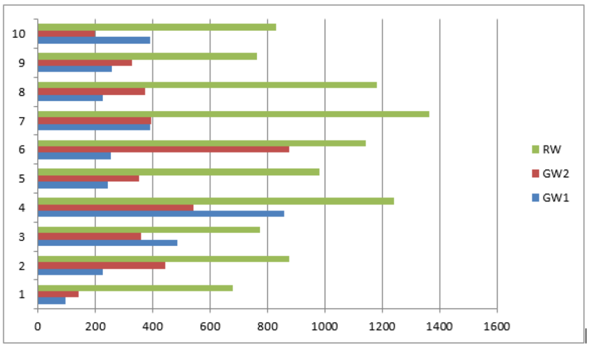

Chart -5: Graph plotted for Chloride Vs Samples

MPN

MPN is the bacterial density which if actually present in sample would more frequently would have given the observed results. The test are done to identify whether E.coli (Escherichiacoli) is present. E.coli is the indicator of sewage (contamination) in water. It is no harmful but its present in water indicates the presence of other pathogenic microorganisms. The minimum and maximum values of MPN in ground water is observed to be <1 and 3 respectively. The minimum and maximum values of MPN in river water is 30 and 156 x 10^9

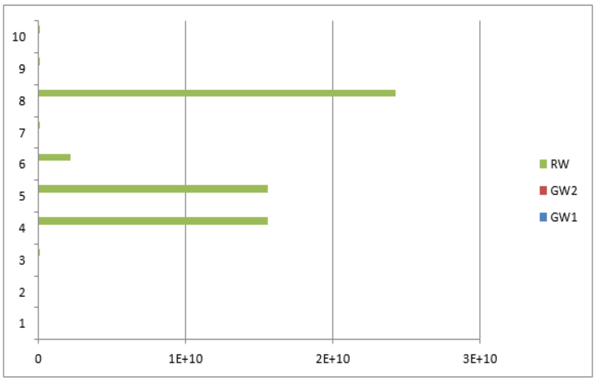

Chart -5: Graph plotted for MPN Vs Samples

5. CONCLUSION

This project "An Experimental analysis and treatment of water in the Thirumanimutharu River, its impact on ground water" is to know the water quality of river and to analyze the pollutants in the water by physico chemical parameters and biological parameters. Various samples are collected from the Thirumanimutharu river and the nearby ground water in various location used for further analysis of physico chemical and biological parameters in the water to know the water quality and the pollutants level in the River. Sources for the pollutants in the River is from nearby sago industries, dyeing industries and municipal waste water into the river without the treatment. So in this project the pollutants in the river, physico chemical and biological parameters, and details of the river and its source of pollution. Test results of samples from polluted river stretch have been analyzed and found major pollutants. In further as a suitable remedy for the treatment of polluted water phytoremediation process is taken. In which microalgae were used in the treatment of Waste water as a result the water is treated moderately. The parameters of water such as pH, BOD, DO, Chloride, TDS and Coli form bacteria were improved in considerable amount by microalgae. Hence phytoremediation process using microalgae can be recommended for the treatment of waste water with some improvement in the process technically, during the open pond system for effective results while implementing in the large scale. Thus it can improve the quality of water. Since phytoremediation process is eco-friendly and cost effective than the other treatment process further researches should be done for the effective treatment of waste water using microalgaes for productive and harmless environment.

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BIOGRAPHIES

	**S. Monika,** P.G student, Dept. of Civil Engineering, Gnanamani College of Engineering, Namakkal, Tamilnadu, India.
	**K. Soundhirarajan,** Assistant Professor, Dept. of Civil Engineering, Gnanamani College of Engineering, Namakkal, Tamilnadu, India.
	**D. Roopa,** Assistant Professor, Dept. of Civil Engineering, Gnanamani College of Engineering, Namakkal, Tamilnadu, India.
	**P. Siva Kumar,** [4] Assistant Professor, Dept. of Civil Engineering, Master of simulation technology, Tamilnadu, India.