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A Spatial Study on Variation in Physico-Chemical (Water Quality) Parameters in the Surface Water of River Lokapavani in Mandya District, Karnataka

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Abstract: ***Comprehensive spatial study along the full length of river Lokapavani revealed that the physico-chemical (water quality) variables studied show abrupt pattern. This abrupt pattern may be due to different geographical condition or addition of waste water from different point and nonpoint sources. Mid-stream surface water was collected along the river Lokapavani from four different sites between 07.30 am and 12.30 pm. Water samples were collected in a clean, well rinsed 15 litre capacity polythene bucket and transferred to 5 litres polythene container. Determination of physico-chemical (water quality) variables was followed based on APHA (1992). The environmental parameters such as Conductivity, SWV, Chloride, TASA and Calcium responded differently with respect to spatial variation in the site LPR-4. This may be due to entry of used water from irrigated fields and other wastes water from the adjoining sugar cane crushing industries to this site, human activity like bathing, washing cloths, vehicles, cattle and bullock cart etc., were commonly noticed in this site during spatial investigation or due to differences in superficial geology might be the reason. Further, some of the water quality parameters such as, DO, BOD, Chloride, Carbon di-Oxide, Nitrate, Sulphate, Calcium were well within the permissible limits, where as the values of Conductivity, Turbidity, COD, Phosphate and Total Suspended Solids were above the permissible limits of drinking water standards as prescribed by WHO, ISI and USPH. Hence, in the present investigation the content of some of the parameters could be minimized and indiscriminate entry of domestic sewage, agricultural runoff and other effluents into this running water course is prevented.***

Keyword: River Lokapavani, Water quality, Permissible limit, Anthropogenic, Spatial variation

1. Introduction

Aquatic ecosystems play an important ecological role on a global scale, as the greater part of many natural microbial conversions occur in water. The environmental persistence of various synthetic chemicals and plastics, bio-magnification of pollutants, eutrophication, depletion of ozone by Nitrous Oxide, and a plethora of other environmental problems reflect unintended interactions of human activities with the microbial component of the global ecosystem. The composition of the microflora and microfauna of a stream or river may be a good indicator of the extent of pollution. Heterotrophic bacteria in fresh waters are important in the processing of natural organic matter and in bio-purification of water, which receives organic pollution. Degradation of organic matter contributes to the purification of the ecosystem and is therefore a major process controlling water quality (Servais and Garnier, 1993). As in other ecosystems, populations of riverine organisms are controlled by a variety of abiotic factors. There is evidence that physico-chemical factors in rivers, for examples, temperature, discharge and concentration of suspended solids (Goulder, 1980; Milner and Goulder, 1984; Yamakanamardi and Goulder, 1995; Harsha et al., 2007) and inorganic phosphate (Mohamed, *et.al*., 1998; Castillo, 2000; Castillo, *et.al*., 2004), influence the abundance and distribution of micro-organisms. Further, the anthropogenic nutrients inputs to rivers may be profound impact on the microbial loop and the river as a whole. Literatre survey shows that, over the years enormous research literature has piled up on the hydrobiology of marine waters and lentic fresh waters. Only available reports are on physico-chemical parameters of lotic waters / rivers (Singh and Singh, 1995; Desai, 1995; Jameson and Rana, 1996; Chandra et al., 1996; Abbasi et al., 1996; Srivastava et al., 1996; Sharma and Pande, 1998, 1999; Prasanthan and Nayar, 2000; Jayashree, 2002; Jayaraman et al., 2003; Das et al., 2003; Mini *et al.*, 2003; Drusilla *et al.*, 2004, 2005; Harsha *et al.*, 2006). The river Lokapavani is an important and small tributary, which joins the main river Cauvery near Srirangapatna taluk of Mandya district. It originates at Nagamangala taluk near Bhosandra village. The used water from irrigated fields in the wet lands of the catchment areas of the krish raja sagar (KRS) reservoir is the main water source to this tributary. The river Lokapavani travels for a distance of 48 Kms before joining the main river Cauvery near Srirangapatnam. The natural agricultural crops around the basin area mainly consist of paddy, sugarcane, ragi and groundnut. Coconut and mulberry are commercial crops around this basin. During the entire period of seasonal study, no aquatic plants were observed in the surface waters of river Lokapavani. Water was always turbid, because of inflow of water from the nearby agricultural fields and wastes water from the adjoining sugar cane crushing industries, which enters into this river. Human activities like bathing, washing of cloths, vehicles, cattle and bullock cart and also occasional fish cleaning activity were observed during the sampling period. The river Lokapavani was different in having different nature of water and more anthropogenic activities. But, the surface water in river Lokapavani was less polluted, generally this may be due to regular water flow in the river Lokapavani, which might have prevented the accumulation of pollutants in this water course. Further, regular contamination of agriculture waste and other effluents from the near by sugar cane crushiong industry and also more anthropogenic activities in the river Lokapavani a detailed spatial study was under taken to find out the spatial variation along the river Lokapavani. Its main aims of this investigation were 1). To describe the variation of environmental variables along the river Lokapavani and 2). To investigate causes and factors which are responsible for such variations.

