Studies on distribution of heavy metals in selected water samples of Gudalur taluk collected during southwest monsoon

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Abstract

The heavy metals are found naturally in the earth considered as critical toxic contaminants of aquatic eco systems due to their high potential toxicity. Heavy metals are more easily accumulated in wetlands due to changes in natural environment and influence of human activities. The present work was carried out as a survey to determine the heavy metals such as Calcium, Potassium, Sodium, Mercury, Chromium, and Manganese in the samples of water were collected from different water bodies of Gudalur taluk in Nilgiri District. GPS positions of the study area are Devala 11°28′09.37″N 76°23′59.07″E, Nadugani 11°28′15.48″N 76°23′37.49″E, Irumpupalam 11°32′05.44″N 11°32′05.44″E, O'Vally 11°29′38.04″N 76°27′24.67″E and Puthurvayal 11°26′44.35″N 76°28′05.45″E.The samples were collected from the study sites during monsoon, in the months of July to September. Five stations were selected for the present study. The selected heavy metals were Hg, Cr, Mn, Ca, Na and K, All the water samples were analysed by using Atomic Absorption Spectrophotometer (AAS). Calcium-1.078 mg/l, Potassium-1.322 mg/l, Sodium-1.780 mg/l, Mercury-0.860 mg/l, Chromium-0.781 mg/l and Manganese-0.26 mg/l were found relatively higher in Puthurvayal canal, which has high anthropogenic pressure in the form of outlet from agriculture fields as well as outlet from Gudalur town. The station O'Vally showed Mercury-0.009 mg/l and low levels of heavy metals, which is also exposed to low levels of anthropogenic pressure. The metal concentrations in water were significantly lower than those recommended by the WHO.

Key Words: chromium, Gudalur, heavy metals, manganese, mercury

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INTRODUCTION

The heavy metals are considered as critical toxic contaminants of aquatic eco systems, due to their high potential to enter and accumulate in food chain (Olojo *et al*., 2005).The main sources of heavy metal pollution are the agriculture, industry and metropolitan cities, and the bio accumulation of toxic heavy metals in fish species in different aquatic systems is dependent on their foreign polluted substances. The heavy metals are distributed in water sediments and fish play a key role in the bioaccumulation of heavy metals in the aquatic ecosystem (Forstner and Wittman, 1981).

The pollution of the biosphere with toxic metals has dramatically increased since the beginning of the industrial revolution (Nriogo, 1979). Contamination of aquatic environment by toxic metal ions is a serious pollution problem. Metals cannot be easily degraded and usually require chemical or physical removal. The toxic pollutants in the effluents can cause injury or death depending upon their concentration and distribution in the ecosystem. The industrial by products, wastes and effluents contain high level of heavy metals such as As, Cd, Cr, Fe, Hg, Mn, Ni, Pb and Zn.

Metalloids or stable metals with the density greater than 4.5 g cm-3 are called as heavy metals, which include mercury, lead, cadmium, iron, nickel, copper and manganese (Oehlenschläger, 2002;Anderson, 2003; Reilly, 2007). They are considered as integral component of the ecosystem and living matter (Nicholas, 1998; Carolyn *et al.,* 2004).

Heavy metals are non-degradable and affect internal organs and nervous system (Kar *et al.,* 2008). Although the major role of the river is transportation of industrial waste, municipal waste and agricultural runoff sources such as industrial pesticide, textiles, paints, domestic effluents, pharmaceutical mine drainage, acid rain, etc., are also the reason for increased load of heavy metals in the water sediments (Ansari *et al.*, 2004).

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According to Bryan (1976), some heavy metals like Copper and Cobalt are essential for enzymatic activity at low levels, and at higher concentration they act as enzyme inhibitors. Cadmium and lead do not have any essential role in living organism and are very toxic at low concentration. However, the occurrence of heavy metals in the water bodies of Gudalur taluk, Tamilnadu, India, has not yet been studied. With this view in mind, the present investigation was planned

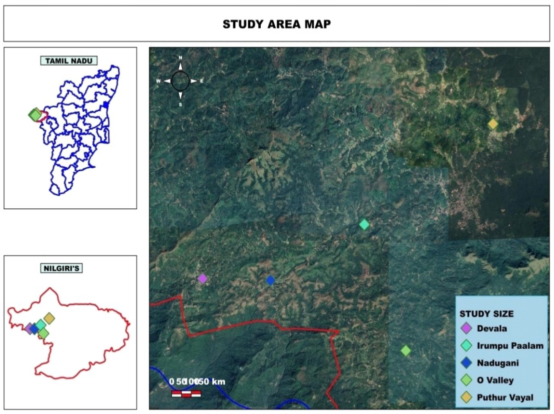

Figure. 1. Map of Study Area

Table 1. Instrumental conditions for analysis of heavy metals studied.

