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Status of Water Quality and Heavy Metal Pollution from Coovum River, Tamilnadu, India

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Abstract:
The Coovum River which was once navigable and recreational has now become a sink of garbage dumping and a sewage outlet. Two sampling stations were chosen – Arumbakkam and the Coovum River Mouth. All results obtained are corresponding to the monsoon (December 2009) and post – monsoon season (January 2010). Heavy eutrophication was a common occurrence. Levels of nutrients were high, but levels of essential nutrients, like sulphate, the electron acceptor of oxygen was very low. The water has almost no dissolved oxygen, and instead there are traces of heavy metals like copper, besides sewage and sludge. Apart from this, the microbial load of the river also has gone risen far above the optimum levels. Industries have largely contributed to the high metal concentrations in the waters. Alongside bank settlements and sewage disposals in the river has accounted to the heavy microbial load. It has reached far beyond saturation levels and is fully loaded with nutrients, metals and microbial load, which accounts to its unpleasant stench. This is of great concern, because it has a negative impact on our surroundings. It can be the breeding grounds for several infectious disease causing pathogens. Moreover, when this water enters the sea, it creates a huge impact on the water quality of the seas, especially at the mouth region. If this river is going to pollute at this rate, without any measures it will result in several health and environmental issues. Necessary steps should be taken to stop polluting these waters and steps to clean the Coovum river should be taken.

Keywords: Coovum, heavy metals, pollution, water quality

1.0 Introduction:
The Coovum river in Chennai, is the famous river which ends in the city of Chennai on the Bay of Bengal. The river almost bisects the city. The name of Coovum appears to be derived from Tamil Literature. It is also considered to be the shortest classified river draining into the Bay of Bengal and is only about 65 km long. Its source is in a place by the same name Kosovo in Tiruvallur district adjoining Chennai district. (Shanmugam *et al.,* 2006). The River Coovum originates in a village of the same name, about 70 km away from Chennai. Once a fresh water source, it is today a drainage course inside Chennai, collecting surpluses of 75 small tanks of a minor basin. The length of the River is about 65 km, of which 18 km fall within the Chennai city limits. Once a fishing river and boat racing ground, it has borne the brunt of the city's unplanned explosion. Coovum is presently a river spoiled by filth and pollution and the water quality is considered to be highly toxic and completely non-potable.

The mouth of the Coovum River is narrow, placid, slow and meandering. The water has almost no dissolved oxygen, and instead there are traces of heavy metals like copper, besides sewage and sludge. Due to its narrowness and about 3500 illegal hutments along its banks, it has not been recently desalted, which has closed it to river traffic (Shanmugam *et al.,* 2006). The quality of water in river Coovum is most affected by the discharge of sewage and other commercial activities. Mostly the river Coovum serves as a receptacle for the treated/partially treated sewage, which has resulted in the contamination level of pollutants higher than in other waterways.

Heavy metals are among the most common environmental pollutants and their occurrences in water and indicate the presence of natural or anthropogenic sources (Singh *et al*., 2004). At present the anthropogenic contribution of heavy metals in the environment far exceeds natural inputs. Human activity has inevitably increased the levels of metal ions in natural water systems. The main sources of heavy metals in the aquatic system are weathering of soils and rocks and from anthropogenic activities, whereby industrial and urban wastes are discharged into water bodies (Pardon *et al*., 1990; Boughriet *et al*., 1992; Yu *et al*., 2001, Ankley *et al*, 1996, Sathish, 1998, Sharma *et al.*, 1999). Other sources such as mine drainage, off shore oil and gas explorations, industrial pesticides, paints, textile, pharmaceuticals, domestic effluents, agricultural runoff and acid rain have all contributed to the increased metal load in these waters being ultimately incorporated in to aquatic sediments (Ansari *et al*., 2004). The metals can be either absorbed on to sediments or accumulated in benthic organisms, sometimes to toxic levels. To mention some of the sources are from congenital intoxication, copper cookware, copper pipes, dental alloys, fungicides, industrial emissions, insecticides.
Minamata disease referred as Chisso-Minamata disease is a neurological syndrome caused by severe mercury poisoning. Symptoms include ataxia, numbness in the hands and feet, general muscle weakness, narrowing of the field of vision and damage to hearing and speech. In extreme cases, insanity, paralysis, coma and death follow within weeks of the onset of symptoms (Blevins *et al*, 2000, Comans and van Disk, 1988). Some of the other effects apart from minamata disease are adrenal dysfunction, allergy, alopecia, anorexia, anxiety, birth defects, blushing, brain damage, cataracts, cerebral palsy, poor coordination / jerky movements, deafness, depression, dermatitis, discouragement, dizziness, drowsiness, eczema, emotional disturbances, excess saliva, fatigue, gum bleeding and soreness, headaches, hearing loss, hyperactivity, hypothyroidism, forgetfulness, immune dysfunction, insomnia, irritability, joint pain, kidney damage, loss of self-control, memory loss, mental retardation, metallic taste, migraines, nervousness, nerve fiber degeneration, numbness, pain in limbs, rashes, retinitis, schizophrenia, shyness, speech disorders, suicidal tendencies, tingling, tremors, vision loss and weakness (Ademoroti, 1996, Govindan and Devis, 1991).

