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Studies of Heavy metals (Pb, Cd, Mn, Cu, Ni) in drinking water sources in Mysuru City, Karnataka, India

Devendra J. Haware[1*], Ravi Kumar[2], Ramteke D.S.[3] and Farin Inam[4]
[1]Food safety and Analytical Quality Control Laboratory, CSIR-CFTRI, Mysuru, India
[2]Maharishi Markandeshwar University, Mullana, Ambala, Haryana, India
[3]EIRA Division, CSIR-NEERI, Nagpur, India
[4]Department of Chemistry, Institute of Science, Nagpur, India
devendra@cftri.res.in

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Abstract

The present study was carried out to estimate the concentration of heavy metals (Pb, Cd, Mn, Cu & Ni) in drinking water collected from different fields located in Mysuru, Karnataka. Atomic Absorption Spectrophotometer was used to determine the concentration of heavy metals. The purpose of study was to assess heavy metals in drinking water and determining human health associated water contamination by heavy metals. The result show that average heavy metals in drinking water sample in winter seasons followed a descending order Mn>Cu>Ni>Pb>Cd and summer seasons followed a descending order Mn>Cu>Ni>Pb>Cd. It was observed that heavy metals not exceeded the maximum permissible limits in drinking water as specified by regulatory bodies except cadmium which was below standard and pollution index result confirmed significant pollution of Manganese and copper.

Keywords: Drinking water, Heavy metals, Permissible limit, Pollution index.

Introduction

Water is one of the important and essential that support all forms of life (plant & Animal). Water generally obtained from two natural source surface and ground water. Surface water like (fresh water lake, rivers, and streams) ground water like (borehole water and well)[1]. Due to its polarity and hydrogen bonds of water it is able to dissolve absorb adsorb and suspend many different compounds[2]. Due to human, animal as well as biological activities nature water is not pure as its acquires contaminates from surroundings.

Today most important environment issue is surface water contaminants and because of wide diversity of contaminants affecting the water resources. Particular concern the toxic metals considering their strong toxicity even at very low concentration[3]. Most parts of world surface and ground water is used for domestic, agriculture and industrial purpose. Due to industrialization and urbanization and human activities like agriculture and domestic release large number of contaminants into the water bodies[4]. In the present situation in Mysuru the growth of Industry technology, population and water use has increased the stress upon both our land and water resources. The quality of water (surface and ground) has been degraded because of municipal, chemical, fertilizers, pesticides, industrial waste have entered the soil[5]. As the urbanization process continues water pollution problem have become increasingly evident the have to led to serious ecological and environment problem[6]. Now a day, water pollution is burning issue in all over the world. In India also reaches in alarming situation, water crisis in Mysuru city due to pollution the quality and quantity of water level decreases so there is need for continuous evaluation of water quality and pollution levels in order to promote better living condition. Recent report by WHO/UNICEF, million people in the developing world lack of potable water due largely to chemical and microbiological contamination[7,8]. An assessment of the environment risk due to water pollution is of very much importance for agricultural and non-agriculture areas, because heavy metals which are potentially harmful to human health which is persist in water for a long time[9]. There are more than 50 elements that can be identified as heavy metals out of 17 elements are considered to be very toxic and relatively accessible. The long term exposure of these metals results in physical, muscular, neurological degenerative processes that cause different diseases. Drinking water has been discussed centre stage as commodity to be priced or paid for by the uses, following the observation of the United Nation International Drinking Water supply and Sanitation Decade (IDWSSD) during 1981-91, the initiation of new era of economic reforms and liberalization[10].

The growth of chemical industries in Mysuru is predicted to continue to increase. In this context it is recognized that the assessment and management of risk from exposure to contaminants are among of the highest priorities in pursuing the principle of sustainable development[11,12]. Therefore, this research work was aimed to assessing the concentration of heavy metals in drinking water. Also to determine the heavy

metals pollution indices as well as compare the observed concentration with the water quality permissible limit specified by the regulatory bodies[13-16].

