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ASSESSMENT OF HEAVY METAL POLLUTION OF POWAI & VIHAR LAKE MUMBAI INDIA

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ABSTRACT

Essential to both life and wellness is water. Water is a basic necessity for living a healthy and respectable life, hence every person has the right to get it. It is necessary for all additional human rights to be realized. Lake water has already been sought after as a source of water by many developing and poor nations in order to offer healthy drinking water. In the center of Mumbai's suburbs, Powai Lake is flanked by Powai Garden and Vihar Lake. The investigation of the levels of heavy metal pollution in the water has been conducted around the Powai and Vihar Lakes. The sampling has been done along selected seven sites of both the lakes. Water samples have been regularly drawn for 2 years for three seasons i.e., summer, monsoon (Pre-monsoon and Post-monsoon) and winter.

Physical, chemical, and heavy metal characteristics of water samples have been examined. In both lakes, the collected water samples were analyzed in 2021–2022, looking for certain heavy metals (As, Al, Cd, Cr, Co, Cu, Fe, Hg, Mn, Ni, Pb, and Zn). Selected heavy metals have been detected using an AAS-ICP-AES (atomic absorption spectrometer, inductive coupled plasma, and emission spectrometer). The AAS-ICP-AES method used in this study to analyses samples of lake water for heavy metals produced excellent findings for both lakes. Even while the investigation found certain heavy metals, their concentrations were not excessive enough to qualify as chemical contamination. This could be as a result of the river's generation power of domestic sewage (including animal waste from cow sheds) from its source at Powai to where it meets Mahim Creek. This area's domestic sewage volume is far greater than the amount of industrial effluent discharged, which could provide dilution. The contrast above clearly shows that environmental activity is hardly evident due to the enormous volume of home sewage. The study found that the effluent and untreated sewage from the neighborhood have a negative impact on Powai Lake.

KEYWORDS: HEAVY METALS, MUMBAI LAKES AND AAS-ICP-AES

INTRODUCTION

The Powai Lake is a man-made body of water that was created in Powai village's Powai valley. As per the survey by Hindustan times[1] the lake is heavily loaded with the suspended particles household sewage and industrial waste, the load is approximately eight times from the permissible limit[2]. Similarly, the Vihar Lake constructed in 1860 in Vihar village is also facing a heavy load of pollutants. The lakes were also utilized for the religious process, such as Ganesh visarjan. Initially these two lakes are the source of drinking water to certain areas of Mumbai[3,4]. Later the water quality was found misfit for the potable purposes. In 1891 first issue observed and within two-year water supply was restricted from the lakes[5].

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Heavy metals in the water, such as Al, As, Cd, and Zn, are the main contaminant since they are known to cause chronic and acute toxicity in living things6. When waste water is enriched with these metals above safe levels, it can result in poisoning, which can affect the kidney, reproductive organs, liver, brain, and central nervous system. The consistency and bioaccumulation of heavy metals are crucial characteristics that cause their acute toxicity.

Efforts have been made in the current inquiry to analyse the heavy metal concentration in the two lakes as well as the impact of the season the station of collection of samples on the percentage of the heavy metals. Al, As, Cd, Co, Cr, Cu, Mn, Ni, Pb, Zn, and Fe are among the 11 metals measured in the sample of two lakes.

For example, atomic absorption spectroscopy, thermal spectroscopy, spectrometry (ICP spectroscopy (ICP-MS), electrically heated methods, neuron activation analysis, and inductively coupled plasma atomic emission spectroscopy were all used to identify the heavy metals in the water samples.

Inductively Coupled Microwave Atomic Emission Spectrometer is the spectroscopic technique employed in the current investigation to achieve a high level of accuracy and sensitivity (ICP-AES). Since it became commercially available more than 41 years ago13,14, inductively plasma has been used to test trace metals in various solutions. Inductively coupled plasma mass and inductively coupled plasma spectroscopy (ICP-OES) are two of the techniques that can be used to accomplish ICP (ICP-MS). As an aerosol that travels into the plasma's core, sample solutions are delivered into the ICP (Superheated inert gas). The aerosol is transformed into a solid by the plasma, which subsequently turns the solid into a gas and breaks down the gas's molecules into atoms. The atoms and ions are excited by this high temperature source (plasma). The atoms and ions are excited by the high temperature source (plasma) to emit light at specific wavelengths that are related to various elements in the sample solution. The discovered element's concentration and emission intensity are correlated.