2. Materials and Methods

Description of sampling sites

Based on the availability of water, human activity and sampling convenience, four sampling stations were located on river Lokapavani for the study of spatial variations of physico-chemical (water quality) variables. The sampling sites along the river Lokapavani are described as LPR-1, LPR-2, LPR-3 and LPR-4 (Figure. 1). The sampling spot for site LPR-1 was located at Honkere village of Nagamangala Road Bridge, 41 Kms away from the Srirangapatna taluk of Mandya district. Here the water level was very low with stagnant nature of water this may be due to absence of seasonal rainfall in the catchments. Greenish water with foams, and algal patches was noticed on the water surface during sampling. The sampling site LPR-2 was located at Gangodi village 36 Kms away from the Srirangapatna taluk. Here the water level was very low, greenish water with foams, algal patches was noticed on the water surface. Sampling site LPR-3 was located at Sangapura village 28 Kms away from the Srirangapatna taluk. Water level was very low and was covered with algal patches with foams. Aquatic plants like *Eichhornia* (water hyacinth), *Pistia* and also human activities such as cattle washing and fishing were common. Waste materials like old cloths, slippers, plastics, dead twigs were observed. The sampling site LPR-4 which was routinely sampled during the seasonal study was located at Bapurayanakoppal (Latitude 12^0 25″N and Longitude 76^0 41″E), near Srirangapatna taluk of Mandya district. During the entire spatial study, no aquatic plants were observed in the surface waters of this site. The inflow of water from the nearby agricultural fields and wastes water from the adjoining sugar cane crushing industries was the main water source for this site. Human activities like bathing, washing cloths, vehicles, cattle and bullock cart and also occasional fish cleaning activity were observed during the sampling period. There was always water flow in this site.

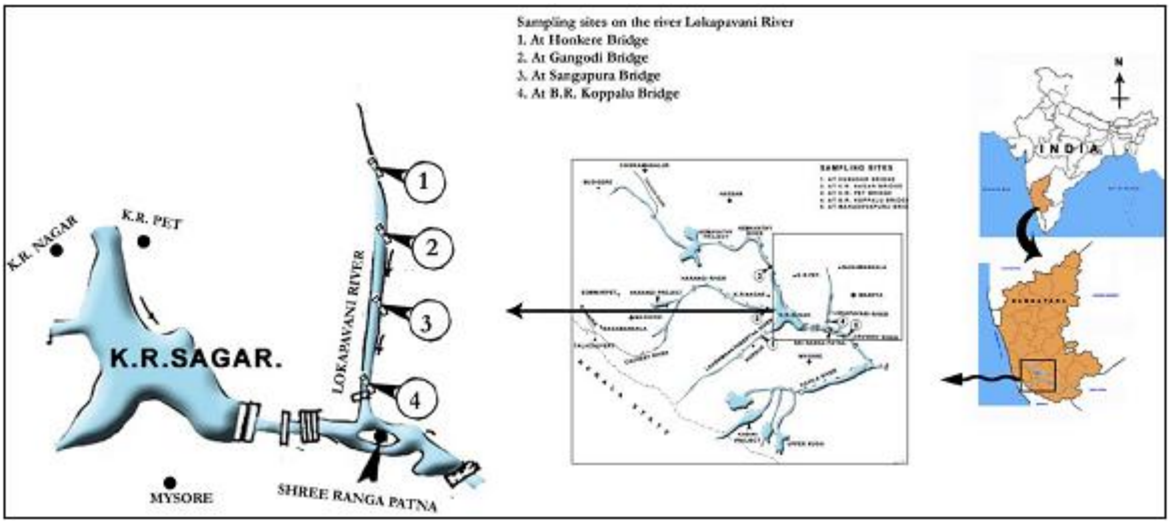

Figure 1: Map showing the sampling sites along the river Lokapavani for spatial study

