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SYSTEMATIC SURVEY OF RIVER PERIYAR TO ENCOUNT THERMAL POLLUTION

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ABSTRACT

*Water pollution does more than make the river smell bad. It wrecks ecosystems and livelihoods and is not something to be ignored. The main harmful side of water pollution is the raising of the water temperature. In most studies, pollution of water due to artificial means is not concentrated beyond a limit which is the most dangerous stage-**thermal pollution**. The raising of the air or water temperature by artificial means is thermal pollution. Thermal pollution is largely water associated. Thermal pollution is related to chloro-fluoro carbons (CFCs), carbon dioxide and global warming. The addition of excess of undesirable heat to water thereby making it harmful to man, animal or aquatic life. The inter link between thermal pollution of water and air is a vast concern. The addition of these undesirable heats to a level more than the auto recyclable ability of water turns the water more dangerous than poison. Research on regional and global climate changes and variabilities and their impacts on water resources have received considerable attention in recent years. Potential impacts of climate change and its effects have been much in discussion but relatively fewer studies are being done on changes in water quality. From a global perspective, climate change is usually perceived as an increase in average air temperature. So with increase in surface water temperature, air temperature increases. This affects the water quality of river. Most of the bacteriological activities and chemical activities of the river increase with increase in water temperature, which reduces the dissolved oxygen in the river. In this work, a detailed survey on river Periyar has been done to encounter the amount of thermal pollution it undergoes and the net impact on global warming. This survey report will be very helpful for the researchers who focus on the river and its diversity to be protected.*

I. INTRODUCTION

The State Government of Kerala in India is being petitioned by international activists because a major regional waterway, the Periyarriver, is under threat from pollution. Towards the mouth of the river, researchers have found high levels of DDT, lead, cyanide and mercury produced by local industry, agriculture and domestic waste. This poses a health risk to humans as well as destabilising the aquatic environment. Environmental campaigners claim that the Kerala Pollution Control Board has failed to take proper samples when serious pollution has been reported. Four major causes of thermal pollution of water may be identified, viz. use of water as a **cooling agent**; **soil erosion; deforestation of shorelines**; and **run-off from hot paved surfaces**.

The effects of thermal pollution are difficult to define with precision. However, two types of effects are discernible, namely, **thermal shock** and **thermal enrichment.**Change in water temperature above its normal level, due to hot wastewater, can harm fish and organisms adapted to a particular water temperature regime from thermal shock. For example, warmer water may interfere with fish growth, reproduction, and food supply. In some cases, fish may be killed due to the sudden and rapid rise in temperature. However, some argue that heated water may be used for beneficial purposes, calling it thermal enrichment. For example warm water from power plants may be used for irrigation to extend plant growing season in frost-prone areas, speed the growth of fish and shellfish for commercial production, melt snow on sidewalks, desalinate ocean water etc. However, the harmful effects of thermal pollution seem to outweigh the beneficial effects.

Increase in water temperature affects the ecosystem. Recently people have realized that only small changes in temperature (typically 1 or 2 degrees Centigrade) are needed to have considerable environmental impact. The amount of oxygen dissolved in the water is believed to be affected, most importantly, because oxygen is less soluble in warm water. Also, increase in temperature increases photosynthesis and aquatic plant growth, like algae, which may crowd out the zooplankton. Excess plant growth is harmful because of eutrophication. Increased plant growth means increased dead plants. These dead plants are decomposed by bacteria, which in turn use up oxygen thus depleting the water of oxygen for other aquatic animals like fish. Warmer temperature is also known to increase the metabolism of fish, thereby increasing their need for oxygen. Increase in the fish metabolism rate will increase the consumption of aquatic insects, resulting in an increase in fish population and depletion of aquatic insects - an imbalance in the food chain or food web and ecosystem. Higher temperatures can cause enzymes and microbes to speed up metabolism, and can eventually kill them. Also, changes in temperature cause fish to migrate to regions where the water is at the best temperature for them, and can kill any species which cannot move away. Thus thermal pollution can contribute to ecological imbalance in an otherwise balanced ecosystem in many ways.