The primary advantage of AES over atomic absorption spectroscopy is the simultaneous simultaneous detection of all the excited atoms in a sample (AAS). By using an induction coupled argon plasma as the excitation source and a direct reading emission spectrometric technique, all parameters are obtained concurrently on a single sample. Through the use of a spray chamber and torch assembly, samples are pushed into a compressor nebulizer, atomized, and delivered into the plasma. Every study is based on the average of two duplicate exposures that have each had their background adjusted using a spectrum shifting approach.

Trace metal estimations in the lake water samples were carried out using ICP-AES methods. ICP- AES analysis was carried out on Labtam 8440 Plasma lab Inductive coupled plasma emission spectrometer.

MATERIALS AND METHODS

2.1 Sampling: Two locations provided water samples, including Powai Water Lake (19.13° N 72.91° E) in Powai Valley, Powai Village, Mumbai. Other lake is a Vihar Lake (19.1440° N 72.910 ° E) situated located near Vihar village. These lakes were heavily up streamed by industrial waste which contain heavy metals.

2.2 Sample Collection: There are two variables considered in the present investigation; first is the season, as this the well-known fact that composition of water changes up to a certain extend in each season. Samples were collected in summer, winter, pre-monsoon and post-monsoon.

Before the monsoon, there is no rain, and the river levels drop; after the monsoon, there is considerable rain, and the river levels rise. The post-monsoon season in the examined water

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body showed higher water flow than the winter season, which may have an impact on the change of metal concentrations in the water and sediment.

Second variable is the sample station, samples were collected from four different stations (S1-S4) of Powai Lake and three different stations (S5-S7) of Vihar Lake for comprehensive study.

Total 56 samples were collected from the lakes (32 from Powai Lake and 24 from Vihar Lake) from 2021-2022 presented in **Table 1-7**.

2.3 Sample Preparation: Water samples were collected in 500 ml bottles from 50 cm below the water's surface, passed through a Whatman 0.45 m glass fibre filter, and then transferred to 500 ml polypropylene bottles.

At each sampling location, a sample of the water weighing around 1 L was taken. Samples were filtered, acidified with 10% HNO3, and stored at 4 oC pending analysis.

2.4 Utilizing an inductive coupled plasma atomic emission spectrophotometer, metals have been analysed. Using the microwave digestive system, sample preparation. the amount of concentration in mg/l. The levels of heavy metals in the water were statistically compared between the seasons. The correlation coefficient between water and several seasons was calculated.

2.5 Analysis of Metal: To determine the ppm of each analyte in the digested solution, the samples were compared to a multi-element standard curve. The materials were examined using a Labtam 8440 Plasmalab Inductive coupled plasma emission spectrometer three separate times. The wavelengths utilised for Al, As, Cd, Co, Cr, Cu, Mn, Ni, Pb, Zn, and Fe detection and measurement, respectively, are 396.152, 188.980, 214.439, 238.892, 267.716, 327.395, 257.610, 231.604, 220.353, 213.857, and 238.204 nm.

2.5 Statistical Analysis: The findings of a two-way ANOVA have been taken into account and are shown in Table 8 to explore the effects of season and sample station. The statistical software SPSS 20.0 was used to statistically analyse the data (SPSS Inc., Chicago, IL, USA).

3. Discussion: Table 1–7 displays the outcomes of the inductively coupled plasma atomic emission spectroscopy. and relative concentration of the metal in all the four seasons for two subsequent years i.e., 2021 and 2022 is depicted.