Sampling

Mid-stream surface water was collected along the river Lokapavani from four different sites at Honkere village, at Gangodi village, at Sangapura village and at Bapurayanakoppal Road Bridge near Srirangapatnam, between 07.30 am and 12.30 pm. Water samples were collected in a clean, well rinsed 15 litre capacity polythene bucket and transferred to 5 litres polythene container for the analysis of physico-chemical (water quality) variables, care being taken not to disrupt the sediment. However, at sites where the water level was shallow, the samples for the analysis of physico-chemical variable were collected by slowly immersing the bucket in mid-stream, to avoid mixing of soil from both bottom and stream banks. Water samples for the determination of water quality variables are transported back to laboratory in wooden box.

3. Methodology

Determination of physico-chemical (water quality) variables was followed based on APHA (1992); Yamakanamardi (1995), and as described by Harsha et al., (2006). Surface water pH was measured in the field using Griph-D-pH meter with glass electrode. The electrode was calibrated against pH 7.0 buffer each time before measurements. However, pH of the surface water samples in the laboratory were measured by using µ-pH meter which was previously calibrated with pH 4.0, 7.0 and 9.2 buffers. The surface water temperature was measured with a hand held mercury-in-glass thermometer. The conductivity was determined in laboratory using microprocessor controlled conductivity meter it was previously calibrated with 0.1 M KCl solutions at 25^0C. Turbidity was measured in the laboratory using digital-nephelo-turbidity meter, which was set up using ultra pure water as zero and respective range (0-1, 1-10, 10-100 and 100-1000 NTU) using Farmazine solution. The surface water velocity (SWV) was determined by timing a semi submerged float (Lemon fruit) over a measured distance. The dissolved oxygen (DO) content of these water samples were estimated by Wrinkler's method. The DO in the sample was immediately fixed with 2 ml potassium iodide and 2 ml of manganese sulphate in the field itself soon after collection. BOD of water sample was determined as described in Mackereth (1963). The difference between the initial and final DO concentration i.e., DO_0-DO_5 gave the BOD value. The chemical oxygen demand (COD) of the surface water samples were detrmined by dichromate method as described by Aneja (1996). The free carbon-di-oxide (CO_2) of the water sample was estimated by titrimetric method. Chloride concentration of the surface water sample was determined by argentometer method. Calcium contenet was estimated by titrimetric method (APHA). Nitrate concentration in the water sample detrmined by brucine method. Inorganic phosphate concentration of water was analysed by using stannous chloride method and the optical density of the samples for both parameters were measured by using UV-VIS Spectrophotometer. The concentration of nitrate and phosphate were calculated from the standard curve. Sulphate concentration of the surface water sample was determined by turbiditimetric method. The standard curve was used to calculate the sulphate concentration (Trivedy and Goel 1986). Total Anions of Strong Acids (TASA) was calculated by adding the concentrations of chloride, nitrate and sulphate. Total Suspended Solids (TSS) and Particulate Organic Matter (POM) of surface water sample was detrmined gravimetrically as described in Yamakanamardi (1995); and Harsha *et al* (2006). The Chlorophyll-a of surface water sample was determined spectrophotometrically as described by Jesperssen and Christoffersen (1987).

