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Research Article

STUDIES ON THE HEAVY METALS CONCENTRATION IN THE PYKARA LAKE, UDHAGAMANDALAM, NILGIRIS, TAMILNADU

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ABSTRACT

The present study was designed to demonstrate the monthly variations in heavy metals of Pykara lake for a period of two years from Jan 2013 to Dec 2014. Water samples were collected on monthly basis and analyzed for Copper (Copper), Zinc (Zinc), Manganese (Manganese), Nickel (Ni), Chromium (Cr), Aluminium (Al), Sodium (Na), Lithium (Li) and Potassium (K) also recorded. An attempt has been made to explain the effect of above stated heavy metals concentration due to seasonal changes on the ecosystem of Pykara lake. The result of the study states that overall water quality of the study sites remained within the safe limits throughout the study period.

Key words: Pykara lake, Monthly variations, Heavy metals, Effluent.

INTRODUCTION

The demand for water has increased over the years and this has led to water scarcity in many purposes of the world. The situation is aggravated by the problem of water pollution or contamination. Due to increasing industrialization, urbanization and various developmental activities there is a severe pressure on the water body like Pykara dam (Azeez *et al.*, 1998). Industrial pollutants mainly contaminate land surface due to disposing of unwanted materials and the effluents discharged directly to the surrounding environment (Shanmughavel, 1993, Singaram, 1995). Heavy metal contamination may have deteriorating effects on the ecological balance of the recipient environment and a diversity of aquatic flora and fauna (Ashraj, 2005; Vosyline and Jankait, 2006; Farombi *et al.*, 2007). Metals in the surface water system largely come from anthropogenic and natural resources now a days ,metal levels resulting from natural resources are relatively low Excessive metal amounts in a aquatic environment cause serious problem for both people and the environment (Karakas, 2003; Simeonov *et al.*, 2003; Sekabira *et al.*, 2010; Udhyakumar *et al.*, 2011). The present study was aimed to investigate the heavy metals concentration in the Pykara lake, Udhagamandalam, Nilgiris, Tamilnadu.

MATERIALS AND METHODS

Pykara is a river located 19 km from Ooty is considered very sacred by Community Todas. The Pykara river rises at Mukurthi peak, passes through hilly tract, generally keeping to North and turns to West after reaching the Plateau's edge. The river has a dam and power plant. The river flows through a series of cascades; and the last two falls of 55 meters and 61 meters are known as Pykara falls.

Sample collection

Sampling was done during the rainy season (June, July, August and September), Summer season, (January, February, March and April) and winter season (October, November and December). Samples were collected on every month during the day time (11.30 am to 12.30 pm). Water samples were collected from four sources of Pykara at Ooty. The samples were analyzed for heavy metals, following standard methods given by Fresenius *et al.*, 1987 and Greenberg *et al.*, 1992 using Atomic Absorption Spectrophotometer Perkin ELMER; MODEL 3300. In the present investigation three stations located in the Pykara dam. The heavy metals like Copper, Zinc, Manganese, Nickel and Chromium were analyzed by Atomic Absorption Spectrophotometer and, Aluminium, Sodium, Lithium and Potassium were analysed by Flame photometer.

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RESULTS

Water samples were collected from Pykara Lake and analysed for heavy metals for a period of two years from January 2013 to December 2014 and the results were presented in the form of Tables (1-8) and Figures (1-6).

Heavy Metals of Pykara Lake (First Year Jan 2013 - Dec 2013)

Water samples were collected at Pykara lake in station I, II and III and analysed the heavy metals for a period of 12 months from January 2013 - December 2013 and the results were presented in the form of Tables 1 to 3 and Figures 1-3.

Cu: The Cu was ranged in station I were ranged from 0.017 mg/l to 0.047 mg/l, in station II it was from 0.023 mg/l to 0.052 mg/l and 0.022 mg/l to 0.051 mg/l in station III. The maximum values were noted in the months of February and December, 2013 and the minimum values in the months of March and August 2013. It was noticed that summer has recorded and winter has minimum in three stations.

Zn: The Zn was ranges from 0.013 mg/l to 0.097 mg/l in station I, from 0.021 mg/l to 0.098 mg/l in station II and from 0.032 mg/l to 0.097 mg/l in station III respectively. The maximum values were noted in the months of March, June and October 2013 and the minimum values in the months of March and August 2013.

Mn: The amount of Mn was ranged from 0.015 mg/l to 0.086 mg/l station I from 0.026 mg/l to 0.098 mg/l in station II and from 0.025 mg/l to 0.097 mg/l in station III. The Mn value was maximum value in the months of July and December 2013 and minimum value was noted in the month of March 2013.

Ni: The values of Ni were ranged from 0.017 mg/l to 0.090 mg/l in station I and from 0.034 mg/l to 0.097 mg/l in station II and from 0.033 mg/l to 0.096 mg/l in station III. The maximum values were recorded in the months of September and August 2013. The minimum values were recorded in the months of March and January 2013.

Cr: The value of Cr were ranged from 0.018 mg/l to 0.096 mg/l in the station I, from 0.022 mg/l to 0.099 mg/l in the station II and from 0.021 mg/l to 0.098 mg/l in the station III respectively.

Al: The values of Al were ranged from 0.016 mg/l to 0.068 mg/l in the station I from 0.025 mg/l to 0.080 mg/l in the station II and from 0.024 mg/l to 0.079 mg/l in the station III. The maximum value was noted in the month of July 2013 and minimum value in the month of January 2013 was recorded.