Element	Current(mA)	Slit width	Wavelength	Flame type	AAS technique
Ca	3.0 mA	0.15	422.7	Acetylene	Flame
K	6.0 mA	0.15	766.5	Acetylene	Flame
Na	5.0 mA	0.15	589	Acetylene	Flame
Hg	3.0 mA	0.15	253.7	Acetylene	Flame
Cr	6.0 mA	0.15	357.9	Acetylene	Flame
Mn	5.0 Ma	0.15	279.5	Acetylene	Flame

and the distribution of heavy metal in water sediments of selected aquatic ecosystems of Gudalur was studied in detail.

STUDY AREA

Water samples were collected from 5 stations of Gudalur taluk (Fig.1)Gudalur is municipality and taluk in Nilgiris District in the Indian state of Tamil Nadu. Gudalur is one of the major towns in west Tamil Nadu and is located at 52km from Ooty in the hilly terrain of the Nilgiris District. It is situated at the junction of Tamil Nadu, Kerala, and Karnataka. Gudalur gets about 120 inches (3,000mm) of rain fall in a year from south west and north east monsoons. It is located at a height of approximately 3500 feet (1,100m) above sea level. The economy of this area is dependent mainly on the tea industry.

Nadugani is located at 11°28'15.48"N76°23'37.49"E, and it is a small town in the Nilgiri District of Tamil Nadu. It is situated at a distance of 14 km from Gudalur. Many small streams in the forest combine to form rivulets which ultimately end up joining the Chaliyar River in Kerala.

Devala is located at 11°28'09.37"N 76°23'59.07"E in the Nilgiri District of Tamil Nadu. It is situated at about 16 km from Gudalur towards Pandalur road. A Stream originating from here flows to Kerala and reaches Maruthappuzha in Malapuram district of Kerala.

Puthurvayal is located at 11°26'44.35"N76° 28'05. 45"E and is a town of Nilgiri District of Tamil Nadu. It is situated at about 10km from Gudalur. It is surrounded by agricultural land. The water from the canal is used for irrigation and agricultural purpose.

Irumbupalam is located at 11°32'05.44"N76°30'27.7"E and is a village in the Nilgiri District of Tamil Nadu. It is situated at a distances of 6km from Gudalur. Many small water streams in the forest and combines to form small rivers which ultimately ends up joining the river Karimpuzha.

O'valley is located at 11°29'38.04"N 76°27'24.67"E is a town Panchayat in the Nilgiri District of Tamil Nadu. It is situated at a distance of 15 km from Gudalur. The stream found in this location is originated from forest area. It is used as a source of drinking water.

METHODS

Water samples were collected from the selected above water bodies of Gudalur in Nilgiri District. The samples were collected from the month of July to September. The water samples for the present study were collected ones in a fortnight from the each station, from 1cm below the water surface, and stored in 2 litre polythene bottles. All the water samples were immediately brought to the laboratory, the presence of selected heavy metals (Hg, Cr, Mn, Na, K, Ca) in all the water samples were analysed by using Atomic Absorption Spectrophotometer (AAS). (Table:1)

RESULTS AND DISCUSSION

Natural sources of heavy metals into river are through land runoff, and the weathering of rocks by mechanical and chemical process and also the heavy metal components can be washed and carried into the river through rainfall, forest fire, wind blow, dust, etc., from the atmosphere. Heavy metal distribution in water at five stations varied and was relatively higher during monsoon in the Puthurvayal than other stations (Figs.2-8).