4. Results and Discussion

The spatial study along the full length of river Lokapavani (till near confluence point with main river Cauvery) was carried out and the results of physico-chemical (water quality) variables studied are given in the (Table 1). The mean pH was above 8 in the sites LPR-1, LPR-2, LPR-3 and LPR-4 respectively. It was noteworthy that the highest pH (F) of 9.24 and lowest pH of 7.28 measured in LPR-2 were the highest and lowest recorded value among the four sites studied. There was not much spatial fluctuation noticed in pH (L), and the pH (L) measured was almost 8 or above 8 of all the four sites throughout the study period. Generally, the natural water with pH value of 6.0 to 8.0 can be considered as neutral water and majority of potable water fall within this category (Bulushu, 1987). But in the present investigation, the water pH measured in both field and laboratory was always in alkaline nature (>8.0) in all the sampling sites. The anthropogenic activities such as use of soaps and detergents during bathing and washing of cloths may be the reason. Similar to present investigation Borges *et al.,* (2003) also reported alkaline condition of pH in Pirapó river. The temperature did not show much spatial variation, it was almost similar in the sites LPR-1 (28.85^{0}C), LPR-2 (30.80^{0}C), LPR-3 (26.30^{0}C) and LPR-4 (27.70^{0}C). Further, the highest temperature of 36^{0}C measured in site LPR-2 and lowest temperature of 25^{0}C measured in the sites LPR-1 and LPR-4 were the highest and lowest recorded temperature values. The variation of temperature in water may be due to differential time of collection and influence of season (Jayaraman et al., 2003; Tiwari et al., 2004; Harsha et al., 2006). The conductivity was more and also similar in the sites LPR-1 (806.75 µS cm^{-1}), LPR-2 (946.80 µS cm^{-1}) and LPR-3 (945.60 µS cm^{-1}), but it was less and also significantly different in site LPR-4 (609.0 µS cm^{-1}). The highest conductivity value of 1220.0 µS cm^{-1} was recorded in the site LPR-2 and the lowest conductivity value of 440.0 µS cm^{-1} in the site LPR-4. High conductivity in water may due to low level of water, maximum anthropogenic activities, discharge of sewage and agricultural waste, all of which enriches the nutrient level in the water (Sharma and Pandey, 1998; Borges *et al.,* 2003; Mini *et al.,* 2003), might be the reason. The mean turbidity was more and also different significantly in the site LPR-2 (25.26 NTU) than the other 3 sites. The turbidity showed little spatial fluctuation and it was almost below 30.0 NTU (range, 2.30 to 27.9 NTU) throughout the study period, except for one prominent peak of 90.4 NTU in site LPR-2. Turbidity is an expression of optical property that causes light to be scattered and absorbed rather than transmitted in straight lines through the sample. The turbidity of river water is mainly caused by suspended matter, such as clay, silt, finely divided organic and inorganic matter and plankton and other microscopic organisms (APHA, 1992). Except in sites LPR-1 (2.50 NTU) and LPR-4 (2.40 NTU), the turbidity recorded in the river Lokapavani was above the permissible limit (5 NTU) as suggested by CES (1980) and WHO (1993). Total suspended solids (TSS) include the solids that are suspended in water bodies in the form of inorganic and organic particles of immiscible liquids. The mean concentration of TSS measured was similar in sites LPR-1(14.15 mg l^{-1}), LPR-3 (11.78 mg l^{-1}) and in LPR-4 (15.54 mg l^{-1}), but was more (35.58 mg l^{-1}) and also different significantly in the site LPR-2. Suspended solids influence the turbidity of water which inturn affect light penetration results in reduced photosynthesis (Patel et al., 1983; Drusilla et al., 2004). Further, the TSS showed little spatial variation with the range (3.80 to 41.6 mg l^{-1}) throughout the study period and it was below the permissible limits of 25 mg l^{-1} as described by ISI (1991) and WQA (1992). The velocity of a water body can significantly affect its ability to assimilate and transport pollutant. Thus measurement of velocity is extremely important in any assessment programme. The mean surface water velocity (SWV) was more (0.36 m Sec^{-1}) and was also significantly different in site LPR-4 as compared to other three sites studied. Further, there was no flow and it was almost stagnant in the sites LPR-1, LPR-2 and LPR-3, this might be due to low water level because of absence or scanty seasonal rainfall in the catchment area. Water velocity can vary within a day, as well as from day to day and season to season, depending on hydrometeorological influences and the nature of the catchment area (WQA, 1992; Harsha *et al.,* 2006). Determination of dissolved oxygen (DO) concentration is a fundamental part of water quality assessment since; oxygen is involved in, or influences all chemical and biological process within the water bodies. It is also essential to all forms of aquatic life especially for those organisms responsible for self purification process in natural waters. The mean DO was similar in LPR-1 (11.90 mg l^{-1}), LPR-2 (9.23 mg l^{-1}), LPR-3 (8.65 mg l^{-1}) and LPR-4 (9.01 mg l^{-1}). The highest concentration (14.78 mg l^{-1}) of DO was recorded in site

