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Determination and Analysis of Heavy Metals Present in Water from Datav Village of Raigad district, Maharashtra, India

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ABSTRACT

Industrial effluents discharged into the environment pose a serious threat to our agricultural products and health. In view of this, levels of some heavy metals, Zn, Pb, Cr, Cu, Ni, Co, Ag, Fe and Mn were determined in water samples collected from two pollution prone areas the vicinity of the industrial area near Datav village of Raigad district of Maharashtra state in India. The levels of the heavy metals were determined by Atomic Absorption Spectrophotometry. The results obtained show that the mean values of all heavy metals (with the exception of Zn) in water samples from the polluted areas studied were significantly higher than in the control site ($P < 0.05$). These mean values have also exceeded the acceptable limits.

***Key words**: Heavy metals, Pollution, Environment*

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INTRODUCTION

In India, the major sources of heavy metals pollution are industrial effluents discharged from various processing industries. This increases the influx of metals, which can be transported by wind and water and thus become available to plants and animals. These heavy metals attain higher concentrations and accumulate in dangerous quantity in different plants' part, and finally pose serious health hazard to human beings and the animals through biomagnification [1]. Heavy metals are elements having atomic weight between 63.545 and 200.5g [2] and a specific gravity greater than four [3]. The toxicity of these metals has also been demonstrated throughout history: Greek and Roman physicians diagnosed symptoms of acute lead poisoning long before toxicology became a science. Exposure to heavy metals has been linked with developmental retardation, various cancers, kidney damage and even death [4]. A legacy of incident tells us about the seriousness of high levels of exposure to some metals, especially cadmium and methyl mercury [2]. In the 1950s, chronic poisoning from rice coupled with dietary deficiencies caused epidemic of kidney damage and a painful skeletal disease among middle – aged women in Japan; the itaitai disease [5]. Also in Japan, mercury poisoning from fish in a polluted bay became known as Minimata disease [5]. Industrial pollution seriously threatens the quality of water resources and the environment in industrial area near village Datav of Raigad Maharashtra India. For instance, the deposition of refuse from food industries has been reported to have contaminated water from virtually all the industrial area near village Datav of Raigad Maharashtra India. The incidence of water discharge is possibly the biggest threat to city farming and has been identified as a major environmental hazard in the region [6]. A study conducted in 1989, which monitored the activities of 15 tanneries in industrial area near village Datav of Raigad Maharashtra India revealed that in all cases, permissible limits for effluents discharged were violated [7]. The same study indicated that not only do downstream fish and crops become heavily contaminated by heavy metals, but human health is further threatened in industrial area near village Datav of Raigad Maharashtra India because over 60% of the local people depend on rivers and ground water for their domestic use. Thus, from the studies highlighted above, it can be said that industrial pollution in Nigeria poses a serious threat to human beings. It needs to be tackled from every angle simultaneously using industrial technology, biotechnology, legal measures and environmental awareness education. It is therefore, quite imperative to

conduct various researches with the view to exploring all sources of heavy metal pollution in the environment. This may lead to the discovery of the presence of heavy metals and other contaminants and equally the levels at which they occur and their possible mode of control.

MATERIAL AND METHODS

Sample Collection The method employed by Environmental Protection Agency as reported by Gregg (1989) was adopted for the collection of water samples. The immediate source of water for the irrigation was used. The sources include the effluents pumped by the farmer's machines for irrigation and also from the channels leading away from the industries. The water from the control site was directly collected from the dam and then from the channels leading to the farmlands. The composite samples of water were collected in prerinsed plastic containers and mixed to make representative samples.

Digestion of Water Sample

The EPA vigorous digestion method was adopted [7]. 100ml of each of the representative water samples were transferred into Pyrex beakers containing 10ml of concentrated HNO3. The samples were boiled slowly and then evaporated on a hot plate to the lowest possible volume (about 20ml). The beakers were allowed to cool and another 5ml of Conc. HNO3 was added. Heating was continued with the addition of Conc. HNO3 as necessary until digestion was complete. The samples were evaporated again to dryness (but not baked) and the beakers were cooled, followed by the addition of 5ml of HCl solution (1:1 v/v). The solutions were then warmed and 5ml of 5M NaOH was added, then filtered. The filtrates were transferred to 100ml volumetric flasks and diluted to the mark with distilled water. These solutions were then used for the elemental analysis.