Potassium in nature occurs only in ionic salts. Potassium ions are vital for the functioning of all living cells. Most industrial application of potassium is the exploitation of water soluble potassium compounds such as potassium soap (Sruthi, 2017) The concentration of Potassium ranged between 0.010 mg/l to 0.082 mg/l in the water of the auxiliary river of Moyar. The distribution of potassium was found to differ significantly ($p<0.01$) in samples of different stations studied. The potassium level was found relatively high in Nadugani (0.9743 ± 0.1621) and Puthurvayal (0.914 ± 0.6321), and in Nadugani (1.079 mg/l) and Puthurvayal (1.322 mg/l) during the month of July and September respectively, and low in O valley (0.045 mg/l) during in the month of August (Fig:2). This may be due to high level of rain fall received in the month of August The rain water seems to have dissolved Potassium salts in soil and water resulting in high potassium levels.

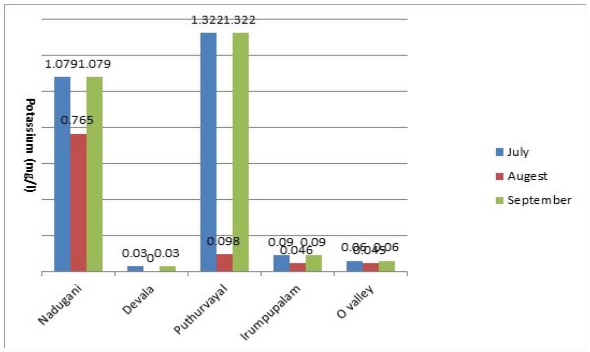

Fig:2 Occurrences of Potassium levels (mg/l) in water samples of different localities of Gudalur taluk during Southwest monsoon

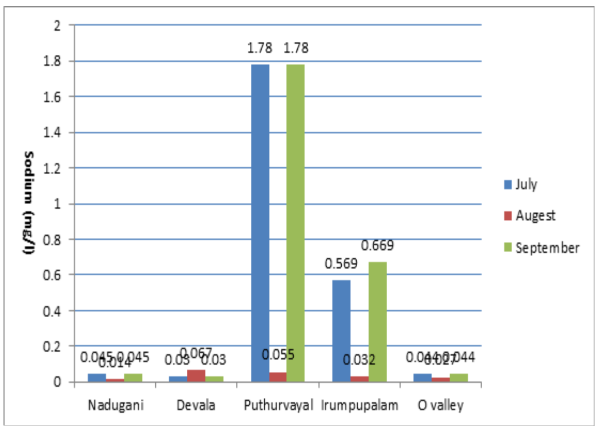

Fig: 3 Occurrences of Sodium levels (mg/l) in water samples of different localities of Gudalur taluk during South west monsoon.

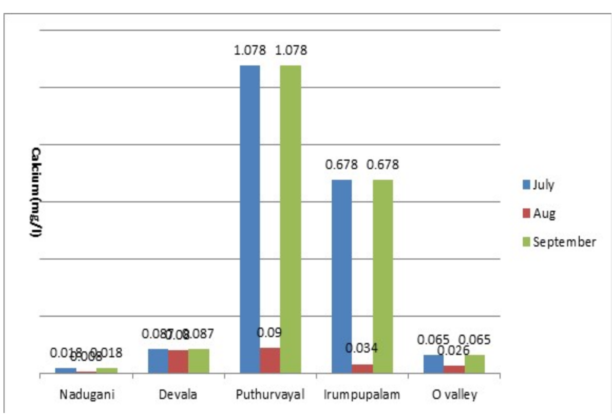

Fig: 4 Occurrences of Calcium levels (mg/l)in water samples of different localities of Gudalur taluk during Southwest monsoon.

Sodium chloride may impact a salty taste at 250 mg/l, public drinking water standards required chloride level not to exceed 250 mg/l. When Sodium combine with Chloride leads to salty tastes to the water. JelcyRani (2017) recorded the concentration of Sodium ranged between 0.004 mg/l to 0.068 mg/l in the well water used for irrigation. The higher amount of Sodium leads to several diseases like Circulatory disease, renal and cardiac problems(CPCB 2008).The distribution of Sodium was found to differ significantly ($p<0.000$) in samples of different stations studied and the Sodium level was found high in Puthurvayal (0.9140± 0.6321). It was high in the months of July and September. Sodium in Puthurvayal was 1.78 mg/l and low in Nadugani (0.014 mg/l) in the month of August (Fig.3). This may be due to high level of rain fall received in those months.