II. PERIYAR: AN OVERVIEW

The river Periyar, the longest river of the state is considered to be the life line of Central Kerala. It originates from the Sivagiri peaks of Sundaramala in Tamil Nadu. The total length is about 300Kms (244Kms in Kerala) with a catchment area of 5396Sq Kms (5284 Sq. Kms in Kerala). The total annual flow is estimated to be 11607cubic meters. During its journey to Arabian Sea at Cochin,the river is enriched with water of minor tributaries like Muthayar, Perunthuraiar, Chinnar,Cheruthony, Kattappanayar and Edamalayar at different junctures. Periyar has been performing a pivotal role in shaping the economic prospects of Kerala, as it helps in power generation, domestic water supply, irrigation, tourism, industrial production,collection of various inorganic resources and fisheries. However, as in the case of many other inland water bodies, river Periyar is gradually undergoing eco-degradation throughout its course of flow due to various anthropogenic stresses, which include indiscriminate deforestation, domestic-agricultural- industrial water pollution, excessive exploitation of resources, large scale sand mining, various interferences in the flow of water etc.

III. MATERIALS AND METHODS

Water samples were collected from 10 different stations during December 2015. The locations and names of sampling stations are given in Table 3.1.

Table.3.1 Names of sampling stations

SLNO	SAMPLING POINTS
1	NEAR PERIYAR PARK
2	CHERUTHONI
3	UPPUTHARA
4	VANDIPERIYAR
5	PANAMKUTTI
6	NERIYAMANGALAM
7	BHOOTHATHANKETTU
8	KURICHILAKODU
9	THEKKUMBHAGOM
10	VALIYAPANICKENTHURUTHU

IV. FINDINGS AND DISCUSSION ON RIVER WATER QUALITY

Physical parameters like turbidity and colour shows wide variations. The colour of the samples was generally high because the river receives considerable run-off from high the lying terrains during the rains, which are very frequent in the region. The sites which showed high values are identified ascenters of developmental activities like tourism, urbanization, paddy cultivation, or the downstreamreaches of important discharge stations. The concentration of cations like Ca, Mg, Na, K recorded low concentrations and within theBIS limits during all the five seasons. It is reported that the concentration of iron is relatively low. Dissolved oxygen concentration ranged from 5.87 to 8 mg/l. Chloride is one of the anions which determine the total salinity of water and make a quantitativeaccumulation of this anion over a period of time is an indicative of anthropogenic pollution. Highchloride content in water bodies harms metallic pipe and structures as well as agricultural crops. Dissolved oxygen is necessary to sustain aquatic biota and it also provides a self purificationcapacity to water. Biodegradation of dissolved, suspended and deposited organic materials dependson oxygen, as also on the respiration of aquatic biota. If the river is heavily loaded with organicmaterials, the amount of oxygen consumed may be more than what can be absorbed throughwater-air interface so that the oxygen content quickly falls. Dissolved oxygen values of most ofthe samples were above the minimum requirement .