TABLE 1: SEASONAL VARIATION OF CONCENTRATION OF HEAVY METAL AT POWAI LAKE S1

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	2021				2022			
Heavy Metals	**S**	**W**	**PRE-M**	**POST-M**	**S**	**W**	**PRE-M**	**POST-M**
Al	0.20	0.30	0.23	0.15	0.13	0.25	0.28	0.20
As	ND	ND	ND	ND	ND	ND	ND	ND
Cd	ND	ND	ND	ND	ND	ND	ND	ND
Co	ND	ND	ND	ND	ND	ND	ND	ND
Cr	0.191	0.2	0.17	0.08	0.13	0.19	0.16	0.07
Cu	0.009	0.015	0.010	0.010	0.010	0.019	0.016	0.010
Fe	1.10	1.32	1.67	1.30	1.20	1.57	1.50	1.35
Hg	ND	ND	ND	ND	ND	ND	ND	ND
Mn	0.14	0.22	0.21	0.16	0.14	0.23	0.20	0.17
Ni	0.008	0.030	0.030	0.017	0.013	0.021	0.020	0.016
Pb	ND	ND	ND	ND	ND	ND	ND	ND
Zn	ND	ND	ND	ND	ND	ND	ND	ND

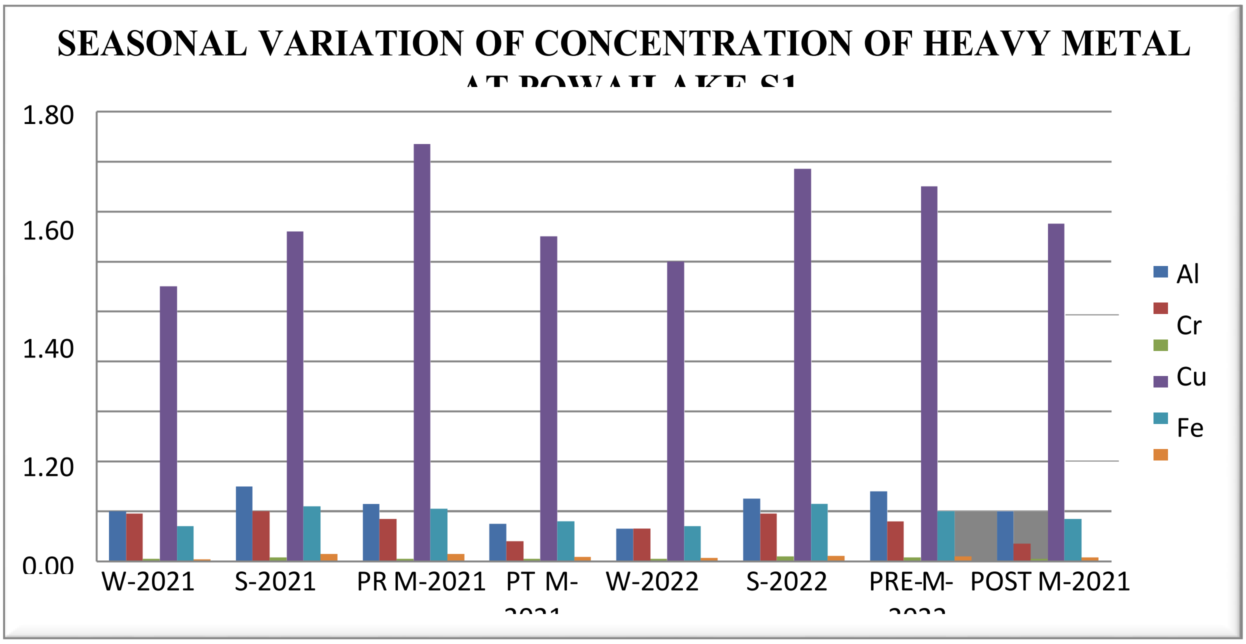

FIGURE 1: RELATIVE CONCENTRATION OF HEAVY METALS IN POWAI LAKE (S1)