Materials and methods

Study area: Mysuru is having around 11 lakh populations and state of Karnataka. It lies between 12°8' and 11°7' latitude and 77°8' longitude and general elevation is little more than 1801 ft above sea level. The climate of the city is moderated throughout the year with temperature during summer ranging from 32°C to 40°C. Rainy season is from April to October, winter season is from October to February and. The main source of water in Mysuru city is mainly from the Cauvery river water and ground water for domestic, industrial and irrigation purpose. Growing cities of Karnataka Mysuru is one of the clean city in India due to presence of industrial resources and a well-developed communication network At present situation industrialization has become main cause of city's growth. Because of the diversity in industrial and scape growth of Mysuru with haphazard distribution. The industrial areas are distributed all over the city and its surroundings with lack of order and regulation in industrial location. Number of small and medium scale industries exists in and around the Mysuru city. Engineering chemical, pharmaceutical food brewery, textile, steel and metal smelting most of all medium scale industries we found in and around Mysuru city.

Sampling and analysis: From the above mentioned study area, two litre of pre-cleaned polythene bottles were used to collect water samples from the different source. On site, concentrated 69% pure HNO_3 was added to fix the metals in the water sample to a pH <3. The plastic bottles were corked firmly and transfer to the laboratory for analysis on getting to the laboratory; the samples were quickly transferred to a deep freezer, in order to preserve the integrity of the samples while awaiting analysis. Digestion of water samples done by 69% ultra pure HNO3 for metal analysis following standard procedures[17]. To ensure for removal of organic impurities from the collected samples and thus prevent interference in analysis. The water samples were digested with 69% ultra pure HNO_3. 4 ml of the concentrated Nitric acid was added to 10 ml of the water samples and the mixture evaporated on a hot plate to a final volume of 4 ml. another 4 ml of concentrated HNO_3 was added to the mixture and refluxed for 25 min after which the mixture was heated on hot plate while the concentrated HNO_3 was added until the mixture was light in coloured. The resulting digests were filtered by whatmann filter no 1. And made upto 30 ml with Milli Q water before analysis. Simultaneously prepared blank. The digested water samples were analysed for investigating heavy metals using Atomic Absorption Spectrophotometer (iCE 3000 Thermo fisher Series AAS). The instrument was calibrated with NIST standard stock solution of heavy metals. A blank was run for each digestion procedure to correct the measurement and to check all reagents and procedure for interference and cross contamination[18].

Heavy metals pollution Index (HPI): Represent the total quality of water with respect to heavy metals. HPI based on two steps, first by establishing a rating scale for each selected parameter giving weightage and second by selecting the pollution parameter on which the index is to be based[19]. The rating system is an value between 0 to 1 and its selection depends upon the importance of individual quality consideration in a comparative way or it can be assessed by making values inversely proportional to the recommended standard for the corresponding parameter[20,21].

The following equation calculated as Heavy metals pollution Index

$$\text{Heavy Metal Pollution Index} = \frac{\sum_{n=1}^{n} WiQi}{\sum_{n=1}^{n} Wi}$$

Where: Wi = weightage of i^{th} parameters, Qi = index of the i^{th} parameter.

Whereas arithmetic weighted index method has been used for calculation of Heavy metals pollution Index. The weight (Wi) has been found by using formula

$$\text{Wi} = \frac{K}{Si}$$

Where: K = proportionality constant, Si = standard permissible value of i^{th} =parameter. The sub-index of (Qi) of the parameter calculated by

$$\text{Qi} = \sum_{n=1}^{n} \frac{|Mi - Ii|}{Si - Ii}$$

Where: Mi = monitored value of heavy metal of i^{th} parameter, Ii = ideal value of i^{th} parameter which is taken from the Indian drinking water specification[15]. Si = standard value of the i^{th} parameter in ppm. After completion of the result the concentration of each pollutants of each pollutant was converted into HPI. The higher HPI value causes the greater the damage to the health. The critical heavy metals pollution index value is 100[22-24].