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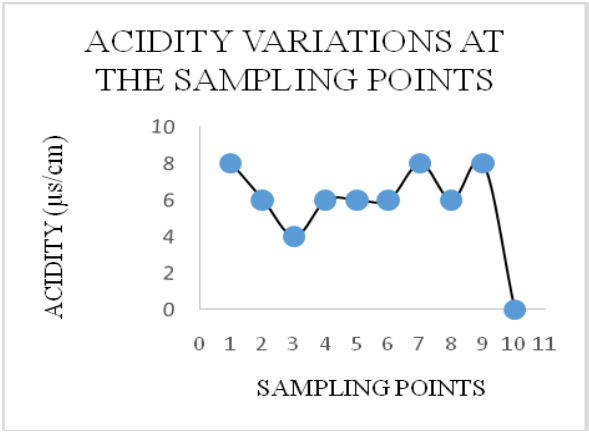
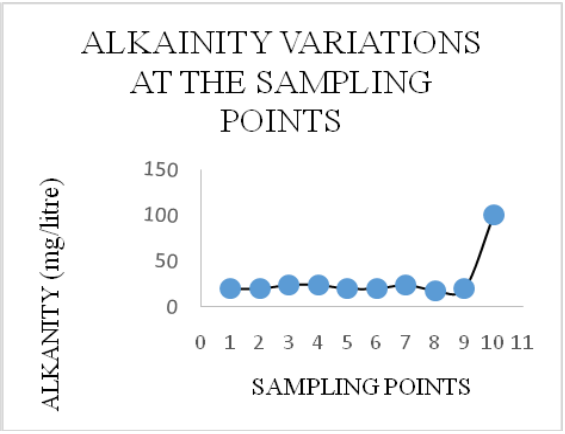
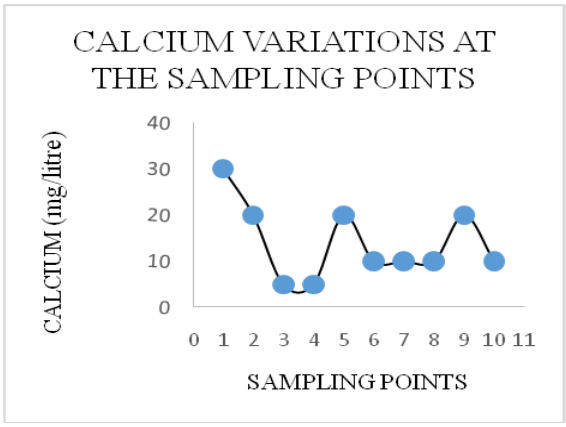
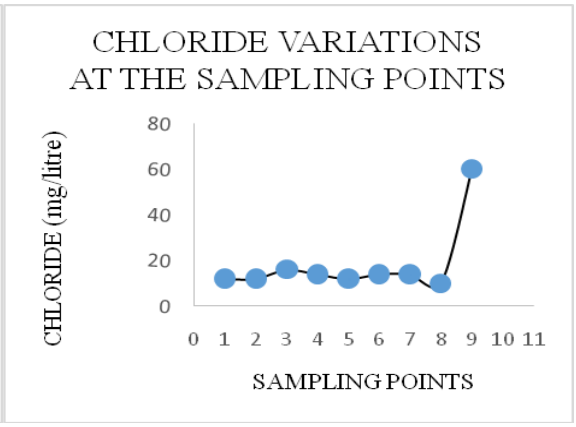
Table 4.1 variations of parameters at various sampling points