TABLE 2 SEASONAL VARIATION OF CONCENTRATION OF HEAVY METAL AT POWAI LAKE S2

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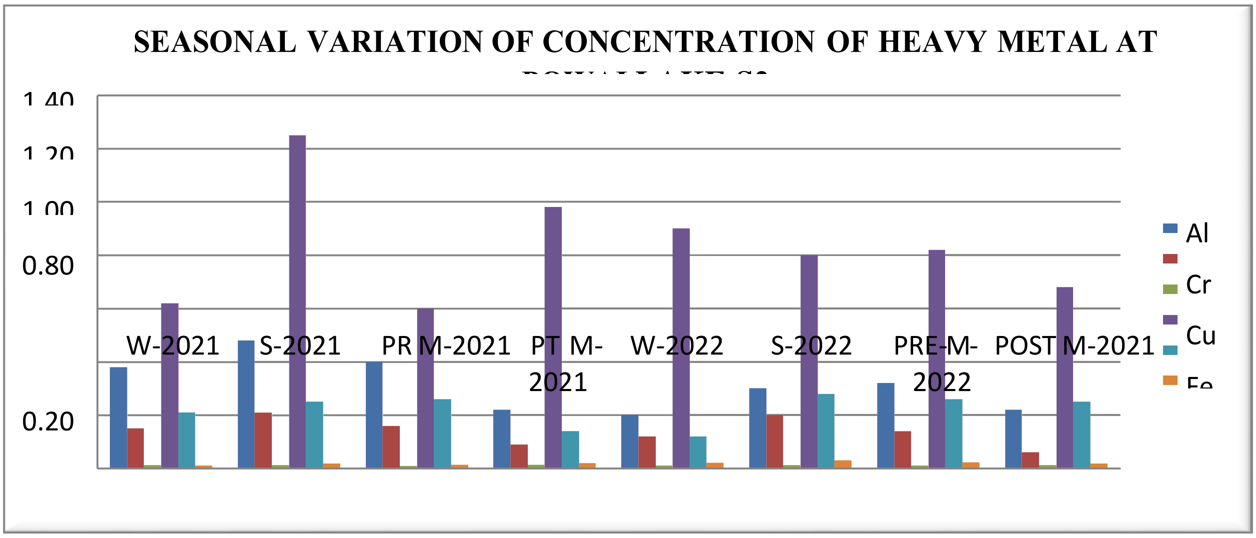
Heavy Metals	2021 S	2021 W	2021 PRE -M	2021 POST-M	2022 S	2022 W	2022 PRE-M	2022 POST-M
Al	0.38	0.48	0.40	0.22	0.20	0.30	0.32	0.22
As	ND	ND	ND	ND	ND	ND	ND	ND
Cd	ND	ND	ND	ND	ND	ND	ND	ND
Co	ND	ND	ND	ND	ND	ND	ND	ND
Cr	0.151	0.21	0.16	0.09	0.12	0.2	0.14	0.06
Cu	0.012	0.012	0.009	0.013	0.011	0.012	0.010	0.012
Fe	0.62	1.25	0.60	0.98	0.90	0.80	0.82	0.68
Hg	ND	ND	ND	ND	ND	ND	ND	ND
Mn	0.21	0.25	0.26	0.14	0.12	0.28	0.26	0.25
Ni	0.010	0.018	0.013	0.020	0.021	0.030	0.023	0.018
Pb	ND	ND	ND	ND	ND	ND	ND	ND
Zn	ND	ND	ND	ND	ND	ND	ND	ND

FIGURE 2: RELATIVE CONCENTRATION OF HEAVY METALS IN POWAI LAKE (S2)

TABLE 3 SEASONAL VARIATION OF CONCENTRATION OF HEAVY METAL AT POWAI LAKE S3



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	2021				2022			
Heavy Metals	**S**	**W**	**PRE-M**	**POST-M**	**S**	**W**	**PRE-M**	**POST-M**
Al	0.30	0.39	0.37	0.29	0.23	0.35	0.36	0.25
As	ND	ND	ND	ND	ND	ND	ND	ND
Cd	ND	ND	ND	ND	ND	ND	ND	ND
Co	ND	ND	ND	ND	ND	ND	ND	ND
Cr	0.128	0.18	0.13	0.07	0.11	0.16	0.12	0.05
Cu	0.010	0.013	0.013	0.014	0.010	0.015	0.011	0.011
Fe	1.00	1.40	1.11	1.01	1.00	1.21	1.20	0.99
Hg	ND	ND	ND	ND	ND	ND	ND	ND
Mn	0.24	0.30	0.33	0.18	0.16	0.30	0.27	0.16
Ni	0.020	0.019	0.014	0.031	0.020	**0.033**	0.000	0.019
Pb	ND	ND	ND	ND	ND	ND	ND	ND
Zn	ND	ND	ND	ND	ND	ND	ND	ND