Metal Analysis

A total of nine metallic elements were determined in the pre – treated samples of water using Atomic Absorption Spectrophotometry [7]. These include Ca,Mg,Na, K, Cr, Cu, Zn. Ni , Fe and Mn.

RESUTS AND DISCUSSION

Metal Contents:

(a) Calcium: Calcium is an essential and important nutrient for aquatic organisms being a cell wall constituent and regulatory factor for physiological function. It is commonly found in all water bodies [8]. Calcium adds in water by dissolution from rocks which are rich in calcium minerals.

Calcium content ranges from 4.01 to 76.15 mg/L (Fig. 1). All the values for calcium were within the acceptable limits of WHO (105 mg/L). The decrease in amount of calcium may be due to its absorption by living organisms [8]. The value of calcium is found to be higher at N2 (76.15) in winter 2011 and minimum at N4 (4.01) in winter 2010 and summer 2012. The similar results were obtained by [2, 5]. The higher value of calcium may be due to the presence of rock soil in the study area, seepage of surface runoff.

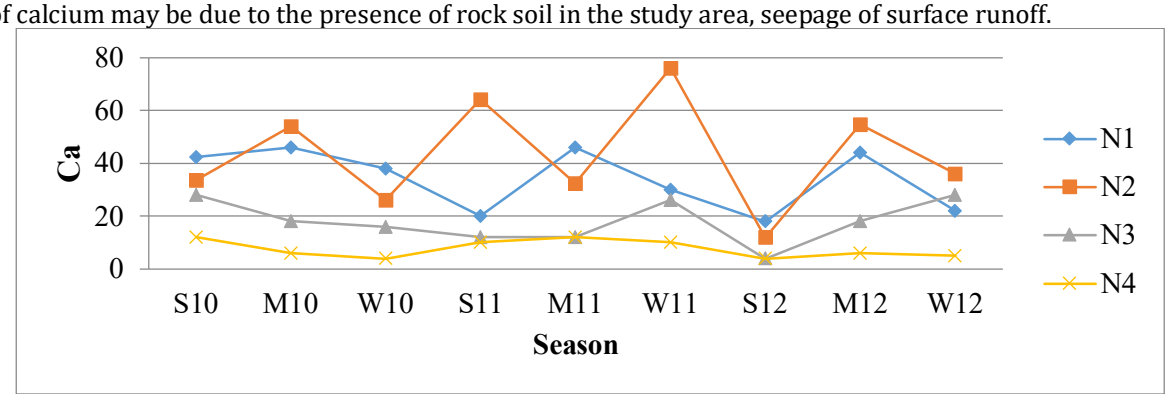

Fig. 1 Seasonal variation in Calcium of surface water samples during summer (S10, S11, S12) monsoon (M10, M11, M12) & winter (W10, W11, W12)

(b) Magnesium: Magnesium ions are common in natural water and essential element for all organisms. Magnesium when combined with bicarbonate, carbonate, sulfate and other species contribute to hardness of natural waters. When water is heated they deposited as scale. Concentration of magnesium was found to be lower than that of calcium.

The magnesium content of surface water ranges from 2.43 to 51.04 mg/L. The concentration of magnesium were found to be higer at N2 (51.04 mg/L) in winter 2011 and 2012 (Fig. 2). The magnesium values for all samples were found to be within the range of permissible limit (WHO 150 mg/L). Similar results were obtained by [6-8].