E. coli

The seawater microcosm, the death of *Escherichia coli* in unfiltered seawater was more than in the filtered seawater and the death rate was higher when incubated in light than in the dark. Total sewage bacteria declined rapidly in seawater microcosm. Fecal coli-forms had less surviving ability compared with the total bacteria and 100 % mortality was recorded in seawater microcosm. Significant reductions in ATP and biomass were recorded with increase in incubation in the seawater microcosm but the reduction was 88% in pure seawater (Shanmugam *et al*., 2006).
This study is mainly focus to determine the water quality of the Coovum River at River Mouth and Arumbakkam by assessing the following parameters to estimate the surrounding environmental parameters of water salinity, temperature, pH and dissolved oxygen, to analyse the inorganic compound levels in the water like nitrite, sulphate, shosphate, alkalinity and silicate, heavy metal content of the water collected from two different stations and microbial load with special reference to *E. coli.* In this perspective there is a urgent need to study the current status of water quality, heavy metal and *E.coli* load from the Coovum River.

2.0 Materials and methods

The samples were collected from two different stations (Coovum river mouth (Latitude - 13˚04’03.43”N; Longitude - 80˚17’10.36”E) and Arumbakkam (Latitude – 13˚03’40.40”N; Longititude – 80˚12’40.96”E) in two different periods. The periods were Monsoon (October – December, 2009) and Post Monsoon (January – February, 2010). The parameters such as temperature, pH, dissolved oxygen, salinity were determined. A water sample of about 1000 ml was collected from each sampling site in a pre cleaned, in high density polythene bottle.

2.1 Physico-Chemical parameters

1. **Temperature -** Temperature of the water sample is measured by using calibrated mercury filled Celsius thermometer with an accuracy of 0.1˚C.
2. **pH -** pH of the water sample is measured by using pH pen.
3. **Salinity -** Salinity of the water sample is measured with standard salinometer (Refractrometer).
4. **Dissolved oxygen -** Dissolved oxygen of the water sample is measured with DO meter.
5. **Alkalinity -** Alkalinity of the water samples analyses by Grasshoff *et al*., 1999.

2.3 Nutrients

All the nutrients level were analyzed by the method given by Grasshoff *et al.,* 1999.

2.4 Heavy metals

Water samples were collected in acid washed polythene containers, filtered and acidified with concentrated nitric acid to bring the pH approximately to 2. Acidification minimizes precipitation and adsorption of metals on the walls of containers. Samples were stored frozen until further analyses. All the heavy metal analysis was carried out in the laboratory followed methods outlined in APHA (1981).

2. 5Tests for *Escherichia coli*

Pretreatment of samples being examined: Proceed as described under the test for total aerobic microbial count but using lactose broth or any other suitable medium shown to have no antimicrobial activity under the conditions of test in place of buffered sodium chloride-peptone solution pH 7.0. Place the prescribed quantity in a sterile screw-capped container, add 50 ml of nutrient broth, shake, and allow standing for 1 hour (4hours for gelatin) and shaking again. Loosen the cap and incubate at 37° for 18 to 24 hours.