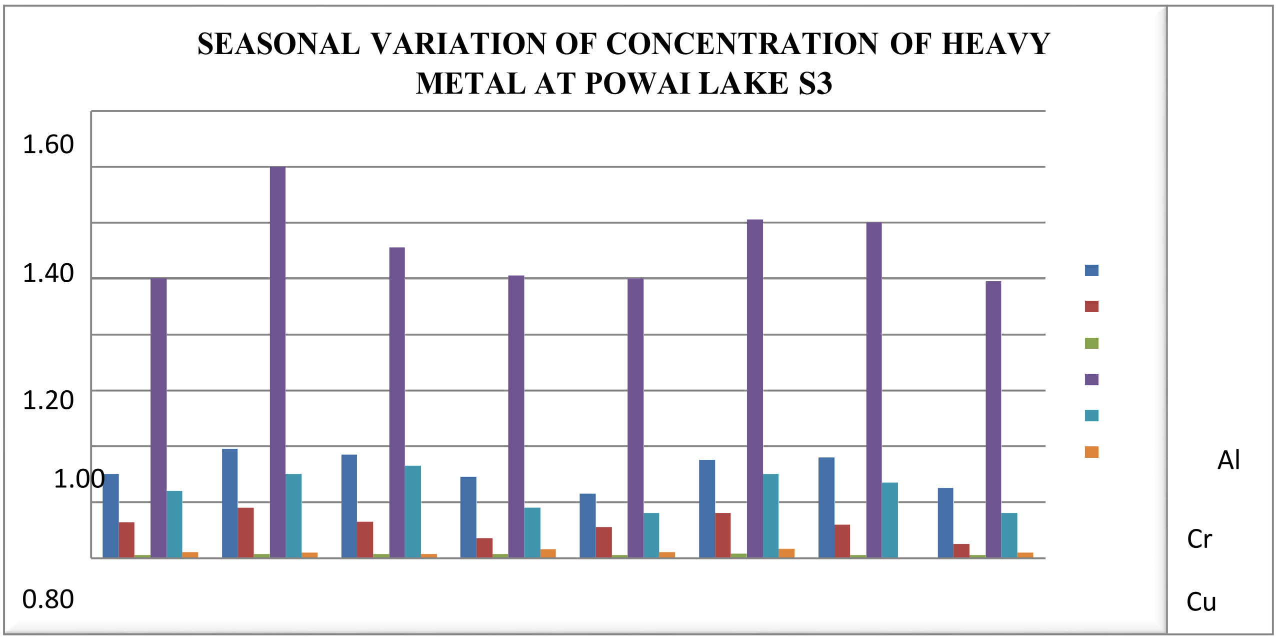

FIGURE 3: RELATIVE CONCENTRATION OF HEAVY METALS IN POWAI LAKE (S3)

TABLE 4 SEASONAL VARIATION OF CONCENTRATION OF HEAVY METAL AT POWAI LAKE S4

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	2021				2022			
Heavy Metals	**S**	**W**	**PRE-M**	**POST-M**	**S**	**W**	**PRE-M**	**POST-M**
Al	0.26	0.31	0.30	0.26	0.22	0.33	0.35	0.23
As	ND	ND	ND	ND	ND	ND	ND	ND
Cd	ND	ND	ND	ND	ND	ND	ND	ND
Co	ND	ND	ND	ND	ND	ND	ND	ND
Cr	0.107	0.12	0.09	0.06	0.11	0.11	0.1	0.06
Cu	0.013	0.014	0.016	0.015	**0.010**	0.013	**0.010**	0.014
Fe	0.85	1.10	0.93	0.86	0.80	1.10	1.00	0.70
Hg	ND	ND	ND	ND	ND	ND	ND	ND
Mn	0.16	0.20	0.22	0.12	0.10	0.29	0.25	0.18
Ni	0.015	0.021	0.013	0.016	0.015	0.028	0.025	0.011
Pb	ND	ND	ND	ND	ND	ND	ND	ND
Zn	ND	ND	ND	ND	ND	ND	ND	ND