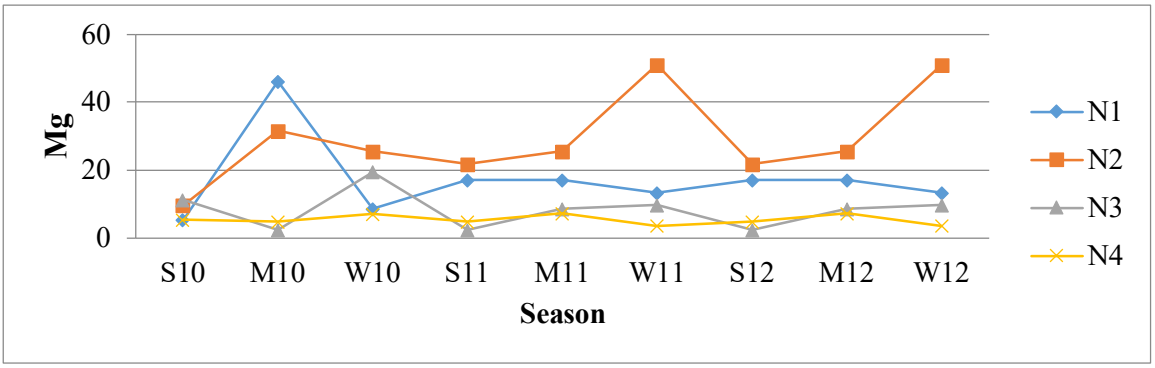

Fig. 2 Seasonal variation in Magnesium of surface water samples during summer (S10, S11, S12) monsoon (M10, M11, M12) & winter (W10, W11, W12)

(c) Sodium: Sodium is a mineral found naturally in some drinking water. The level of sodium in water is particularly important to people who have to watch their sodium intake for health reasons. Too much sodium has been identified for as a risk factor for high blood pressure. It is an important cation occuring naturally. Sewage is one of the important sources of sodium to the fresh water. Water with high sodium content is not suitable for agriculture as it tends to deteriorate the soils for crops. Sodium associate with chloride and sulfate makes the water unpotable [9].

The concentration of sodium ranges from 2.667 to 2400.18 mg/L (Fig. 3). 20% sample shows value for sodium above the standard limit of WHO (200 mg/L). The higher value was found at N1 (2400.18 mg/L) in monsoon 2010 and lower at N4 in summer 2012. It might be due to high rate of mineralization in the sediments, increasing sodium into the nutrient pool there by making more sodium to solubilise [12]. The higher values for sodium were also observed by [10].

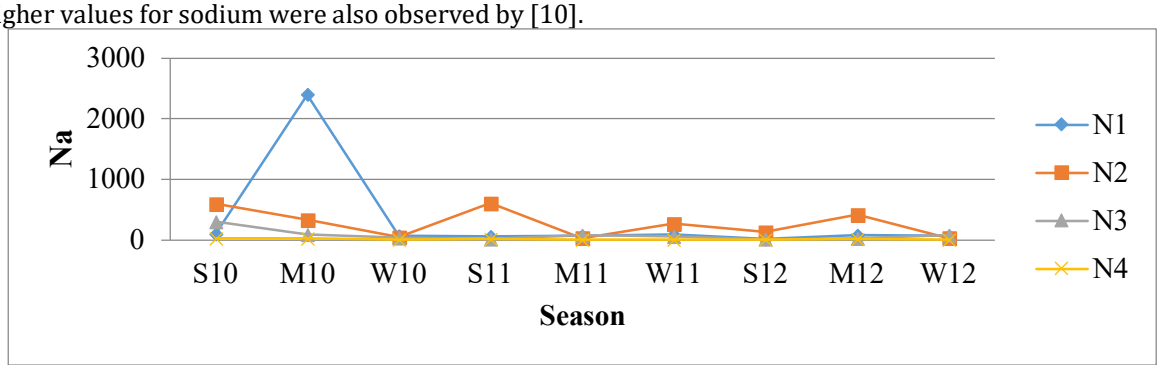

Fig. 3 Seasonal variation in Sodium of surface water samples during summer (S10, S11, S12) monsoon (M10, M11, M12) & winter (W10, W11, W12)

(d) Analysis of Potassium: Potassium is essental for plant and animal.The major source of potassium in natural fresh water is weathering of rocks but quantities increase in polluted water due to disposal of waste water [11].

Potassium content in sample was in the range of 0.283 mg/L – 955.19 mg/L. The higher concentration was noted at N1 in monsoon 2010 (Fig. 4). The high concentration might be due to anthropogenic origin, disposal of waste in the surface water [16]. The high value for potassium in monsoon was also found by [13]. The minimum value was found at N4 (0.283 mg/L) in monsoon 2011 and winter 2012.