Fig.1. Coovum River mouth

Fig.2. Arumbakkam

3.0 Results and Discussion:

Table1: Showing the water quality parameters and nutrients during monsoon and post monsoon in station I and II

Season	Temperature		pH		Salinity		Dissolved Oxygen		Alkalinity	
	St I	St II	St I	St II	St I	St II	St I	St II	St I	St II
Monsoon	27.3	26.5	6	5.8	3	0	8.2	8.8	55.9	105.4
Post Monsoon	27.8	26.2	6.5	5.5	4.2	1.6	7.8	7.4	70.99	98.5
			Phosphate		Nitrite		Silicate		Sulphate	
			St I	St II	St I	St II	St I	St II	St I	St II
Monsoon			36.8	79.6	16.5	42.4	14.2	36.9	158.3	221.8
Post Monsoon			65.8	101.5	44.9	65.5	20.12	23.8	15.9	250.6

The water quality parameters temperature, pH, dissolved oxygen, salinity, alkalinity, phosphate, nitrate, silicate, sulphate, heavy metals such as mercury (Hg), copper (Cu), zinc (Zn), nickel (Ni), lead (Pb) and *E.Coli* were analysed from Coovum river mouth and Arumbakkam stations in the monsoon and postmonsoon period. The results are given from Table 1, 2 &3. The high level of temperature observed in post monsoon at station-I with 27.8˚C and low level was recorded in station-II with 26.2˚C during the post monsoon. The pH noted 6.5 in station – I during post monsoon. The salinity observed in station-I was higher with 4.2 in post monsoon and lower value of 0 noted during monsoon at station-II. The dissolved oxygen obtained higher in station-II with 8.8 in monsoon. The lower dissolved oxygen has been noted 7.4 during post monsoon in station-II. The alkalinity is low with 55.9 in monsoon and higher with 105.4 in station I & II respectively.

The phosphate values are higher in post monsoon at station-II with 101.5 and 36.8 with station-I during monsoon period with lower level. The nitrite observed in station-II was 65.5ppm and 16.5ppm in station-I post monsoon and monsoon respectively. The silicate observed in station-I was 14.2ppm during monsoon with lower values and 36.9ppm with higher values at station-II in monsoon. The sulphate values are higher in post monsoon with 250.6ppm at station-II during post monsoon period.

All the heavy metal values were given in Table.2. The mercury values observed in station-II with higher range 12.88ppm and lower in 6.12ppm at station-I during the post monsoon and monsoon respectively (Fig.1). The copper has 4.2ppm (station-II) during monsoon period and 2.8ppm (station-I) in post monsoon (Fig.2). The zinc has observed in 10.5ppm at station-I during monsoon with higher values and 5.12ppm in post monsoon at station-I with lower values (Fig.3). The lead has been noted with higher range of 8.08ppm during post monsoon at station-II and lower range in observed in station – I was 4.12ppm during monsoon (Fig.4). The nickel observed in station-I with 0.12ppm during monsoon with lower concentration and 0.81ppm at station-II during post monsoon (Fig.5). The *E.coli* population has been observed in station-I was 6810colonies/10ml during monsoon and 570 colonies/10ml during monsoon (Table.3). Whereas it was recorded with 8470 colonies/10ml during the post monsoon season and 710 colonies/10ml during the post monsoon season (Fig.6).

Table 3: Showing the *E. coli* population during monsoon and post monsoon in station I and II

Season	Station – I (colonies/ml)	Station – II (colonies/ml)
Monsoon	6810	570
Post monsoon	8470	710

Table 2: Showing the heavy metals concentration (ppm) during monsoon and post monsoon in station I and II

Season	Mercury		Copper		Zinc		Lead		Nickel	
	St I	St II	St I	St II	St I	St II	St I	St II	St I	St II
Monsoon	6.12	15.8	2.8	4. 2	5.16	10.5	4.12	4.89	0.12	0.56
Post Monsoon	9.12	12.88	2.88	3.89	5.12	9.14	7.78	8.08	0.51	0.81