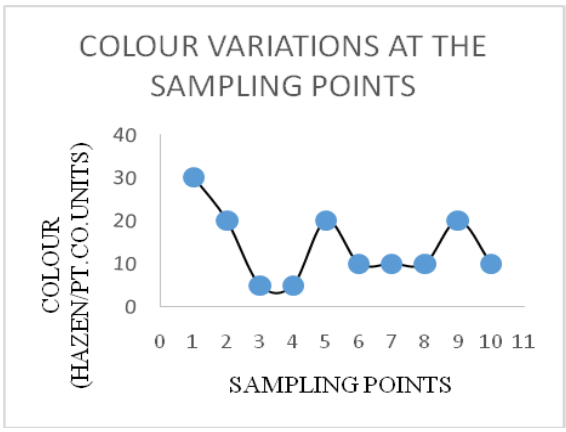
SL NO	CHARACTERISTICS	UNIT	DESIRABLE LIMIT AS PER IS 10500:2012	SAMPLING POINTS									
				1	2	3	4	5	6	7	8	9	10
1	Colour	Hazen/Pt. Co.Units	5	30	20	5	5	20	10	10	10	20	10
2	Turbidity (NTU)	NTU	1	2.07	1.52	0.60	0.49	5.90	1.49	2.49	1.22	2.74	2.73
3	Ph		6.5-8.5	6.67	6.63	6.66	6.60	6.85	7.01	6.87	7.29	6.69	7.74
4	Electrical Conductivity			39.3	56.4	65.2	60.8	63.3	50.5	63.3	44.7	46.8	2380 0
5	Temperature	^{0}C		28.9	28.8	28.9	28.9	28.9	29.0	29.1	29.0	29.0	29.2
6	Acidity	µs/cm		8	6	4	6	6	6	8	6	8	Nil
7	Alkainity	mg/litre	200	20	20	24	24	20	20	24	18	20	100
8	Sulphate (as SO_4)	mg/litre	200	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1540
9	Total Dissolved Solids(TDS)	mg/litre	500	19.4	28.3	32.4	30.5	31.5	25.3	31.5	22.4	23.2	1230 0
10	Total Hardness (as $CaCO_3$)	mg/litre	200	14	22	22	22	28	26	26	20	50	5500
11	Calcium(Ca)	mg/litre	75	4	6.4	6.4	8	6.4	4.8	8	5.6	8	320
12	Magnesium(Mg)	mg/litre	30	0.972	1.458	1.45 8	0.48 6	2.91 6	3.40 2	1.45 8	1.45 8	7.29	1142 .1
13	Chloride(Cl)	mg/litre	250	12	12	16	14	12	14	14	10	60	1690 0
14	Fluoride(F)	mg/litre	1	0.185	0.170	0.20 0	0.20 0	0.18 5	0.20 0	0.20 0	0.18 5	0.18 5	0.95 0
15	Iron(Fe)	mg/litre	0.3	0.635	0.337	0.16 9	0.25 8	0.30 7	0.20 8	0.21 8	0.14 9	0.37 7	0.11 9
16	Nitrate(NO_3)	mg/litre	45	0.416	0.618	0.80 0	0.39 6	0.94 6	0.66 1	0.82 4	0.46 7	0.44 7	0.71 3
17	Residual Chlorine (Rc)	mg/litre	0.2	nil	nil	nil	Nil	nil	nil	nil	nil	Nil	Nil