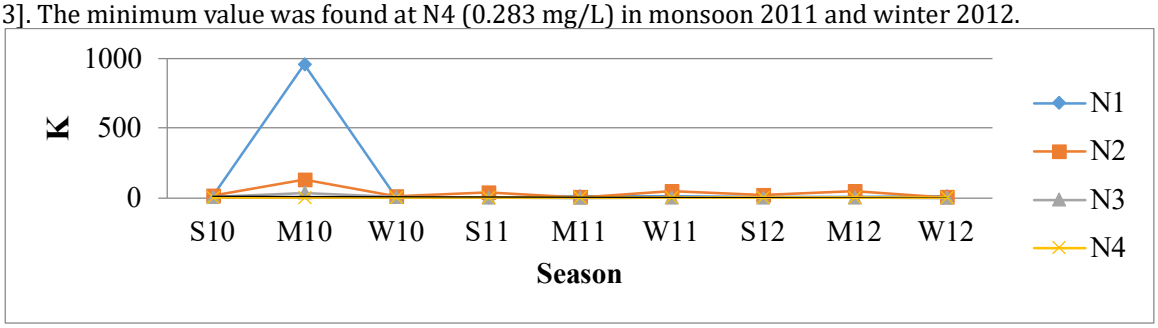

Fig. 4 Seasonal variation in Potassium of surface water samples during summer (S10, S11, S12) monsoon (M10, M11, M12) & winter (W10, W11, W12)

(e) Chromium: Chromium is present in domestic waste which adds in water resources [14]. Wood preservatives and paint products in the waste containing chromium also bring about contamination of water [15]. All surface water samples show chromium in the range of ND- 0.067 mg/L. The samples show either lack of Cr or very low Cr concentration, except at N2 0.067 mg/L which is higher than the WHO (0.05 mg/L) limit (Fig. 3.25). The high may be due to enhanced sorption by finely grained suspended sediments or waste water release contain Cr.

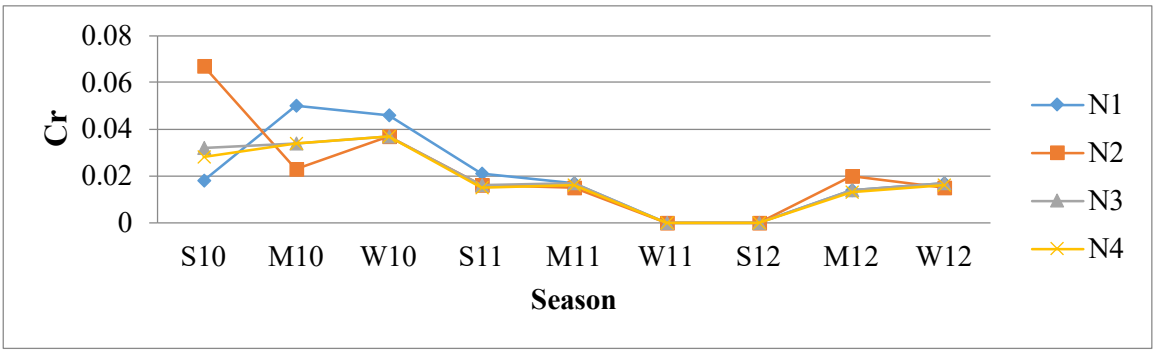

Fig. 5 Seasonal variation in Chromium of surface water samples during summer (S10, S11, S12) monsoon (M10, M11, M12) & winter (W10, W11, W12)

(f) Copper: Copper in drinking water arises from corrosive action of water, leaching of copper from copper pipes [20]. The excess of copper in human body causes sporadic fever, coma and even death [1, 2]. The copper content may be due to the enhaned sorption by finely grained suspended sediments. The samples shows either lack of copper or very low amount. The copper content ranges from 0.0 mg/L, - 0.351 mg/L (Fig. 3.26). All the samples were showing copper concentration below the desirable limit of WHO (2.0 mg/L). The high value of copper may be due to anthropogenic inputs from industries [16, 17]].