LPR-2. In general, the high phytoplanktonic growth in this region might have supported high DO value due to high photosynthetic activity. Similar findings were reported by Brandini (1985) and Brandini *et al.,* (1988) in the Bay of Paranaguá. The free Carbon di-Oxide did not show any significant variation among the four sampling sites on river Lokapavani. The spatial study in the concentration of CO_2 revealed that the zero concentration of the CO_2 was noticed occationally in the sites LPR-3 and LPR-2. The highest CO_2 concentration of 30.8 mg $^{-1}$ in site LPR-2 was the highest recorded value among the different sites studied. Further, the concentration of free carbon di-oxide recorded in the present investigation was above the permissible limits (< 10 mg l^{-1}) as suggested by APHA (1992). Higher levels of free CO_2 in the water courses may be due to respiration of floral and faunal population and decaying products of organic matter (Drusilla *et al.,* 2004; Harsha et al., 2006). Biological oxygen demond (BOD) is the quantity of oxygen required for the metabolic activities of micro-organism for five days at 20^{o}C for the biological degradation of organic matter present in water. The BOD was similar in all four sampling sites on river Lokapavani. Further, the BOD values recorded in the present investigation was below the permissible limit of 5 mg l^{-1} as suggested by ICMR (1975) throughout the study period in all sampling sites, except in the sites LPR-1 (5.14 mg l^{-1}), LPR-2 (5.83 mg l^{-1}) and LPR-3 (5.87 mg l^{-1}) occationally. Chemical oxygen demond (COD) is a measure of oxygen equivalent of the organic matter in a water sample that is susceptible to oxidation. The mean COD was similar in the sites LPR-1 (39.20 mg l^{-1}), LPR-2 (42.72 mg l^{-1}), LPR-3 (40.32 mg l^{-1}) and in LPR-4 (46.56 mg l^{-1}). But, the COD recorded in the present investigation on river Lokapavani was above the permissible limit (4.0 mg l^{-1}) as suggested by USPH (1980). Increased concentration of COD in the water may be due to high temperature and increased evaporation of water (Gyananath *et al.,* 2000; Mini *et al.,* 2003) or due to the presence of chemically oxidisable carbonaceous matter as well as inorganic matter such as nitrate and sulphates (Chandra et al., 2000; Harsha et al., 2006). Chloride, in the form of chloride (Cl^{-1}) ion is one of the major inorganic anions in water and waste water. The mean chloride was less (27.26 mg l^{-1}) and also significantly different in site LPR-4 than the remaining three upstream sites. The spatial study showed that the high concentration of Chloride (74.83 mg l^{-1}) in site LPR-1 was the highest recorded value of all the sites studied. In general, the increased concentration of chloride in the water may be due to sewage contamination and other anthropogenic activities (Desai *et al.,* 1995; Mini *et al.,* 2003; Harsha *et al.,* 2006). However, the chloride content in all the sampling sites of river Lokapavani were well within the permissible level of 200mgl-1 (WHO, 1993) and <250ppm (ICMR, 1975 and ISI, 1991). The Nitrate ion is the common form of combined nitrogen found in natural waters. It may biologically reduced to nitrite by denitrification processes under anaerobic conditions. The mean nitrate did not show any significant variation in any of the water samples studied. Usually, the nitrate content in the aquatic ecosystem will either be assimilated by algae and aquatic macrophytes or transferred to underlying sediments where it undergoes denitrification (Drusilla *et al.,* 2005; Harsha et al., 2006) this may be the reason that the nitrate behave atypically in having similar mean concentration in all the four sites. The nitrate level in the present investigation is well below