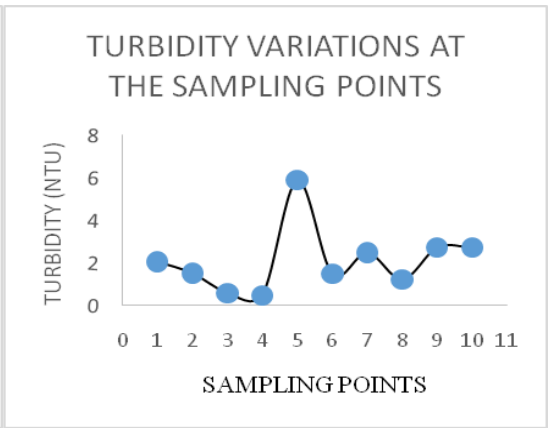

ACIDITY VARIATIONS AT THE SAMPLING POINTS
ACIDITY (µs/cm)
10
8
6
4
2
0
0 1 2 3 4 5 6 7 8 9 10 11
SAMPLING POINTS

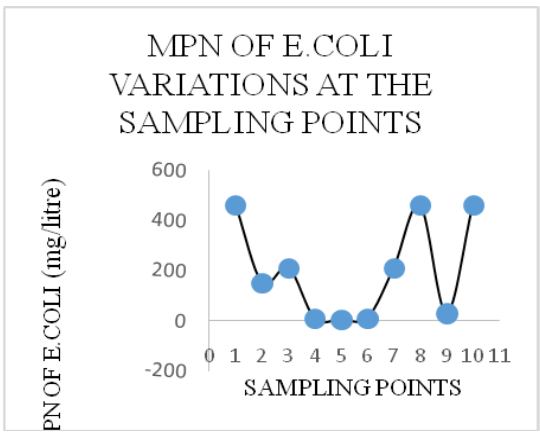

ALKAINITY VARIATIONS AT THE SAMPLING POINTS
ALKANITY (mg/litre)
150
100
50
0
0 1 2 3 4 5 6 7 8 9 10 11
SAMPLING POINTS

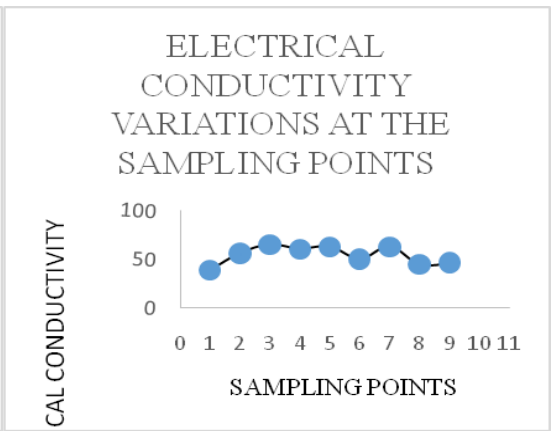

CALCIUM VARIATIONS AT THE SAMPLING POINTS
CALCIUM (mg/litre)
40
30
20
10
0
0 1 2 3 4 5 6 7 8 9 10 11
SAMPLING POINTS

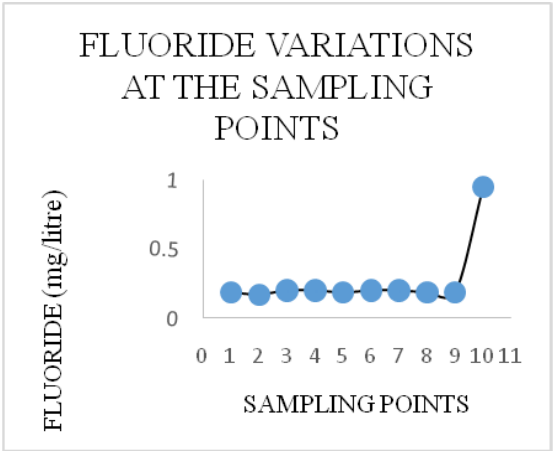

CHLORIDE VARIATIONS AT THE SAMPLING POINTS
CHLORIDE (mg/litre)
80
60
40
20
0
0 1 2 3 4 5 6 7 8 9 10 11
SAMPLING POINTS

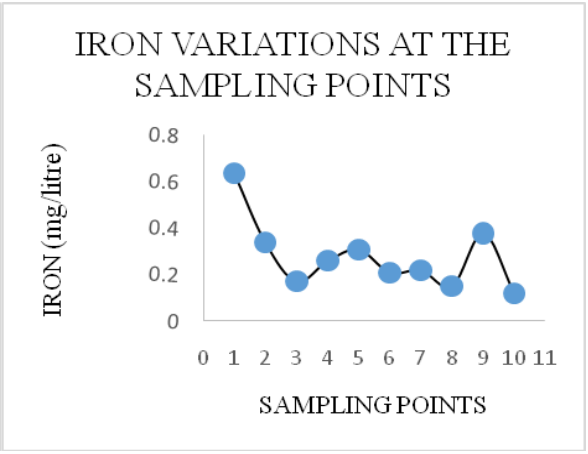

COLOUR VARIATIONS AT THE SAMPLING POINTS
COLOUR (HAZEN/PT.CO.UNITS)
40
30
20
10
0
0 1 2 3 4 5 6 7 8 9 10 11
SAMPLING POINTS