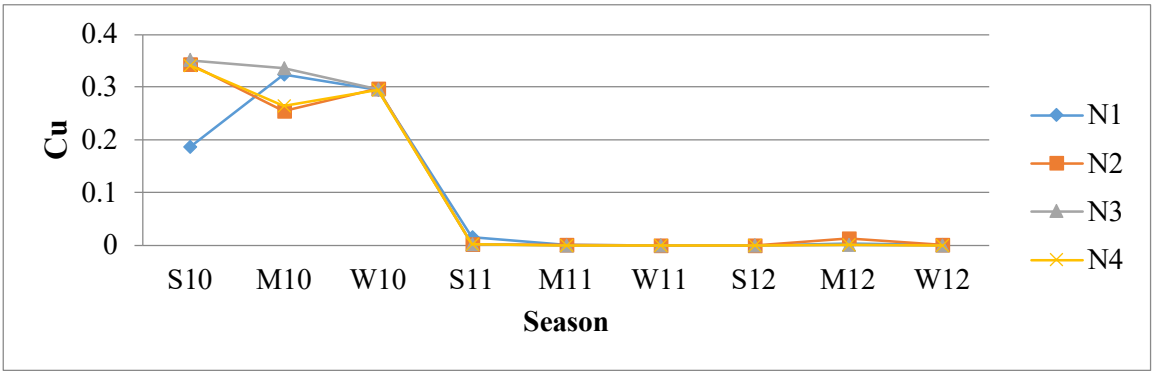

Fig. 6 Seasonal variation in copper of surface water samples during summer (S10, S11, S12) monsoon (M10, M11, M12) & winter (W10, W11, W12)

(g) Zinc: Zinc is naturally present in water and its solibility in water depends on the temperarure and pH of water. It is relatively non-toxic. Zinc adds in water through discharge of fertilizers and pesticides containing zinc [18]. All samples show the zinc in the range 0.0 mg/L – 1.128 mg/L (Fig. 7). All the values were below the range of desirable limit of WHO (3.0 mg/L). The vaues indicates that there was no input containg zinc to river.

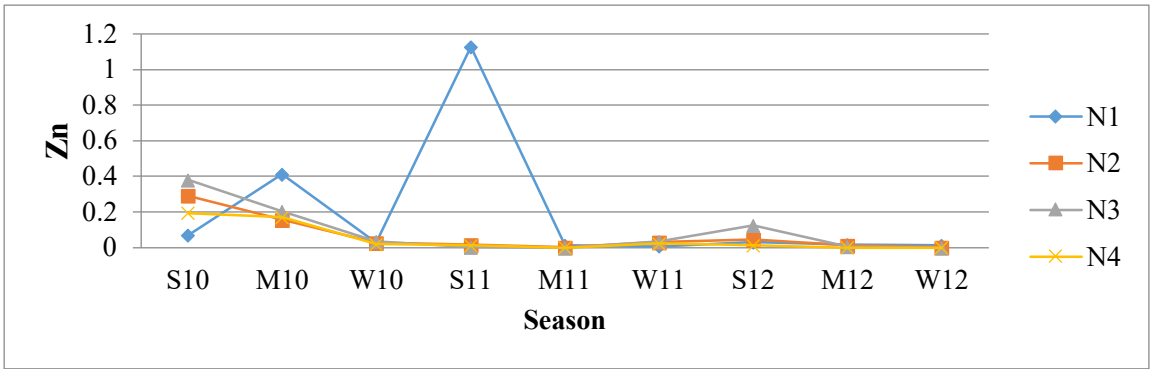

Fig. 7 Seasonal variation in Zink of surface water samples during summer (S10, S11, S12) monsoon (M10, M11, M12) & winter (W10, W11, W12)

(h) Nickel: The nickel has no significant relationship with lithology of the area and is associated with anthropogenic processes such as application of micronutrients [4, 7]. Electroplating industries, the combustion of coal, oil and gasoline, waste incineration and other have boosted the concentration of nickel in the surface waters of the region [6]. All samples show the nickel in the range of 0.0 mg/L- 0.027 mg/L. Except at N1 in monsoon 2010 the value of nickel was found to be more than the desirable limit of WHO (0.02 mg/L) (Fig. 8). The high value was anthropogenic in origin [9]. Discharge of domestic waste and phosphate fertilizers which contain traces of nickel in river [12]. All the samples show nickel values below the desirable limit of standard as per WHO.