the highest desirable limit of 45mgl-1 (ISI, 1991 and WHO, 1993). Sulphate is a naturally occurring anionic nutrient found in almost all kinds of water bodies which may undergo transformation to sulphur or hydrogen sulphide (Drusilla et al., 2005). The mean sulphate was similar among the different water samples studied on river Lokapavani. It was noteworthy that highest sulphate content of 8.0 mg l^{-1} in site LPR-1 and the lowest Sulphate content of 0.20 mg l^{-1} in site LPR-4 were the highest and lowest recorded values among different sites studied. The increased sulphate content in water may be due to discharge of sewage and other industrial or agricultural wastes (Abbasi et al., 1996; Das et al., 2003; Harsha et al., 2006) However, the sulphate content in the present study is well within the permissible limit of 250 mg l^{-1} as prescribed by ISI (1991) and WHO (1993). The sum total of chloride, sulphate and nitrate gives the total anions of strong acids (TASA). The TASA was less (29.13 mg l^{-1}) and was also significantly different in site LPR-4 only. The spatial variation in TASA showed that the highest concentration (82.93 mg l^{-1}) of TASA was noticed in the site LPR-1 was the highest recorded value among the different sites studied. The mean TASA was similar to the result of chloride, i.e., the mean concentration of TASA was significantly less in site LPR-4 as compared to remaining three sites. Calcium is one of the most abundant elements in natural waters impairing hardness. The mean calcium was more (27.95 mg l^{-1}) and also significantly different in site LPR-1 when compared other three sites. The highest calcium content of 31.66 mg $^{-1}$ in site LPR-1 and the lowest calcium content of 17.23 mg $^{-1}$ in site LPR-2 were the highest and lowest recorded values. Calcium content of all the water courses in the present investigation is below the highest desirable limit of 75 mg l^{-1} (ICMR, 1975). The phosphate is an essential nutrient for living organisms and exists in water bodies as both dissolved and particulate form. It is generally limiting nutrient for algal growth and therefore controls the primary productivity. The mean phosphate was similar and there was no significant variation in phosphate content in all the sampling sites of river Lokapavani. The phosphate content showed very little spatial variation with the concentration less than 0.2 mg $^{-1}$ and highest peak of 0.85 mg l^{-1} in the site LPR-3. The phosphate concentration in the present investigation is also well below the permissible limit of 0.1 mg l^{-1} (USPH, 1980). In contrast, the phosphate content in Parvathyputhanar river of Kerala was reported as 0.06 to 0.21mg l^{-1} (Prasanthan and Nayar, 2000). The particulate organic matter (POM) did not show any spatial variation between the four sampling sites studied. POM indirectly depends upon the TSS, i.e. organic matter content in the form of Particulate matter, which will burn at 400 ºC in a furnace (Yamakanamardi, 1995; Harsha et al 2006). POM in the water is important for the growth of micro-organisms, which fluctuated due to phytoplankton and other organic substances. The mean Chlorophyll-a measured in the present study revealed clear cut spatial variation with highest (site LPR-1, 19.68 µg l^{-1}), moderate (site LPR-2, 5.28 µg $^{-1}$) and lesser (sites LPR-3, 2.37 µg l^{-1} and LPR-4, 2.42 µg l^{-1}) Chlorophyll-a concentration. The Chlorophyll-a is a measure of phytoplankton biomass and is an index of productivity, which may further increase by the addition of nutrients such as phosphate and nitrate. Water with low nutrient content decreases the concentration of Chlorophyll-a (<2.5 μg l^{-1}) in contrast high nutrient content increases it up to 140 μg l^{-1} (WQA, 1992).