The acceptable limit of Calcium in waters is usually 75 mg/l whereas, its maximum permissible limit is 200 mg/l (ICMR,1975). The source of Calcium, in natural water is basically leaching from Calcium rich mineral rocks such as lime stone or mineralisation of organic matter by the bacteria. Therefore, Calcium in natural waters differs according to difference in geographical regions or anthropogenic impact. Calcium, in the form of Ca^{2++} ion, is one of the major inorganic cations, or positive ions, in salt water and freshwater (Sruthi,2017). The concentration of Calcium ranged between 0.009 mg/l to 0.058mg/l in the water of the auxiliary river of Moyar. The distribution of Calcium was found to differ significantly ($p<0.000$)in samples of different stations studied and Calcium level was found to be high in Puthurvayal (0.7487± 0.5102) and Irumpupalam (0.4633 ± 0.3326), and in Puthurvayal (1.078 mg/l) and Irumpupalam (0.678mg/l) in July and September respectively, and low in Nadugani 0.008 mg/l in the month of August (Fig.4). This may be due to high amount of rain fall received in those months.

The current standards for mercury in drinking waters were set by EPA and WHO at the very low levels of 0.002 mg/L and 0.001 mg/L, respectively (WHO, 2004a). Mercury exposure to human being is mainly caused through food especially fishes are main sources of Mercury (Zhang and Wong, 2007). Non-essential element mercury (Hg) was recorded maximum in the

Monsoon and similar results were recorded by Ramachandran (1990) from Uppanar estuary Nagapattinam. Sruthi, (2017) recorded 0.22 mg/l to 0.092mg/l of mercury in the water of the auxiliary river of Moyar. It was suggested that the higher concentration of these elements in monsoon might be due to the heavy rainfall which could carry all the municipal and agricultural wastes into the river and also the residues of heavy metals from the pesticides (Pragatheeswaran *et al*., 1986). Similar observations were found in the present study.

The distribution of Mercury was found to differ significantly ($p<0.000$). The level during Southwest monsoon was high in samples of different stations studied and the Mercury level was found relatively higher in Puthurvayal (0.8280 ± 0.0496) and Devala (0.4273 ± 0.2845) in the month of July, and it was 0.86 mg/l (Puthurvayal) and 0.611mg/l (Devala) in the month of September. The level during south west monsoon was high in the months of July and September and low in O'valley (0.016 mg/l) during the month of July (Fig. 5).

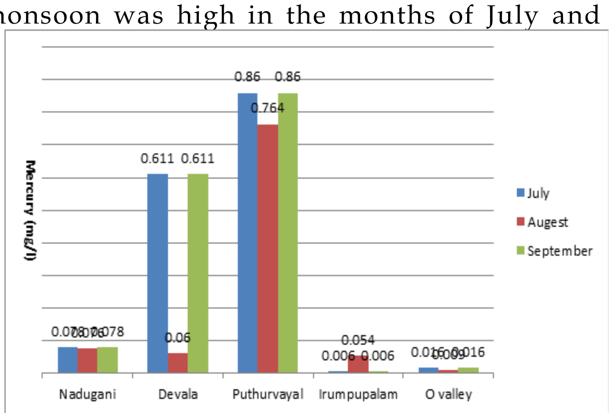

Fig: 5 Occurrences of Mercury levels (mg/l) in water samples of different localities of Gudalur taluk during South west monsoon.

WHO (1973) reviewed several investigations of adult diets and reported that the average daily consumption of manganese ranged from 2.0 to 8.8 mg/day. Higher Manganesese intakes were associated with diets high in whole-grain cereals, nuts, green leafy vegetables and tea. From manganese balance studies, WHO (1973) concluded that 2–3 mg of Manganese per day is adequate for adults and 8–9 mg/day is "perfectly safe". The distribution of Manganese was found to differ significantly ($p<0.000$) in samples of different stations studied and the Manganese level was found relatively high in Irumpupalam (0.0306 ± 0.0020) and Puthurvayal (0.0240 ± 0.0309), it was 0.032 mg/l (Irumpupalam) and 0.026 mg/l (Puthurvayal) in the months of July and September, respectively. It was low in Nadugani (0.008 mg/l) during the month of August (Fig 6).