Sodium: The values of Sodium was ranged from 0.034 mg/l to 0.059 mg/l in the station I , it was from 0.044 mg/l to 0.063 mg/l in the station II, it was 0.043 mg/l to 0.061 mg/l in the station III, The maximum values were observed in the months of January and March 2013. The minimum value was recorded in the months of March, September and December 2013 was recorded.

Li: The values of Li were ranged from 0.038 mg/l to 0.078 mg/l in the station I. In the station II it was from 0.042 mg/l to 0.082 mg/l and in the station III it was from 0.041 mg/l to 0.081 mg/l. The maximum value was noted in the month of March 2013. The minimum value was recorded in the months of December 2013.

K: The values of potassium was found to be ranged from 0.048 mg/l to 0.061 mg/l in the station I, in the station II it was ranged between 0.054 mg/l to 0.069 mg/l and in the station III it was ranged between 0.052 mg/l to 0.068 mg/l. The maximum values were noted in the months of February and May 2013. The minimum values were recorded in the months of September, October and December 2013.

Heavy Metals of Pykara Lake (Second Year Jan 2014 - Dec 2014)

Water samples were collected at Pykara lake in station I, II and III and analysed the heavy metals for 12 months from January 2014 - December 2014 and the results were presented in the form of Tables 5 to 7 and Figures 4 to 6.

Cu: The values of Cu was ranged from in station I, from 0.011 mg/l to 0.039 mg/l in station II and from 0.014 mg/l to 0.044 mg/l from 0.013 mg/l to 0.040 mg/l in station III. The maximum values were noted in the month of February 2014 and the minimum value in the month of and September 2014. It was noticed that summer has recorded and winter has minimum in three stations.

Zn: The values of Zn was ranged from 0.009 mg/l to 0.093 mg/l in station I, from 0.012 mg/l to 0.095 mg/l in station II and from 0.011 mg/l to 0.094 mg/l in station III respectively. The maximum values was noted in the months of October 2014 and the minimum values in the months of January and May 2014 was recorded

Mn: The values of Mn was ranged from 0.012 mg/l to 0.082 mg/l station I from 0.016 mg/l to 0.094 mg/l in station II and from 0.015 mg/l to 0.091 mg/l in station III. The Mn values was maximum in the months of July and October 2014 and minimum value was noted in the months of April 2014 was recorded

Ni: The values of Ni were ranged from 0.010 mg/l to 0.090 mg/l in station I and from 0.015 mg/l to 0.095 mg/l in station II and from 0.013 mg/l to 0.091 mg/l in station III. The maximum values were recorded in the month of July 2014. The minimum values were recorded in the months of March 2014.

Cr: The values of Cr were ranged from 0.020 mg/l to 0.094 mg/l in the station I, from 0.019 mg/l to 0.099 mg/l in the station II and from 0.017 mg/l to 0.096 mg/l in the station III respectively. The maximum values were recorded in the months of January, March and May 2014. The minimum values were recorded in the months of January, may and June 2014 was recorded.

Al: The values of Al were ranged from 0.010 mg/l to 0.065 mg/l in the station I from 0.035 mg/l to 0.074 mg/l in the station II and 0.032 mg/l to 0.071 mg/l in the station III. The maximum values were noted in the month of February 2014 and minimum values in the months of June, August and September 2014 was recorded.

So: The values of So was ranged from 0.024 mg/l to 0.039 mg/l in the station I, it was from 0.039 mg/l to 0.051 mg/l in the station II, it was 0.030 mg/l to 0.048 mg/l in the station III, The maximum value was observed in the month of May 2014. The minimum values were recorded in the months of March and September 2014.

Li: The values of Li were ranged from 0.021 mg/l to 0.038 mg/l in the station I. In the station II it was 0.039 mg/l to 0.053 mg/l and in the station III it was 0.026 mg/l to 0.052 mg/l. The maximum values were noted in the months of April, August and September 2014. The minimum value was recorded in the months of January, February and December 2014.

K : The values of K was found to be ranged from 0.018 mg/l to 0.049 mg/l in the station I, in the station II it was ranged between 0.041 mg/l to 0.066 mg/l and in the station III it was ranged between 0.030 mg/l to 0.059 mg/l. The maximum values were noted in the month of April 2014. The minimum values were recorded in the months of November and December 2014 was recorded.

Heavy metals of raw effluents (First year Jan 2013 - Dec 2013)

The study on the heavy metals of raw effluents for the first year from January 2013 to December 2013 was analysed and the data were presented in Table 4.

Cu: The Cu was ranged from 0.036 mg/l to 0.097 mg/l. The maximum value was noted in the month of August 2013 and the minimum values in the month of February 2013.

Zn: The values of Zn was ranged from 0.020 mg/l to 0.096 mg/l. The maximum value was noted in the month of March 2013 and the minimum value was recorded in the month of October 2013.

Mn: The amount of Mn value was ranged from 0.024 mg/l to 0.098 mg/l. The maximum value of Mn was in the month of November 2013 and minimum value was noted in the month of February 2013.

Ni: The values of Ni were ranged from 0.029 mg/l to 0.097 mg/l respectively. The maximum values were recorded in the month of November 2013. The minimum values were recorded in the months of April 2013.

Cr: The value of Cr was ranged from 0.033 mg/l to 0.097 mg/l in the station IV respectively. The maximum value was noted in the month of October 2013 and minimum value in the month of May 2013 was recorded.