Results and discussion

Industrialization, urbanization and rapid population growth is one the possible source of toxic metals in water and soil resources. Therefore to know the concentration of heavy metals pollution and the pollution index of heavy metals in the selected study area was calculated[25,26]. Heavy metals content viz., copper, nickel, lead, cadmium and manganese were present in drinking water samples. The heavy metals were analysed from the collected drinking water in winter and summer season and result were summarized in Figure-1 to 6. The concentration of copper in selected drinking water samples in winter season were

ranges from 0.0015 to 0.0440 mg/l and summer season was 0.0018 to 0.0757mg/l. The nickel content present in drinking water samples in winter season ranges from 0.006 to 0.0180 mg/l and summer season was 0.0011 to 0.0138 mg/l. Lead was present in drinking water in winter season were in the range of 0.0055 to 0.0092 mg/l and summer season was 0.0018 to 0.0097mg/l. Cadmium almost below detectable levels (BDL) in all drinking water samples. And the manganese content in drinking water samples in winter season were ranges from 0.0033 to 0.1437 mg/l and summer season was 0.0124 to 0.0789 mg/l respectively.

The present data was used for the calculation of heavy metals pollution index (HPI) by using permissible limit for occurrence in drinking water. The calculation of heavy metals pollution index for the different samples of drinking water were given in Table-1. In the present observation near the industrial area the heavy metals pollution index of drinking water almost constant and present up to 5.5 index value[27,28].

Conclusion

Heavy metals pollution index (HPI) is useful tool for calculating over all pollution in drinking water. The observation & result indicated that some area has apparently contaminated the drinking water bodies. The industrial area is low heavy metal pollution as compare with pollution index value of 100. In the basis of above observation the maximum heavy metals pollution index value, chances the threat to the living people consuming polluted water. Mysuru are totally below the critical value but precautions for manging the use of agricultural inputs and prevention of use of industrial or waste water and sewage sludge in agriculture, minimizing the use of organic fertilizer and pesticides.

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Table-1: Heavy metals pollution Index calculation for water available in winter season, based on drinking water standard (IS: 1992, 10500).

Metal Samples	Mean conc ppm (Mi)	Highest permitted values for drinking water(Si)	Desirable maximum value (li)	Unit weightage (Wi)	Sub index (Qi)	Wi x Qi
Cu (winter)	0.0136	1.5	0.05	0.666	0.0256	0.0173
Ni (winter)	0.0103	0.06	0.02	1.666	0.2425	0.4041
Mn (winter)	0.0396	0.3	0.1	3.333	0.3107	1.0357
Pb (winter)	0.012	0.05	0.05	20	0	0
Cd(winter)	0		0.01	100	0	0

$\sum Wi = 125.66$, $\sum WiQi = 1.4571$, HPI = 0.0116.

Table-2: Heavy metals pollution Index calculation for water available in summer season, based on drinking water standard (IS: 1992, 10500).

Metal Samples	Mean conc ppm (Mi)	Highest permitted values for drinking water(Si)	Desirable maximum value (li)	Unit weightage (Wi)	Sub index (Qi)	Wi x Qi
Cu(Summer)	0.0093	1.5	0.05	0.666	0.277	0.0192
Ni (summer)	0.0065	0.06	0.02	1.666	0.35	0.5638
Mn(summer)	0.0352	0.3	0.1	3.333	0.3055	1.0182
Pb(summer)	0.0071	0.05	0.05	20	0	0
Cd(summer)	0		0.01	100	0	0

$\sum Wi = 125.665$, $\sum WiQi = 1.6012$, HPI = 0.0127.