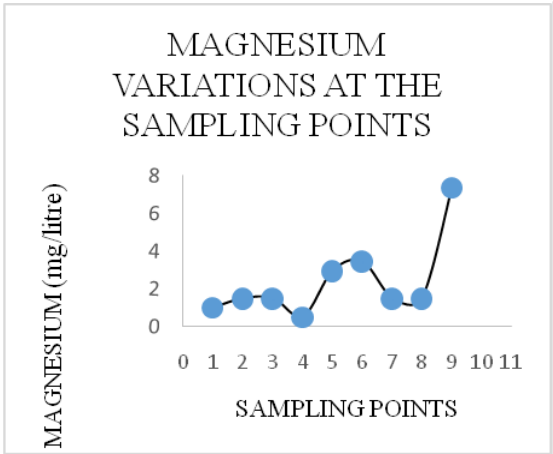

TURBIDITY VARIATIONS AT THE SAMPLING POINTS
TURBIDITY (NTU)
8
6
4
2
0
0 1 2 3 4 5 6 7 8 9 10 11
SAMPLING POINTS

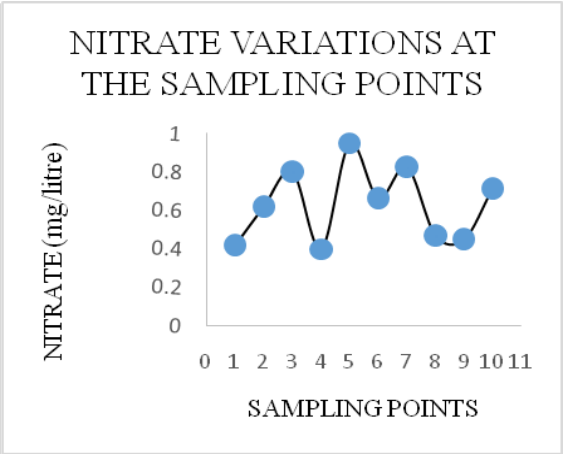

MPN OF E.COLI VARIATIONS AT THE SAMPLING POINTS
PN OF E.COLI (mg/litre)
600
400
200
0
-200
0 1 2 3 4 5 6 7 8 9 10 11
SAMPLING POINTS

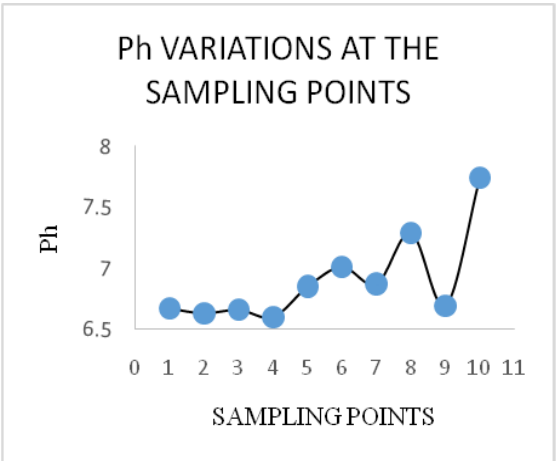

ELECTRICAL CONDUCTIVITY VARIATIONS AT THE SAMPLING POINTS
CAL CONDUCTIVITY
100
50
0
0 1 2 3 4 5 6 7 8 9 10 11
SAMPLING POINTS