Al: The values of Al were ranged from 0.025 mg/l to 0.097 mg/l. The maximum value was noted in the month of November 2013 and minimum value in the month of March 2013.

So: The values of So was ranged from 0.039 mg/l to 0.084 mg/l. The maximum value was observed in the months of September 2013. The minimum value was recorded in the month of January 2013.

Li: The values of Li was ranged from 0.048 mg/l to 0.082 mg/l. The maximum values were noted in the month of March 2013. The minimum value was recorded in the month of November 2013.

K: The values of K was found to be ranged from 0.034 mg/l to 0.092 mg/l. The maximum values were noted in the month of December 2013. The minimum value was recorded in the month of September, April 2013.

Heavy metals of raw effluents (Second year Jan 2014 - Dec 2014)

The studies on the heavy metals of raw effluents on second year January 2014 to December 2014 and data were presented in Table 8.

Cu: The values of Cu was ranged from 0.035 mg/l to 0.096 mg/l . The maximum value was noted in the month of October 2014 and the minimum values in the month oFebruary2014.

Zn: The values of Zn was ranged from 0.026 mg/l to 0.093 mg/l. The maximum value was noted in the month of March 2014 and the minimum value in the month of September 2014.

Mn: The values of Mn was ranged from 0.023 mg/l to 0.095 mg/l. The value of Mn was maximum value in the month of November 2014 and minimum value was noted in the month of February 2014.

Ni: The values of Ni were ranged from 0.026 mg/l to 0.087 mg/l. The maximum values were recorded in the month of May 2014. The minimum values were recorded in the month of July 2014.

Cr: The value of Cr were ranged from 0.030 mg/l to 0.096 mg/l. The maximum value was noted in the month of October 2014 and minimum value in the month of May 2014 was recorded.

Al: The values of Al were ranged from 0.025 mg/l to 0.093 mg/l. The maximum value was noted in the month of July 2014 and minimum values in the month of January 2014.

So: The values of So was ranged from 0.036 mg/l to 0.059 mg/l. The maximum value was observed in the month of May 2014. The minimum value was recorded in the month of January 2014.

Li: The values of Li were ranged from 0.047 mg/l to 0.065 mg/l. The maximum values were noted in the months of May 2014. The minimum value was recorded in the month of October 2014.

K: The value of K was found to be ranged from 0.048 mg/l to 0.061 mg/l. The maximum values were noted in the month of September 2014. The minimum value was recorded in the month of April 2014.

Table 1. Showing the monthly variations in the heavy metals of the Pykara lake at station I Before the mixing of the BPI Factory effluent at eight miles, Ooty for the first year (Jan 2013 - Dec 2013).

Months	Cu (mg/l)	Zn (mg/l)	Mn (mg/l)	Ni (mg/l)	Cr (mg/l)	Al (mg/l)	So (mg/l)	Li (mg/l)	K (mg/l)
Jan	0.018	0.048	0.019	0.069	0.0124	0.064	0.040	0.038	0.049
Feb	0.047	0.069	0.015	0.065	0.048	0.068	0.045	0.039	0.053
Mar	0.028	0.094	0.021	0.017	0.035	0.052	0.034	0.047	0.051
Apr	0.020	0.082	0.017	0.045	0.077	0.020	0.054	0.046	0.056
May	0.018	0.013	0.016	0.089	0.058	0.033	0.045	0.078	0.061
Jun	0.021	0.096	0.028	0.064	0.018	0.039	0.039	0.058	0.057
Jul	0.018	0.017	0.078	0.095	0.083	0.040	0.035	0.052	0.054
Aug	0.026	0.016	0.058	0.068	0.055	0.016	0.036	0.053	0.055
Sep	0.028	0.053	0.079	0.063	0.087	0.018	0.042	0.049	0.050
Oct	0.025	0.097	0.086	0.059	0.096	0.059	0.038	0.044	0.048
Nov	0.017	0.065	0.040	0.069	0.089	0.053	0.059	0.040	0.049
Dec	0.019	0.068	0.045	0.090	0.072	0.036	0.041	0.031	0.051

Table 2. Showing the monthly variations in the heavy metals of the Pykara lake at station II At the point of Mixing of the BPI Factory effluent at eight miles, Ooty for the first year (Jan 2013 - 2013).

Months	Cu (mg/l)	Zn (mg/l)	Mn (mg/l)	Ni (mg/l)	Cr (mg/l)	Al (mg/l)	So (mg/l)	Li (mg/l)	K (mg/l)
Jan	0.024	0.053	0.072	0.076	0.029	0.068	0.063	0.044	0.057
Feb	0.050	0.072	0.070	0.070	0.053	0.070	0.062	0.046	0.069
Mar	0.031	0.098	0.026	0.034	0.040	0.058	0.047	0.059	0.060
Apr	0.023	0.086	0.052	0.053	0.081	0.025	0.060	0.052	0.064
May	0.027	0.021	0.092	0.092	0.062	0.042	0.056	0.082	0.068
Jun	0.025	0.098	0.069	0.069	0.022	0.047	0.045	0.060	0.067
Jul	0.033	0.035	0.098	0.097	0.089	0.055	0.059	0.061	0.059
Aug	0.045	0.033	0.074	0.072	0.060	0.080	0.046	0.059	0.060
Sep	0.046	0.060	0.070	0.065	0.091	0.030	0.044	0.057	0.055
Oct	0.043	0.098	0.062	0.063	0.099	0.065	0.051	0.055	0.066
Nov	0.043	0.068	0.075	0.072	0.092	0.068	0.050	0.061	0.068
Dec	0.052	0.072	0.092	0.093	0.075	0.040	0.051	0.042	0.054

Table 3. Showing the monthly variations in the heavy metals of the Pykara lake at station III after mixing of the BPI Factory effluent at eight miles, Ooty for the first year (Jan 2013 - Dec 2013).