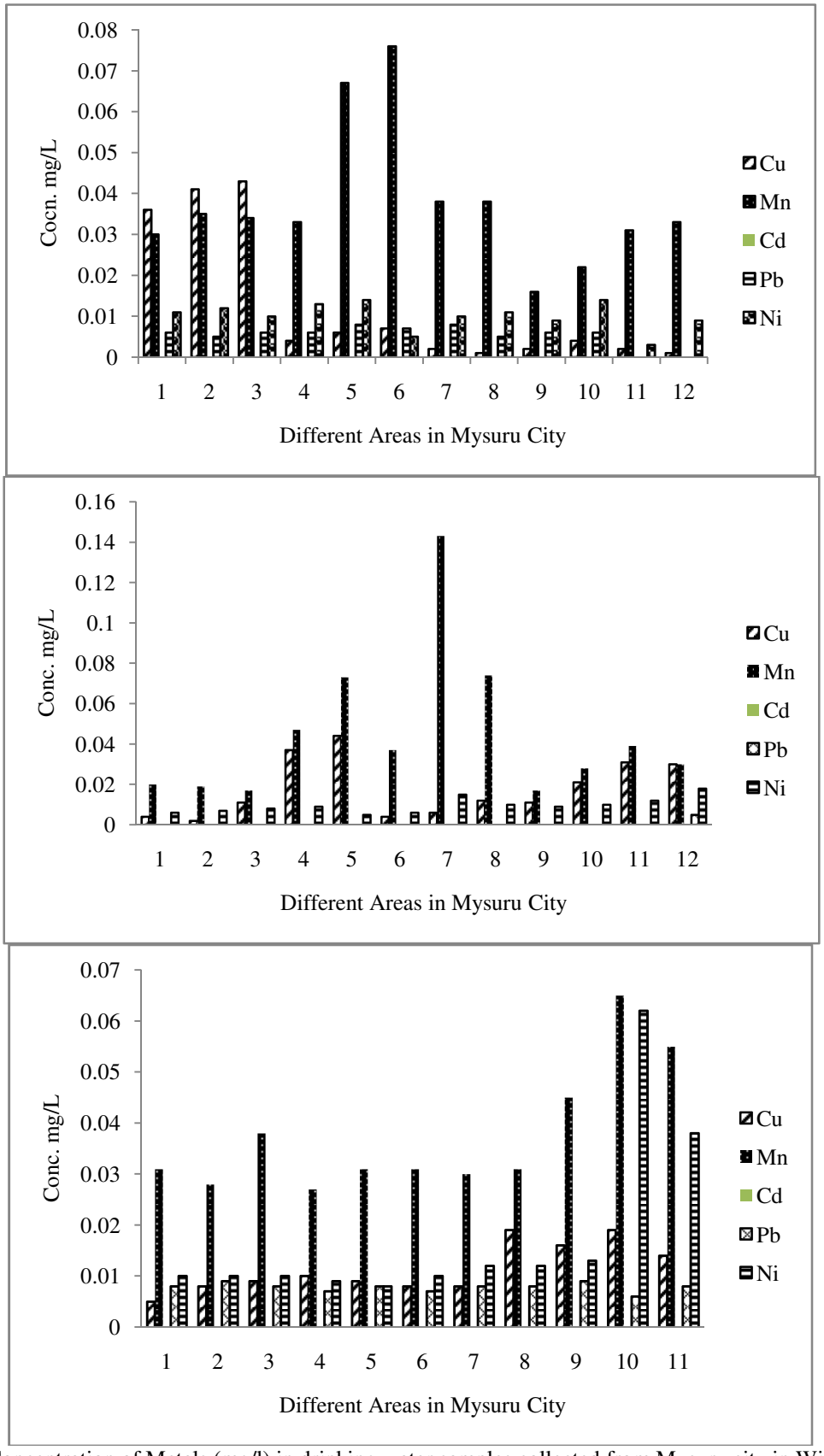

Figure-1: Concentration of Metals (mg/l) in drinking water samples collected from Mysuru city in Winter season.