Table 1: Spatial study the Physico-chemical (environmental/water quality) parameters in the surface-water of river Lokapavani.

Sl. No.	*Physico-chemical Parameters*	*Site1 LPR-1*	*Site 2 LPR-2*	*Site 3 LPR-3*	*Site 4 LPR-4*	*F-value¹*	*P-value¹*
1	pH(F)	8.48^a±0.16	8.28^a±0.71	8.34^a±0.21	8.48^a±0.05	0.3637	0.7801^{NS}
2	pH(L)	8.25^a±0.21	8.18^a±0.33	8.20^a±0.13	8.20^a±0.19	0.1059	0.9554^{NS}
3	Temperature	28.85^a±2.23	30.80^a±3.70	26.30^a±1.15	27.70^a±1.86	2.0857	0.1071^{NS}
4	Conductivity	806.75^a±146.44	946.80^a±162.76	945.60^a±126.91	609.0^b±137.63	6.1340	0.0056*
5	Turbidity	10.23^a±10.33	25.26^b±21.68	8.72^a±7.65	10.22^a±6.72	4.7829	0.0167*
6	SWV	0.00^a±0.00	0.00^a±0.00	0.00^a±0.00	0.36^b±0.25	10.4443	0.0005***
7	DO	11.90^a±2.27	9.23^a±3.19	8.65^a±1.03	9.01^a±2.36	2.0104	0.1521^{NS}
8	BOD	3.87^a±1.16	3.03^a±1.75	2.01^a±1.96	1.85^a±1.62	1.4696	0.2604^{NS}
9	CO_2	15.12^a±3.42	15.93^a±11.11	14.87^a±9.01	13.20^a±4.19	0.1123	0.9516^{NS}
10	COD	39.20^a±9.86	42.72^a±8.74	40.32^a±7.21	46.56^a±6.75	0.7820	0.5212^{NS}
11	Cl_2	51.54^a±13.67	51.40^a±12.28	44.25^a±11.77	27.26^b±5.18	5.1842	0.0108*
12	NO_3	0.18^a±0.13	0.14^a±0.08	0.19^a±0.13	0.20^a±0.09	0.2590	0.8539^{NS}
13	SO_4	5.10^a±2.82	4.44^a±2.77	2.68^a±2.08	1.66^a±2.44	1.9320	0.1651^{NS}
14	TASA	56.82^a±15.63	55.99^a±12.00	47.11^a±11.34	29.13^b±5.60	6.0348	0.0060*
15	Calcium	27.95^a±2.43	21.96^b±3.85	23.66^b±1.81	24.08^b±2.23	4.4290	0.0190*
16	PO_4	0.10^a±0.07	0.09^a±0.06	0.21^a±0.26	0.12^a±0.12	0.3815	0.7677^{NS}
17	TSS	14.15^a±7.73	35.58^b±23.99	11.78^a±12.44	15.54^a±15.06	4.0164	0.0284*
18	POM	7.02^a±3.51	12.58^a±11.46	4.82^a±5.14	7.38^a±8.95	0.8635	0.4802^{NS}
19	Chlorophyll-*a*	19.68^c±17.50	5.28^b±4.96	1.85^a±2.37	1.83^a±2.42	4.0129	0.0296*

Values are Mean ± SD, ¹value obtained from ANOVA post hoc nonparametric test. * = Significant, p<0.05. NS = Non Significant, p>0.05.
Mean values with different superscripts are significantly different (p<0.05, Student-Newman-Keuls test).
pH (F) = pH measured in the field, pH (L) = pH measured in the laboratory, Temp= Temperature, Cond= Conductivity,
Tur= Turbidity, SWV= Surface Water Velocity, RF= Rainfall, DO= Dissolved Oxygen measured in the Field, BOD= Biological
Oxygen Demand, COD= Chemical Oxygen Demand, CO_2= Free Carbon di-Oxide, Cl_2= Chloride, NO_3=Nitrate, SO_4= Sulphate,
TASA = Total Anions of Strong Acids, Cal= Calcium, PO_4= Phosphate, TSS= Total Suspended Solids,
POM= Particulate Organic Matter, Chl-*a*=Chlorophyll-*a*.

5. Conclusion

It was concluded that, the spatial study along the full length of river Lokapavani revealed that the physico-chemical (water quality) variables studied show abrupt pattern. This abrupt pattern may be due to different geographical condition or addition of waste water from different point and nonpoint sources. Some of the environmental parameters such as Conductivity, SWV, Chloride, TASA and Calcium responded differently in the site LPR-4. This was probably due to entry of water from irrigated fields and from the adjoining sugar cane crushing industries or due to human activity like bathing, washing cloths, vehicles, cattle and bullock cart or due to differences in superficial geology. Further, some of the water quality parameters such as, DO, BOD, Chloride, Carbon di-Oxide, Nitrate, Sulphate, Calcium were well within the permissible limits, where as the values of Conductivity, Turbidity, COD, Phosphate and Total Suspended Solids were above the permissible limits of drinking water standards as prescribed by WHO, ISI and USPH. Hence, in this investigation the content of some of the parameters could be minimized and indiscriminate entry of domestic sewage, agricultural runoff and other effluents into this running water course is prevented. Finally, the present study also warrants for strict vigilance and continuous monitoring of these natural water bodies for conservation and sustainable management.

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