Months	Cu (mg/l)	Zn (mg/l)	Mn (mg/l)	Ni (mg/l)	Cr (mg/l)	Al (mg/l)	So (mg/l)	Li (mg/l)	K (mg/l)
Jan	0.023	0.051	0.071	0.075	0.028	0.067	0.061	0.043	0.056
Feb	0.049	0.065	0.069	0.069	0.052	0.068	0.060	0.045	0.068
Mar	0.030	0.098	0.025	0.033	0.039	0.057	0.046	0.058	0.059
Apr	0.022	0.085	0.051	0.052	0.080	0.024	0.059	0.051	0.063
May	0.026	0.020	0.091	0.091	0.061	0.041	0.055	0.081	0.067
Jun	0.024	0.097	0.068	0.068	0.021	0.046	0.044	0.059	0.066
Jul	0.032	0.034	0.097	0.096	0.088	0.054	0.058	0.060	0.058
Aug	0.044	0.032	0.072	0.071	0.059	0.079	0.045	0.058	0.059
Sep	0.045	0.059	0.069	0.064	0.090	0.029	0.043	0.056	0.052
Oct	0.042	0.097	0.061	0.062	0.098	0.061	0.050	0.053	0.063
Nov	0.041	0.067	0.074	0.071	0.091	0.067	0.049	0.060	0.057
Dec	0.051	0.070	0.070	0.091	0.074	0.039	0.050	0.041	0.054

Table 4. Showing the monthly variations in the heavy metals of the Pykara Lake at Station IV raw effluent BPI Factory at eight miles, Ooty for the First Year (Jan 2013 - Dec 2013).

Months	Cu (mg/l)	Zn (mg/l)	Mn (mg/l)	Ni (mg/l)	Cr (mg/l)	Al (mg/l)	So (mg/l)	Li (mg/l)	K (mg/l)
Jan	0.040	0.084	0.043	0.067	0.041	0.040	0.039	0.063	0.059
Feb	0.036	0.090	0.024	0.054	0.038	0.073	0.053	0.067	0.061
Mar	0.040	0.096	0.035	0.034	0.045	0.025	0.048	0.048	0.063
Apr	0.059	0.090	0.049	0.029	0.059	0.062	0.059	0.070	0.034
May	0.067	0.030	0.055	0.089	0.033	0.076	0.064	0.071	0.067
Jun	0.087	0.060	0.068	0.050	0.070	0.080	0.065	0.063	0.065
Jul	0.091	0.071	0.076	0.030	0.085	0.097	0.062	0.068	0.064
Aug	0.097	0.041	0.081	0.060	0.091	0.041	0.057	0.065	0.063
Sep	0.016	0.030	0.091	0.090	0.080	0.050	0.084	0.069	0.062
Oct	0.095	0.020	0.070	0.040	0.097	0.080	0.066	0.064	0.061
Nov	0.084	0.041	0.098	0.097	0.088	0.097	0.057	0.082	0.079
Dec	0.072	0.064	0.092	0.090	0.069	0.085	0.050	0.062	0.092

Table 5. Showing the monthly variations in the heavy metals of the Pykara Lake at Station I Before of the mixing of BPI Factory at eight miles, Ooty for the second year (Jan 2014 - Dec 2014).

Months	Cu (mg/l)	Zn (mg/l)	Mn (mg/l)	Ni (mg/l)	Cr (mg/l)	Al (mg/l)	So (mg/l)	Li (mg/)	K (mg/l)
Jan	0.016	0.009	0.017	0.062	0.020	0.060	0.036	0.024	0.025
Feb	0.039	0.060	0.014	0.060	0.040	0.065	0.034	0.021	0.026
Mar	0.020	0.091	0.019	0.010	0.030	0.040	0.030	0.034	0.028
Apr	0.013	0.080	0.012	0.040	0.070	0.018	0.038	0.037	0.049
May	0.015	0.010	0.014	0.080	0.050	0.029	0.039	0.036	0.035
Jun	0.017	0.092	0.025	0.060	0.010	0.037	0.037	0.034	0.033
Jul	0.014	0.010	0.041	0.090	0.080	0.034	0.032	0.033	0.031
Aug	0.012	0.012	0.054	0.064	0.050	0.010	0.031	0.037	0.030
Sep	0.011	0.050	0.076	0.061	0.080	0.016	0.024	0.038	0.029
Oct	0.018	0.093	0.082	0.057	0.094	0.057	0.035	0.036	0.020
Nov	0.014	0.060	0.032	0.050	0.080	0.049	0.031	0.035	0.018
Dec	0.017	0.060	0.021	0.030	0.070	0.031	0.034	0.030	0.027

Table 6. Showing the monthly Variations in the Heavy Metals of the Pykara Lake at Station II at the point mixing of the BPI Factory effluent at eight miles, Ooty for the Second Year (Jan 2014 - Dec 2014).