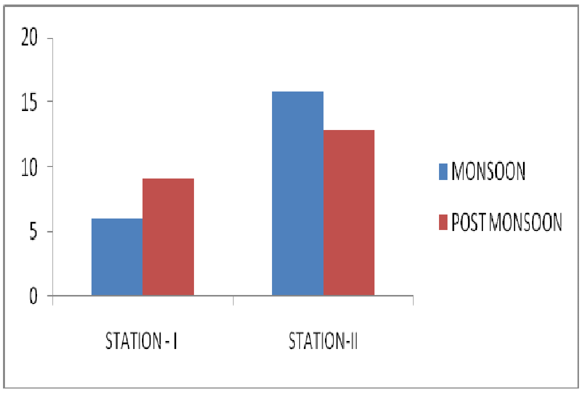

Fig.1 Showing the mercury in ppm. during monsoon and post monsoon in station I and II

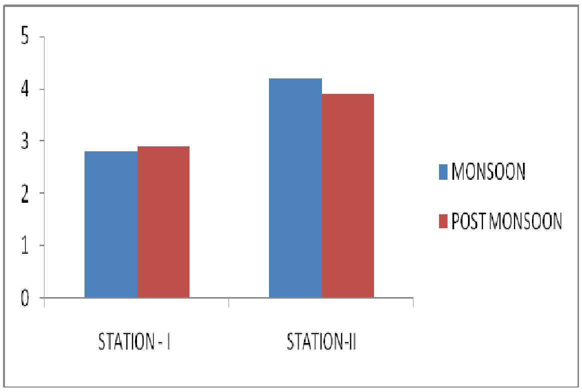

Fig 2. Showing the copper in ppm. during monsoon and post monsoon in station I and II

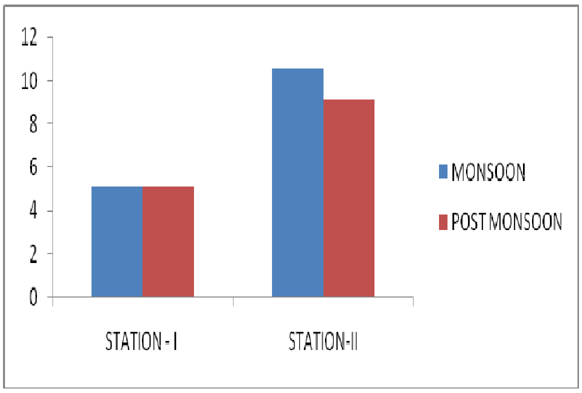

Fig.3. Showing the zinc in ppm. during monsoon and post monsoon in station I and II

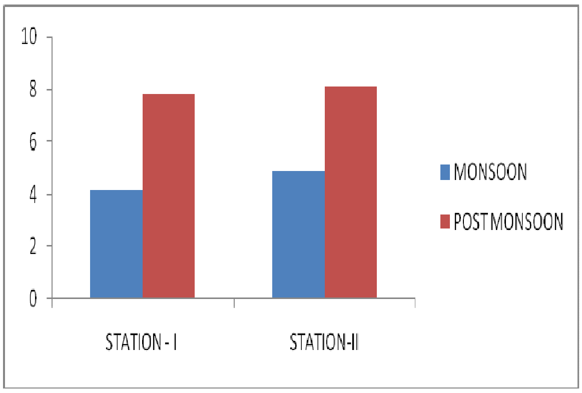

Fig.4. Showing the lead in ppm during monsoon and post monsoon in station I and II

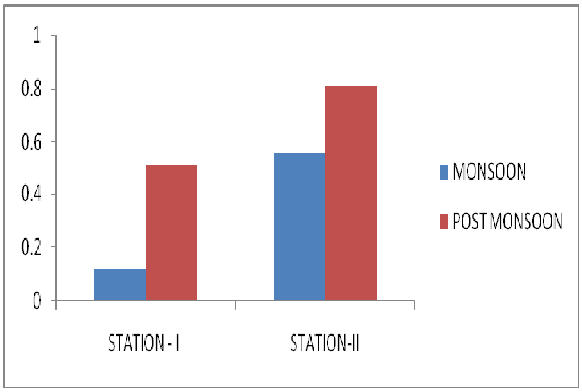

Fig.5: Showing the nickel in ppm. during monsoon and post monsoon in station I and II