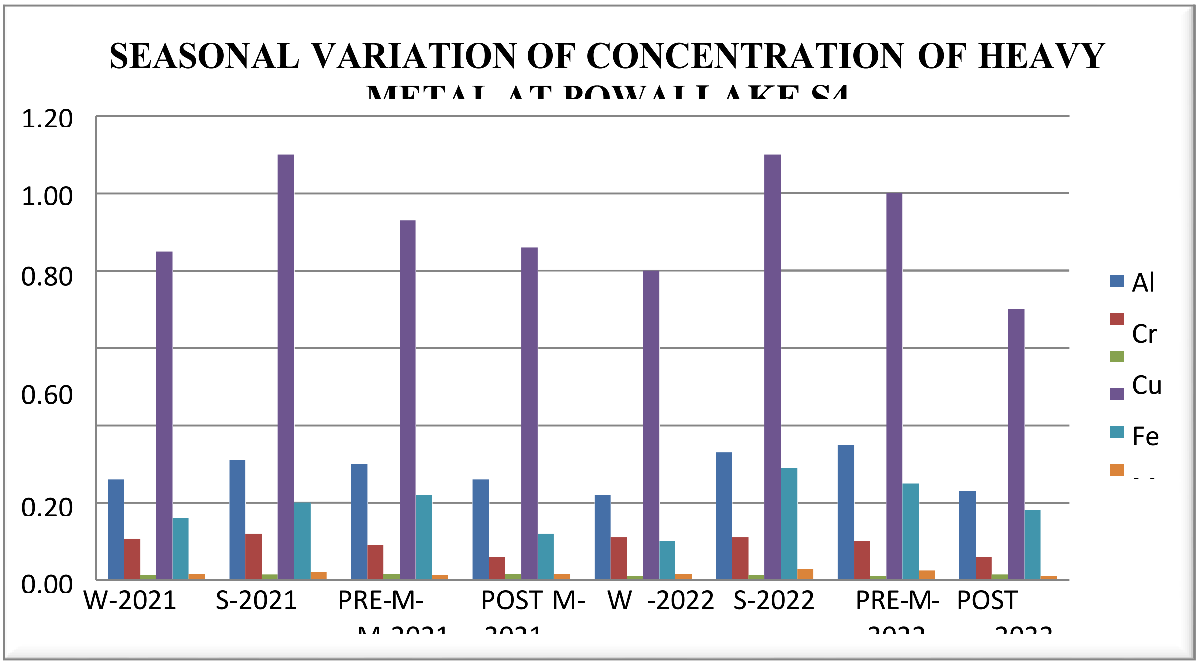

FIGURE 4: RELATIVE CONCENTRATION OF HEAVY METALS IN POWAI LAKE (S4)

TABLE 5 SEASONAL VARIATION OF CONCENTRATION OF HEAVY METAL AT VIHAR LAKE S5

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	2021				2022			
Heavy Metals	**S**	**W**	**PRE-M**	**POST-M**	**S**	**W**	**PRE-M**	**POST-M**
Al	0.10	0.12	0.13	0.12	0.12	0.25	0.18	0.35
As	ND	ND	ND	ND	ND	ND	ND	ND
Cd	ND	ND	ND	ND	ND	ND	ND	ND
Co	ND	ND	ND	ND	ND	ND	ND	ND
Cr	0.01	0.07	0.04	0.03	0.02	0.08	0.06	0.02
Cu	0.010	0.011	0.012	0.012	0.010	0.013	0.015	0.011
Fe	0.19	0.30	0.35	0.25	0.26	**1.07**	0.18	0.16
Hg	ND	ND	ND	ND	ND	ND	ND	ND
Mn	**0.08**	0.11	0.12	0.10	0.10	0.21	0.16	**0.38**
Ni	0.012	0.020	0.031	0.018	0.015	0.027	0.030	0.013
Pb	ND	ND	ND	ND	ND	ND	ND	ND
Zn	ND	ND	ND	ND	ND	ND	ND	ND