Months	Cu (mg/l)	Zn (mg/l)	Mn (mg/l)	Ni (mg/l)	Cr (mg/l)	Al (mg/l)	So (mg/l)	Li (mg/)	K (mg/l)
Jan	0.025	0.012	0.040	0.065	0.043	0.065	0.041	0.042	0.062
Feb	0.044	0.065	0.030	0.064	0.045	0.074	0.043	0.046	0.064
Mar	0.025	0.094	0.050	0.015	0.078	0.046	0.046	0.053	0.065
Apr	0.015	0.085	0.016	0.048	0.067	0.047	0.048	0.044	0.066
May	0.018	0.049	0.030	0.085	0.019	0.058	0.051	0.052	0.067
Jun	0.020	0.045	0.060	0.068	0.083	0.053	0.049	0.050	0.054
Jul	0.016	0.014	0.070	0.095	0.096	0.048	0.047	0.049	0.052
Aug	0.015	0.019	0.080	0.069	0.052	0.044	0.045	0.048	0.053
Sep	0.014	0.055	0.082	0.068	0.087	0.035	0.042	0.040	0.050
Oct	0.020	0.095	0.094	0.062	0.099	0.060	0.040	0.044	0.058
Nov	0.021	0.065	0.035	0.054	0.084	0.052	0.039	0.041	0.060
Dec	0.022	0.063	0.070	0.035	0.081	0.037	0.040	0.039	0.041

Table 7. Showing the monthly variations in the heavy metals of the Pykara Lake at Station III after mixing of the BPI Factory effluent at eight miles, Ooty for the second Year (Jan 2014 - Dec 2014).

Months	Cu (mg/l)	Zn (mg/l)	Mn (mg/l)	Ni (mg/l)	Cr (mg/l)	Al (mg/l)	So (mg/l)	Li (mg/)	K (mg/l)
Jan	0.022	0.010	0.030	0.061	0.042	0.061	0.039	0.026	0.032
Feb	0.040	0.063	0.019	0.062	0.041	0.071	0.040	0.028	0.036
Mar	0.024	0.041	0.020	0.013	0.036	0.043	0.045	0.035	0.038
Apr	0.014	0.081	0.015	0.043	0.073	0.046	0.047	0.039	0.059
May	0.017	0.011	0.028	0.082	0. 063	0.050	0.048	0.038	0.040
Jun	0.019	0.094	0.055	0.062	0.017	0.051	0.039	0.035	0.039
Jul	0.015	0.013	0.065	0.091	0.081	0.046	0.04	0.040	0.037
Aug	0.014	0.018	0.075	0.066	0.051	0.042	0.040	0.042	0.036
Sep	0.013	0.051	0.080	0.065	0.086	0.032	0.030	0.039	0.035
Oct	0.019	0.094	0.091	0.059	0.096	0.058	0.036	0.038	0.033
Nov	0.020	0.061	0.034	0.051	0.081	0.050	0.032	0.037	0.030
Dec	0.021	0.062	0.065	0.032	0.078	0.035	0.038	0.035	0.032

Table 8. Showing the monthly variations in the heavy metals of the Pykara Lake at Station IV Raw Effluent BPI Factory effluent at eight miles, Ooty for the second year (Jan 2014 - Dec 2014)

Months	Cu (mg/l)	Zn (mg/l)	Mn (mg/l)	Ni (mg/l)	Cr (mg/l)	Al (mg/l)	So (mg/l)	Li (mg/l)	K (mg/l)
Jan	0.038	0.083	0.041	0.065	0.040	0.025	0.036	0.056	0.049
Feb	0.035	0.085	0 .023	0.051	0.035	0.045	0.047	0.058	0.051
Mar	0.038	0.093	0.030	0.032	0.042	0.040	0.046	0.057	0.043
Apr	0.057	0.087	0.045	0.028	0.055	0.058	0.052	0.059	0.030
May	0.063	0.025	0.052	0.087	0.030	0.074	0.056	0.065	0.058
Jun	0.086	0.055	0.063	0.048	0.068	0.081	0.052	0.060	0.056
Jul	0.090	0.070	0.072	0.026	0.082	0.093	0.051	0.061	0.054
Aug	0.095	0.038	0.080	0.054	0.090	0.024	0.048	0.062	0.055
Sep	0.015	0.026	0.090	0.062	0.078	0.044	0.047	0.059	0.061
Oct	0.096	0.019	0.069	0.038	0.096	0.039	0.045	0.047	0.058
Nov	0.082	0.040	0.095	0.086	0.085	0.028	0.046	0.054	0.055
Dec	0.071	0.063	0.091	0.088	0.065	0.034	0.039	0.055	0.059