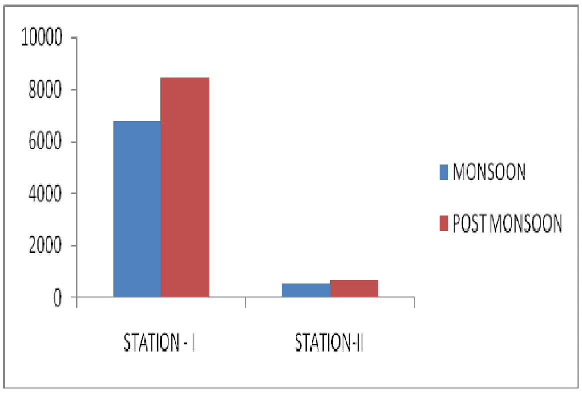

Fig. 6 Showing the *E.coli* in colonies/10ml during monsoon and post monsoon in Station I and II

The Coovum River is one of the oldest River in Tamil Nadu. Through the years the condition and quality of water has rapidly decreased. This deterioration in water quality has further impacts several other related environmental factors. Two sampling stations were chosen viz Coovum River mouth and Arumbakkam for the study. All the results obtained are corresponding to the monsoon (October – December 2009) and post – monsoon season (January – February 2010). The recorded temperatures showed negligible variance. Temperatures were almost the same at both instances of sampling. This may be because the influence of climate was not so drastic. As sampling was not carried out in the summer season, there has been no record of extreme temperature variations. The pH values recorded showed slight increase after the monsoon season. This corresponds to the observations of Ananthraj *et al.,* (1987). pH values showed fluctuation between 6 – 7. The range of pH values of this tropical river is in agreement with other Indian rivers as recorded by Subramanian (1979). Dissolved oxygen values ranged between 7 – 9. Depletion of oxygen in all stations was due to eutrophication and degradation of organic matter present in the sewage by the heterotrophic bacteria, which completely take up all the dissolved oxygen (Welch, 1980, Davies *et al.,* 1991).

Phosphate values were moderately high, ranging from 35 – 102 ppm Station II showed higher values. These high values may be due to the sewage input and excessive eutrophication of the waters of the Coovum. High values of total phosphate were usually recorded in rivers/streams affected by domestic sewage (Ravichandran, 1985). The values recorded for nitrite content were also higher in the post monsoon season, showing clearly the impact of sewage disposal and eutrophication in the Coovum River. These values reconfirm the facts established by Ravichandran (1985). Sulphate content was observed to be highest in station- II in the post monsoon season. The overall values ranged between 150 – 250 ppm. The values obtained were greater than those recorded in other Indian Rivers (Subramanian, 1979). Sulphate becomes the electron acceptor when the dissolved oxygen is completely depleted and used for the organic matter breakdown by bacteria and results in the production of hydrogen sulphide gas which forms bubbles at the surface (Welch, 1980, Probe and Mahadevan, 1992). High sulphate levels were also associated with sewage pollution.

The results recorded for heavy metals shows a distinct connection with the development of industries in the surrounding areas. Levels of mercury, copper, zinc, lead and nickel were assessed. While for most metals, the values obtained at the two stations were more or less similar, the case was not same with nickel. Station-II showed unusually high value of nickel. This may be due to large discharge from electroplating industries. The high nickel value in the post monsoon season is due to evaporation of water and concentration of the metal (Welch, 1980). The high values might also be due to high pollution caused due to sewage and organic matter (Lichtfuss and Gerard, 1981). It could also be due to the mixing of small amounts of enriched bottom waters without flowing surface waters (Ellaway *et al.,* 1980). Microbial load was determined, with special reference to the levels of the bioindicator *E.coli.* Station- I showed very high values of the number of colonies of *E. coli,* when compared to station-II. In station -II, the levels of *E. coli* were much higher in the post monsoon season. This clearly indicates the excessive levels of sewage pollution in the area near station-I. The data show the river Coovum is contaminated by heavy metals through industrial effluents, domestic waste, etc. All these activities are gradually increasing the level of heavy metals in the water and biota in alarming levels. Hence, industrial effluents and domestic wastes should be treated before letting them out into the river to avoid further contamination of heavy metals in Coovum river environment.

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