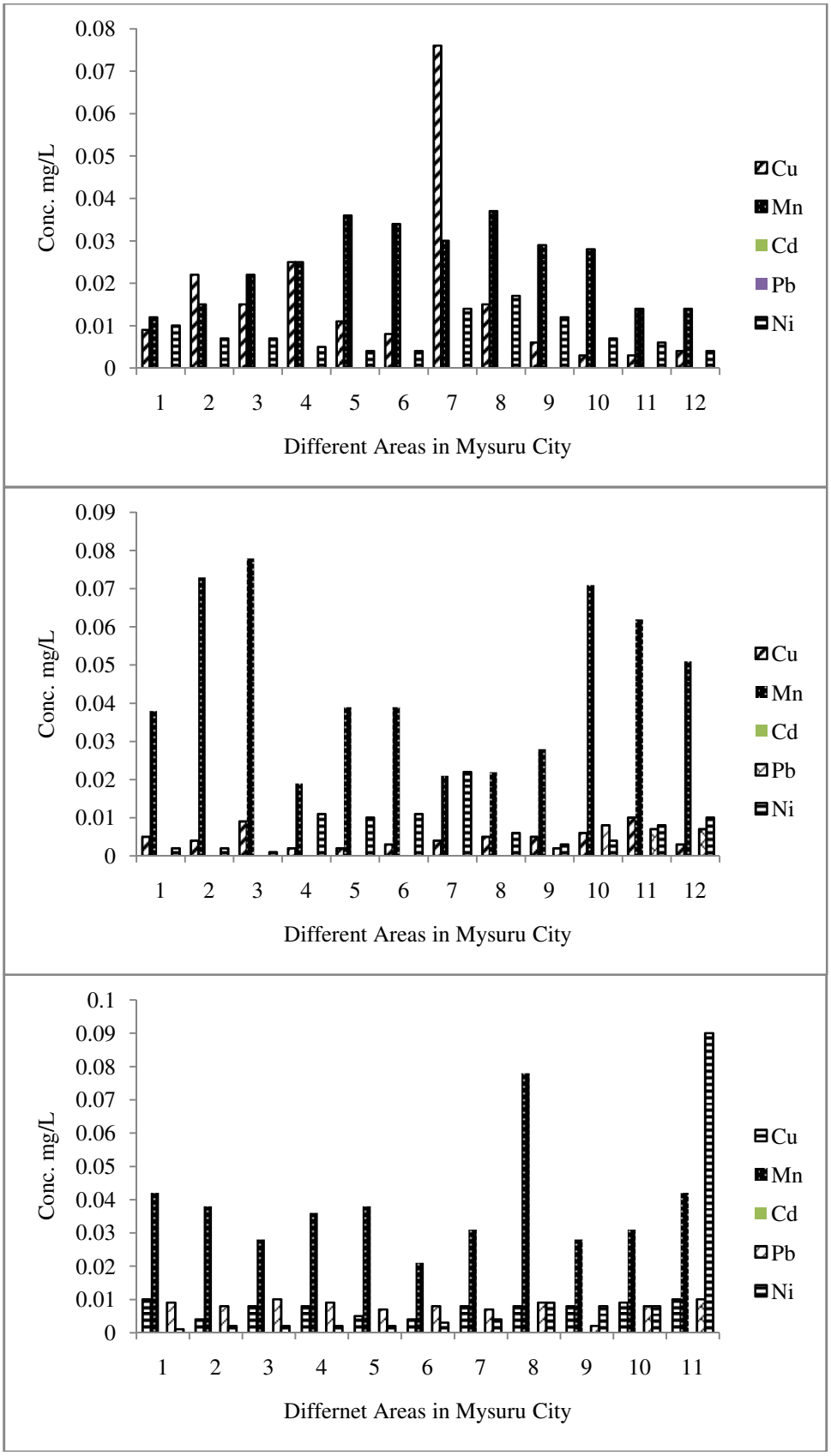

Figure-2: Concentration of Metals (mg/l) in drinking water samples collected from Mysuru city in Summer season.

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