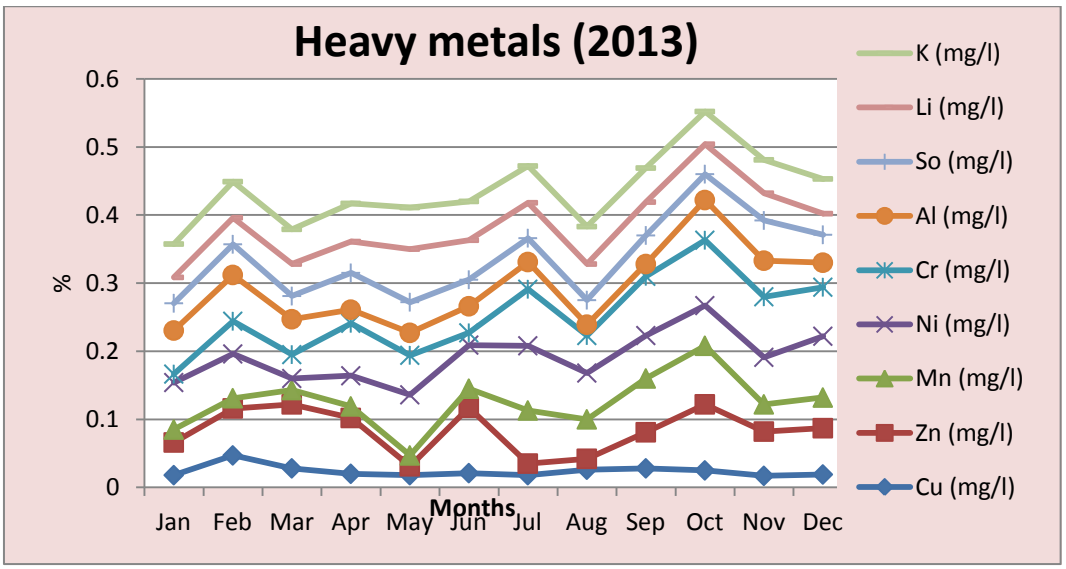

Figure 1. Shows the Seasonal Variations in the Heavy Metals of the Pykara Lake at Station I Before of the mixing of the BPI Factory at eight miles, Ooty for the First Year (Jan 2013 - Dec 2013).

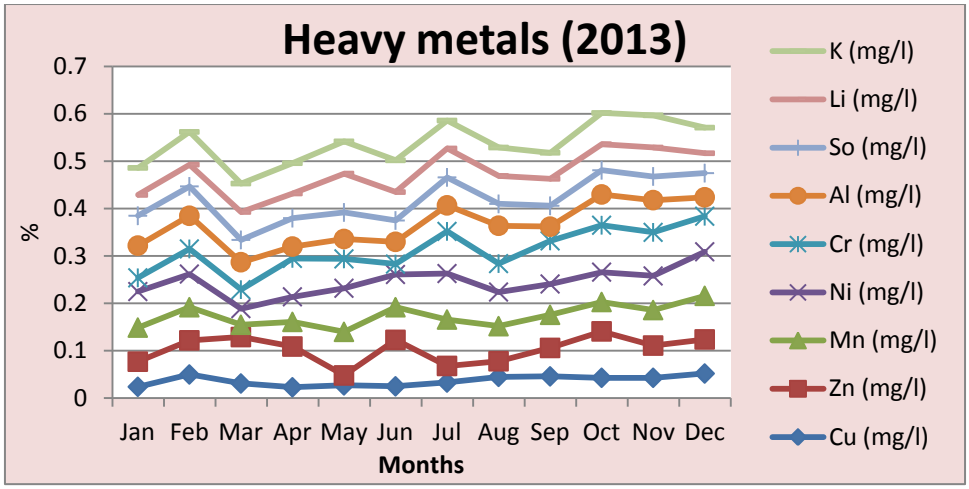

Figure 2. Shows the Seasonal Variations in the Heavy Metals of the Pykara Lake at Station II At the point Mixing of the BPI Factory at eight miles, Ooty for the First Year (Jan 2013-Dec 2013).

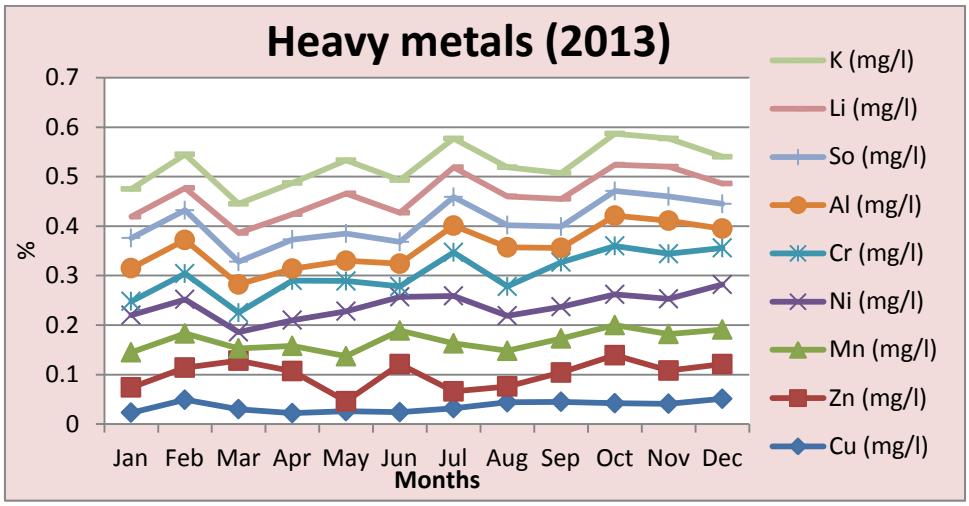

Figure 3. Shows the Seasonal Variations in the Heavy Metals of the Pykara Lake at Station III after mixing of the BPI Factory at eight miles, Ooty for the First Year (Jan 2013 - Dec 2013).