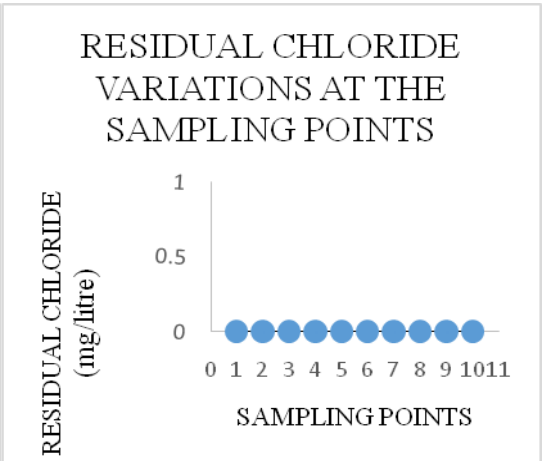

FLUORIDE VARIATIONS AT THE SAMPLING POINTS
FLUORIDE (mg/litre)
1
0.5
0
0 1 2 3 4 5 6 7 8 9 10 11
SAMPLING POINTS

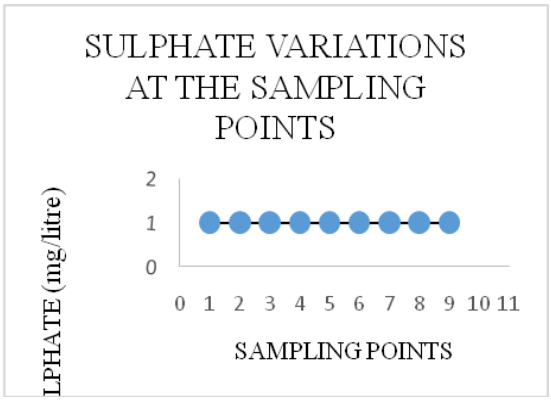

IRON VARIATIONS AT THE SAMPLING POINTS
IRON (mg/litre)
0.8
0.6
0.4
0.2
0
0 1 2 3 4 5 6 7 8 9 10 11
SAMPLING POINTS

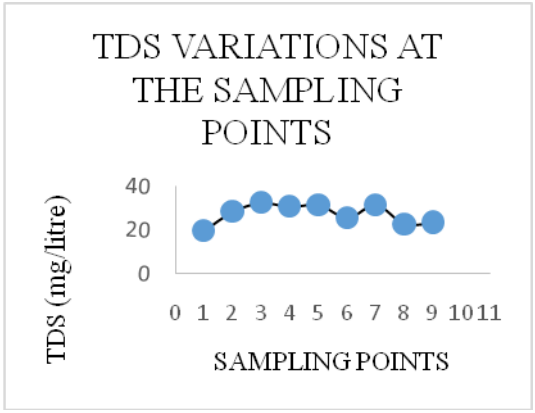

MAGNESIUM VARIATIONS AT THE SAMPLING POINTS
MAGNESIUM (mg/litre)
8
6
4
2
0
0 1 2 3 4 5 6 7 8 9 10 11
SAMPLING POINTS

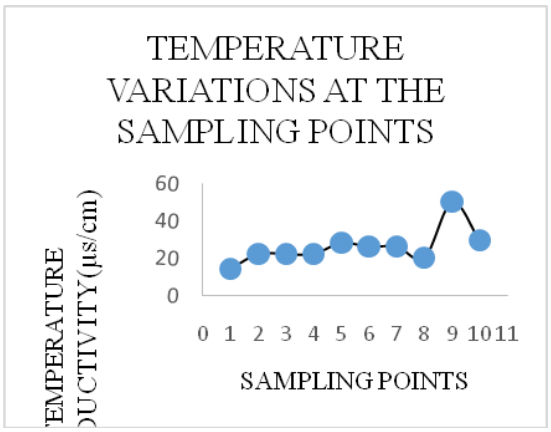

NITRATE VARIATIONS AT THE SAMPLING POINTS
NITRATE (mg/litre)
1
0.8
0.6
0.4
0.2
0
0 1 2 3 4 5 6 7 8 9 10 11
SAMPLING POINTS

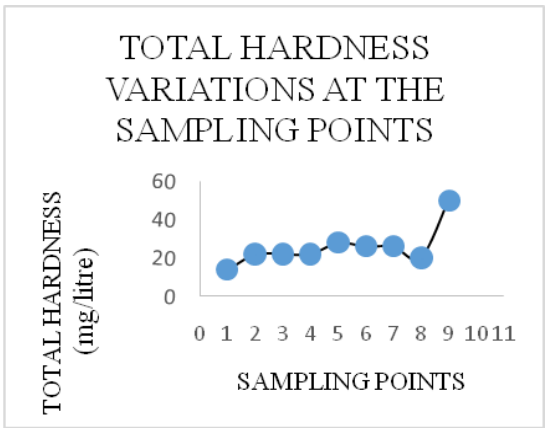

Ph VARIATIONS AT THE SAMPLING POINTS
Ph
8
7.5
7
6.5
0 1 2 3 4 5 6 7 8 9 10 11
SAMPLING POINTS


RESIDUAL CHLORIDE VARIATIONS AT THE SAMPLING POINTS
RESIDUAL CHLORIDE (mg/litre)
1
0.5
0
0 1 2 3 4 5 6 7 8 9 1011
SAMPLING POINTS