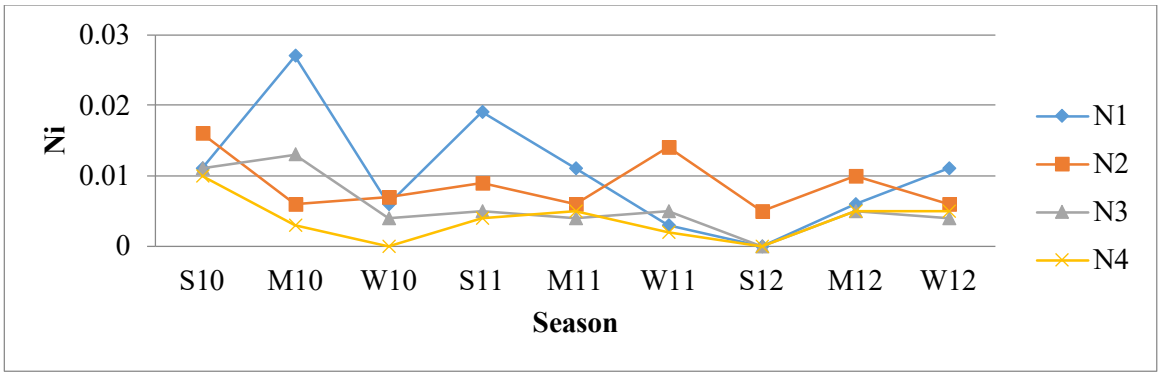

Fig. 8 Seasonal variation in Nickel of surface water samples during summer (S10, S11, S12) monsoon (M10, M11, M12) & winter (W10, W11, W12)

(i) Manganese: The manganese has no significant relationship with lithology of the area and is associated with anthropogenic processes such as application of micronutrients [19, 20]]. Manganese in surface water is in the range of 0.0 mg/L to 3.003 mg/L (Fig. 9). The 19% samples show the concentration of manganese above the desirable limit of WHO (0.5 mg/L). The high concentration is due to addition of effluent in river water by industrial waste containing Mn, which is anthropogenic in origin.

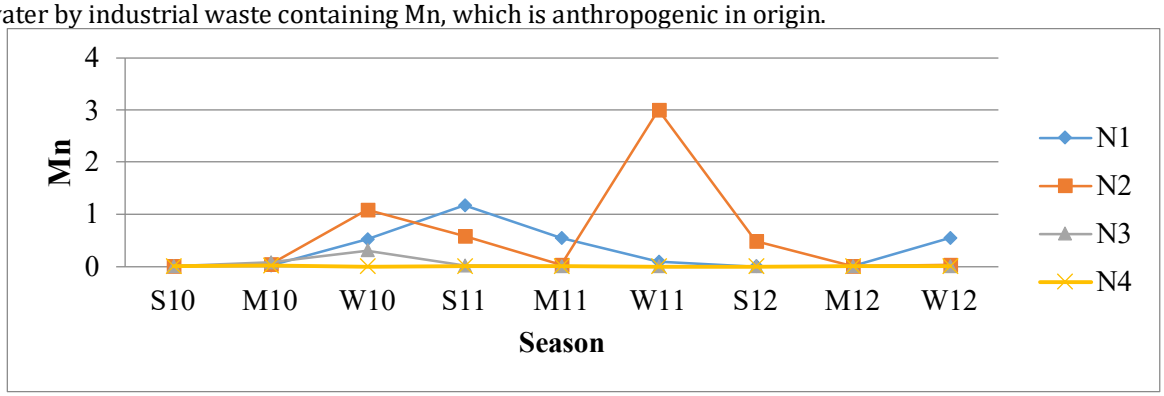

Fig. 9 Seasonal variation in Manganese of surface water samples during summer (S10, S11, S12) monsoon (M10, M11, M12) & winter (W10, W11, W12)

(j) Iron: Source of iron in water is through dumping of metal scrap [7]. Auto body rust, engine parts, bearing wear and brake emissions from automobile outlets around the river basin [19] could be responsible for high values of iron. Presence of iron in substantial quantities can make the water unsuitable for food processing [12]. Iron is absent in 2011, 2012 samples except at N1 in summer 2011 and at N4 in winter 2011 but values were well below the desirable limit of WHO (0.3 mg/L) (Fig. 10). Amongst the surface water smaples in 2010 the concentration of iron at three sampling stations namely N1 (9.493 mg/L) in monsoon, and at N1 (0.992 mg/L) and N2 (0.562 mg/L) in winter 2010 the values exceeds the WHO limit. It might be due to contamination of water due to discharge containg autobody rust, engine parts, bearing wear and break emission from automobile outlets [19-21].