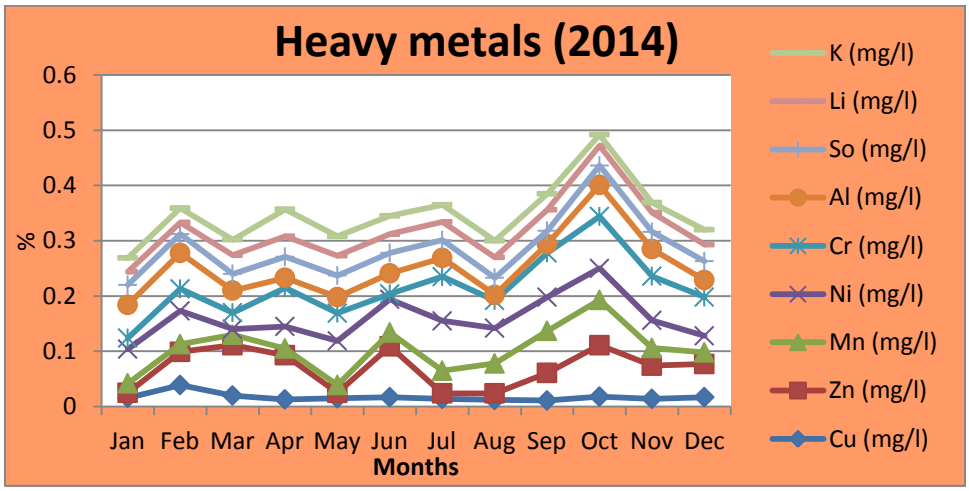

Figure 4. Shows the Seasonal Variations in the Heavy Metals of the Pykara Lake at Station I Before of the mixing of BPI Factory at eight miles, Ooty for the Second Year (Jan 2014 - Dec 2014).

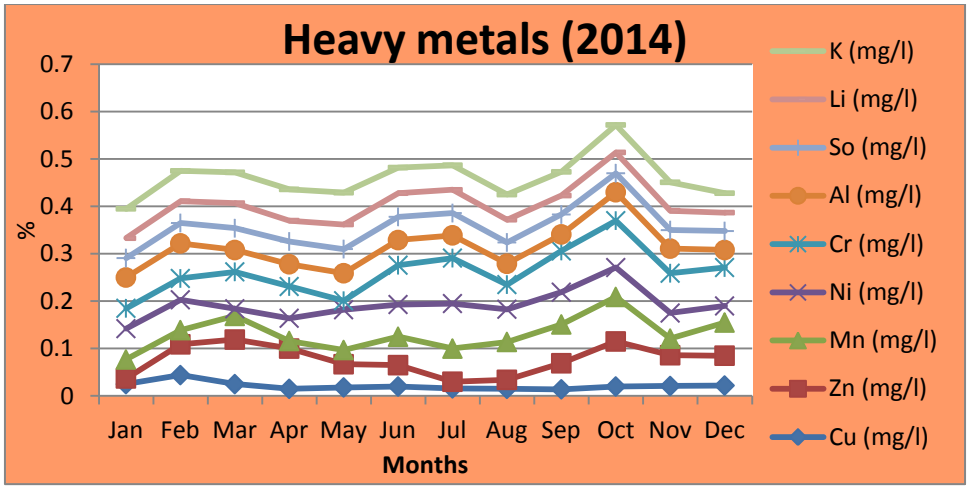

Figure 5. Shows the Seasonal Variations in the Heavy Metals of the Pykara Lake at Station II At the point Mixing of the BPI Factory at eight miles, Ooty for the Second Year (Jan 2014 - Dec 2014)

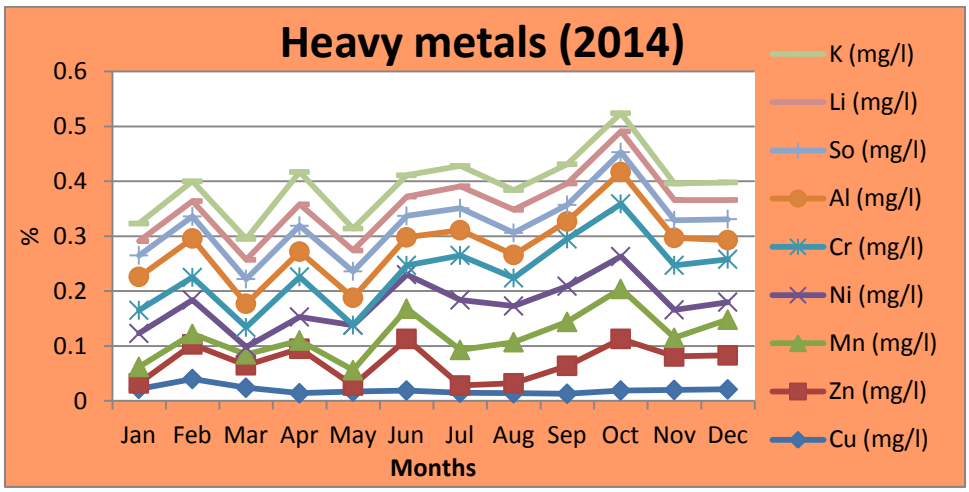

Figure 6. Shows the Seasonal Variations in the Heavy Metals of the Pykara Lake at Station III After mixing of the BPI Factory at eight miles, Ooty for the second Year (Jan 2014 - Dec 2014).

DISCUSSION

Heavy metals are one of the most important inorganic pollution parameters like Zinc, Manganese, Nickel, Chromium, Aluminum, Sodium, Lithium and potassium. Most of the environmental changes of the earth are slow enough to permit living forms to adapt to the changes. In the past two decades; science, industry medicine and agriculture have exposed number of exotic chemicals. Not only and bio-degradable pollutants also processes and there by posing a threat to the life.

Various heavy metals such as zinc, copper, nickel, chromium, aluminum, magnesium, sodium, lithium and potassium are dispersed in our dwelling environment comprising plants, animals, humans, air, water and soil. Several hazardous heavy metals adversely affect the physiological activities and cause biochemical problems to human and animals. In our everyday life all the creatures of the environment are continuously exposed to various metals from several sources. The concept that heavy metal toxicity in experimental animals and human beings may be greatly modified and indeed modulated by the nutritional status of the animal or person is firmly rooted in a great number of reports.