V. BACTERIOLOGICAL ANALYSIS

SLNO	MPN of coliforms in 100ml	MPN of E.Coli
1	1100+	460
2	1100+	150
3	210	210
4	20	7
5	93	4
6	35	9
7	1100+	210
8	1100+	460
9	150	28
10	460	460

The stretch between Angamaly and Kochi is a highly industrialized zone in the Periyar riverbasin. The Eloor - Edayar region of Cochin estuary presents a typical example of industrial pollution.It is situated 17 km north of Eranakulam town area, Eloor is an island of 11.21 sq km in whichmost of the industries of the area are situated. The Eloor - Edayar region, about 20 km from thepoint where the Periyarriver meets the Lakshadweep Sea, is the industrial hub of Kochi. There aremore than 247 chemical industries, including Hindustan Insecticide Limited (HIL), Fertilizers andChemicals Travancore Ltd (FACT), Indian Rare Earths Ltd, Travancore Cochin Chemicals, CochinMinerals and Rutile Ltd (CMRL) etc. These industries take considerable amount of fresh

waterfrom Periyarriver and also discharge effluents treated or partially treated.Colour of these samples varied from 6.8 to 35.1 Hazen. For all samples, a reported value ofcolour was higher, i.e. greater than the desirable limit of 5 Hazen.Turbidity varied from 3 to 34 NTU. Turbidity values were highly correlated with iron (0.9975).Concentration of iron varied from 0.09 to 1.5 mg/l. High value was reported at Station 3 andit was beyond the BIS limit. Dissolved iron showed good correlation with colour (0.9968) andturbidity.The samples were found to be contaminated with iron, turbidity and colour. Oxidation ofdissolved iron particles in water might have changed soluble iron in to red brown solid particles offerric hydroxide, which might be the reason for the red coloration. The source of iron can be fromthe effluents discharged by the industries.

VI. CONCLUSIONS

Water samples were collected from 10 stations along the stretch of the river during December 2015. The results of analysis are given below:

- Most of the physic-chemical water quality parameters exceed the desirable limits of the
- downstream stations during all the seasons.
- Bacteriological analysis clearly indicates the microbial contamination of the river.
- The analytical results of an emergency survey conducted in the downstream stations ofthe river reveal the extent of heavy metal pollution due to the flushing of industrial effluentsdirectly to the river.
- pH analysis points to the fact that the ground water samples are acidic in nature; as perthe quality standards of BIS, 70% of the samples are not fit for drinking.
- The contamination of well water by nitrate (3.9 % of sampled wells) is observed in somecases and it is due to the proximity of wells to the septic tanks or leach pits.
- Microbiological contamination is another major problem observed, more than 90% of thewells are bacteriologically contaminated due to feacal pollution and this situation warrantsfor immediate and periodical disinfection of the wells.
- Pesticide analysis carried out for four selected groundwater samples from Idukki districtindicated the presence of pesticides in all the samples and the concentration ranged from0.1041µg/l to 1.3198µg/l for Aldrin, from 0.5393µg/l to 1.279µg/l for Dieldrin and from0.0961µg/l to 0.6244µg/l for Endo sulfan-beta. The wells in which high pesticide contentis observed are located near the agricultural fields.
- Malayattur, which is a pilgrimage centre on the banks of Periyarriver, reported highPalmer's index value during different seasons which indicates high organic contamination.It supports the presence of most pollution tolerant genera like Ankistrodesmus,Scenedesmus, Oscillatoria, Anabaena, Synedra and Navicula and Rotifer like Philodina,a pollution indicator.
- Plankton reported from Paathalam and Edamulla was Chlorella, Scenedesmus, Oscillatoria,Synedra and mastigophora like Euglena.
- The presence of Chironomidae is dominant at Kalady (under the bridge), which receivesuntreated municipal effluents.
- The assessment of pollution indices indicates that stations of AluvaManappuram, Chowara,Manjummal and Eloor Ferry (Mixing Point) are facing problems due to disposal of organicwaste.