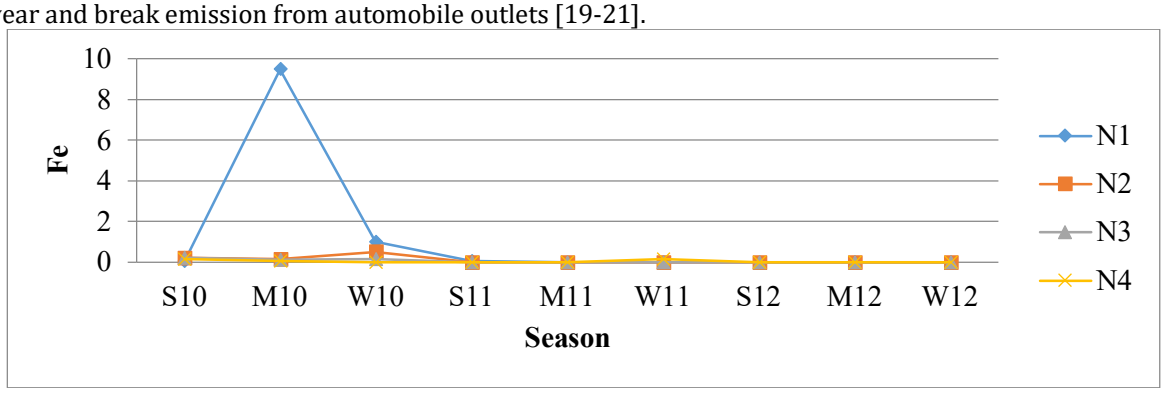

Fig. 10 Seasonal variation in Iron of surface water samples during summer (S10, S11, S12) monsoon (M10, M11, M12) & winter (W10, W11, W12)

(k) Mercury: Mercury occurs in organic as well as inorganic forms and both the forms are highly toxic. Effluents of industries like making switches, batteries, thermometer, fluorescent tubes, high intensity street lamps, pharmaceutical industries contain significant amounts of Hg. Acute toxicity is associated with liver dysfunction, kidney failure, while chronic mercury exposure induces immunological, humeral and metabolic activities involving reproductive, renal and cardiovascular failure [22].

The analysis of mercury showed that the 66.6% of total samples contain the mercury concentration higher than the desirable limit WHO (0.001 g/L). The higher values of Hg in water were due to effluent from industries like making batteries, switches, thermometer, and those industries which are using mercury as a catalyst or as an electrode. The concentration of mercury was found to be the highest at N3 (2.003 gm/L) in winter 2010 (Fig. 11).

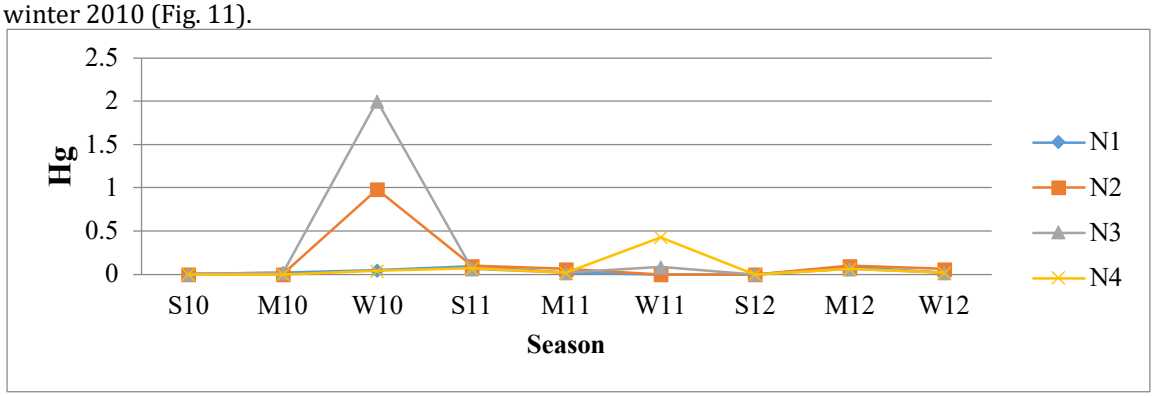

Fig. 11 Seasonal variation in Mercury of surface water samples during summer (S10, S11, S12) monsoon (S10, S11, S12) & winter (S10, S11, S12)

Conflict of Interests: Nil.

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