Extrapolation of results of animal experiment to human problems of heavy metals toxicity may be much more reliable and more satisfactory. The WHO provisional guideline of 0.01 mg/l has been adopted as the standard for drinking water (WHO, 2004). Acute and chronic doses of zinc salt can also cause hematological disorder like reduction in RBC and WBC count, HB content and it can also diminish protein and nucleic acid content of liver, kidney and spleen in experimental animal after accumulation of the metal. Zinc pollution causes kidney problems, joint pain, fever, vomiting and renal dysfunction, diarrhea, pancreatitis and pulmonary fibrosis.

Copper is another toxic heavy metal which also affects blood parameters, tissue proteins and nucleic acids. Copper pollution causes mental disease, coma, anemia, pathological changes in brain tissues, liver and kidney, stomach irritation in human being. Heavy metals have been proved to be toxic to both human and environment health. Heavy metals affect every level of the food web, from producers in the trophic levels to the highest order carnivore by residing in the system and magnifying at every trophic status (Bhargava and Dutta, 2014). Owing to their toxicity and their possible bioaccumulation, these compounds should be subject to mandatory monitoring. Several suitable separation and detection methods are available for laboratories engaged daily in routine analysis of a large number of biological of environmental samples. Permissible limits of certain heavy metals in human beings are Ni -0.2 ppm, Cr- 0.05 ppm, Copper-2.0 ppm and Zinc-5.00 ppm.

Zn concentrations were below the MCL (Maximum Contaminant Level) of 5mg/l recommended by USEPA, 2010. Zn present in large amount in natural water. The relatively high Zn level is suggestive of the influence of refuse dump and domestic sewage sources. It could also be attributed to industrial effluents. Zinc is an abundant element in rocks and ores and is present in natural waters only as a minor constituent. The main industrial use of zinc is in galvanizing and may enter the drinking water from galvanished pipes. Another important use is in the preparation of alloys, including brass and bronze. Food provides the main source of zinc to the body. Zinc may be toxic to aquatic organisms but degree of toxicity varies greatly depends on water quality characteristics as well as the species being considered.

Mn concentration in water in this study ranged from 0.019 mg/l to 0.091 mg/l, through there were variations across the station that were not significantly different ($p>0.005$). Mn levels from this study were above the recommended or acceptable level for unpolluted water. The recommended MCL for Mn in water is 0.005 mg/l. Mn in nature is found inform of oxides, silicate and carbonates. The health based guideline value is 0.4 mg/l. the symptoms in man include problems with central nervous system, euphoria insomnia, serious headache and palsy of feet.

In this study the concentrations of Cr were as low as 0.023 mg/l - 0.054 mg/l in Pykara lake and as high as 0.021 mg/l - 0.064 mg/l in station II. The values were higher than the maximum contaminant level MCL of 0.1 mg/l recommended by USEPA, 2010 for unpolluted water.

Cr oxidizes easily from trivalent to the exavalent. Cr^{3+} ion hot toxic but an essential nutrient, Cr^{6+} ion is very toxic and damages adrenals, levers and lungs. Exposure of man to high concentration of Cr^{6+} may cause dermatitis, ulcer, destruction to mucus of nose and cancer of the stomach. The major sources of Cr in water are via industrial effluents. The concentration of chromium in natural waters is usually very low. Elevated concentrations of chromium can result from mining and industrial processes. Chromate compounds are routinely used in cooling waters to control erosion of pipes and other equipments. Chromium in water supplies is generally found in the hexavalent form.

Sodium when present in large amounts gives a salty taste when combined with chloride. Minimum value of Na^{+} ion concentration was observed in station I before mixing of BPI and while the maximum value was high in the station II and after mixing of BPI station III value is moderate in the study period. Higher values observed in water were due to sodium rich sewage effluents and high values of potassium indicates manmade pollution (Matthews and Harvey, 1982; Davis and De Wiest, 1967) showed that concentration of potassium goes on increasing with degrading in mineral matter in the lake.

Similar to sodium ion and potassium ion also when present in large amounts in the samples due to mixing of BPI factory effluents . Especially when chloride ion is also present gives salty taste to water. These stations potassium ranges from 0.054 mg/l to 0.069 mg/l being low value in station I (from 0.048 mg/l to 0.061 mg/l) and high value ranged in station II (from 0.041 mg/l to 0.066 mg/l) and also in station III moderate value from 0.030 mg/l to 0.059 mg/l. Indian standards for drinking water do not provide any permissible limit for potassium.

Bioaccumulations of these heavy metals are known to adversely affect the liver, muscle, kidney and other tissues of fish body. The accelerated release of heavy metals are even endangering certain aquatic species and also causing extinction of some species of aquatic fauna.

CONCLUSION

The results showed that station I was less polluted than station II and III. The station II was more polluted than station I and II. Station III was less polluted than II and slightly polluted than I. The raw effluent from BPI factory showed more pollution load than station I, station II and station III of Pykara Lake. The heavy metal concentrations are also higher values in the BPI factory effluent than station I, II and III of Pykara Lake. The BPI factory effluents should be treated with efficient treatment plants before discharge into the Pykara Lake. Periodical cleaning of lake is essential. Awareness should be created among the public to protect the Pykara Lake, because it is an asset for Udagamandalam, Nilgiri District.

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