Chromium in excess amounts can be toxic especially in the hexavalent form. Chromium is used in metal alloys and pigments for paints, cement, paper, rubber, and other materials. Electroplating can release chromic acid spray and air-borne Chromium -trioxide, both can result in direct damage to skin and lungs (Grounse *et al*., 1983). Subchronic and chronic exposure to chromic acid can cause dermatitis and ulceration of the skin (U.S.EPA, 1999). Long-term exposure can cause kidney and liver damage, and damage to circulatory and nerve tissue. Chromium often accumulates in aquatic life such as fish and thus it could enter in to the human system.

The highest amount heavy metal accumulation has caused serious effects in the living organisms. The Chromium is an important micronutrient for plants and animals and it becomes a pollutant at higher

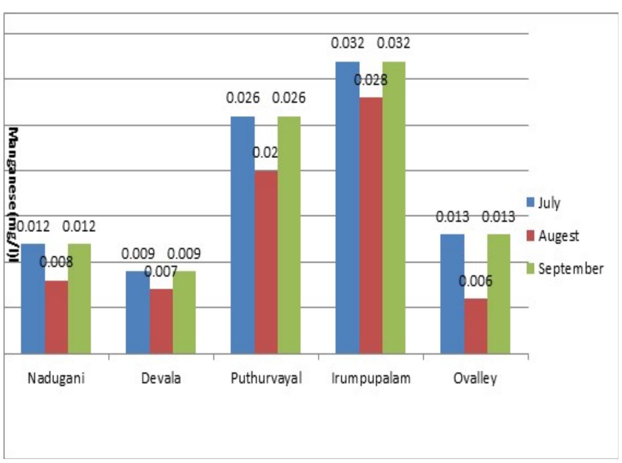

Fig: 6 Occurrences of Manganese levels (mg/l) in water samples of different localities of Gudalur taluk during Southwest monsoons.

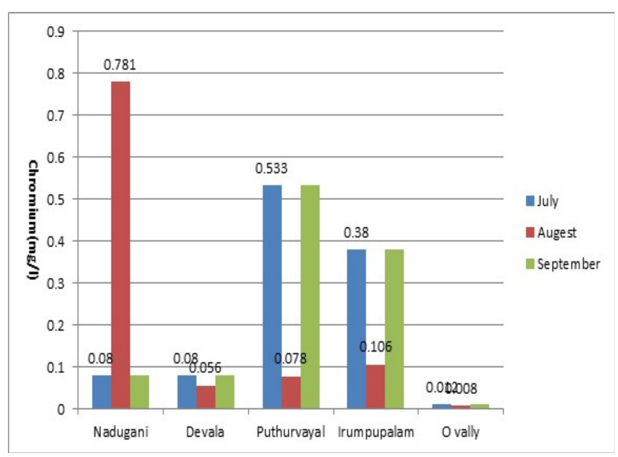

Fig: 7 Occurrences of Chromium levels (mg/l)in water samples of different localities of Gudalur taluk during Southwest monsoons.

concentrations (Lokeshwari and Chandrappa, 2006).The sources of Chromium metals are domestic sewage, anthropogenic activities , tanneries and industrial effluents (Gupta *et al*.,2000). Esther (2016) recorded 0.878 mg/l to 1.606 mg/l of chromium from selected wetlands of Udhagamandalam. The distribution of Chromium is found to differ significantly ($p< 0.015$) in samples of different stations studied, and it was found high in Nadugani (0.3137±0.3620) and Puthurvayal (0.3813±0.2350) and in Nadugani 1.0781mg/l and Puthurvayal (0.533 mg/ l) in the months of July and September, respectively, and low in O valley 0.008 mg/l during in the month of August (Fig:7)

High level of heavy metal found in Station III, Puthurvayal where the water source is situated near agricultural lands. However, the geological means may also be the reason for the heavy metals in water.

CONCLUSION

Even though fluctuations in heavy metal level of the water in the water bodies varied during rain fall of Southwest Monsoon, all the heavy metals are in the desirable and tolerable limits. Hence it is inferred that their water with the vital nutrients such as Mn, Mg, and Zn which is desirable for the irrigation purposes. The Hg and Cr are also found in the tolerable limits and hence the same can be recommended for the domestic uses, aquaculture and agriculture production.

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