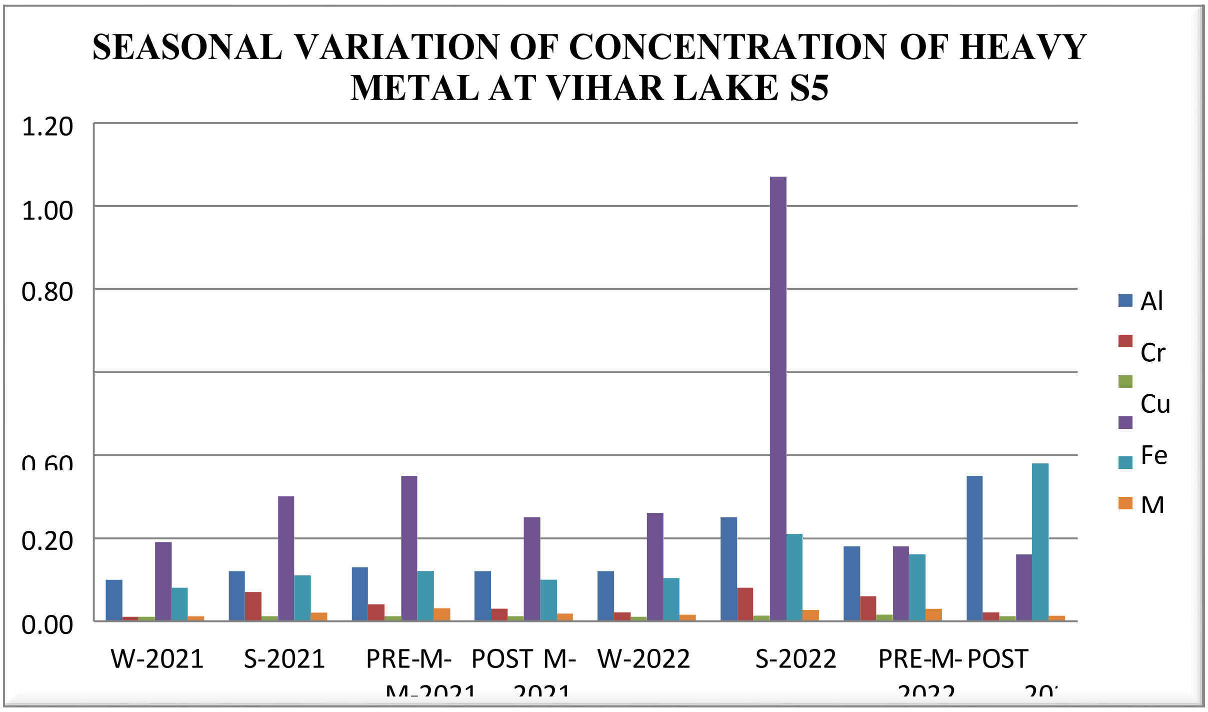

FIGURE 5: RELATIVE CONCENTRATION OF HEAVY METALS IN POWAI LAKE (S5)

TABLE 6 SEASONAL VARIATION OF CONCENTRATION OF HEAVY METAL AT VIHAR LAKE S6

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	2021				2022			
Heavy Metals	**S**	**W**	**PRE-M**	**POST-M**	**S**	**W**	**PRE-M**	**POST-M**
Al	0.08	0.10	0.12	0.11	0.05	0.40	0.22	0.18
As	ND	ND	ND	ND	ND	ND	ND	ND
Cd	ND	ND	ND	ND	ND	ND	ND	ND
Co	ND	ND	ND	ND	ND	ND	ND	ND
Cr	0.03	0.09	0.05	0.04	0.05	0.1	0.05	0.03
Cu	0.012	0.014	0.013	0.010	0.014	0.014	0.012	0.012
Fe	0.23	0.43	0.48	0.30	**0.12**	0.23	0.23	0.33
Hg	ND	ND	ND	ND	ND	ND	ND	ND
Mn	0.09	0.12	0.13	0.11	0.04	0.33	0.23	0.21
Ni	0.010	0.015	0.020	0.012	0.015	0.020	0.025	0.014
Pb	ND	ND	ND	ND	ND	ND	ND	ND
Zn	ND	ND	ND	ND	ND	ND	ND	ND

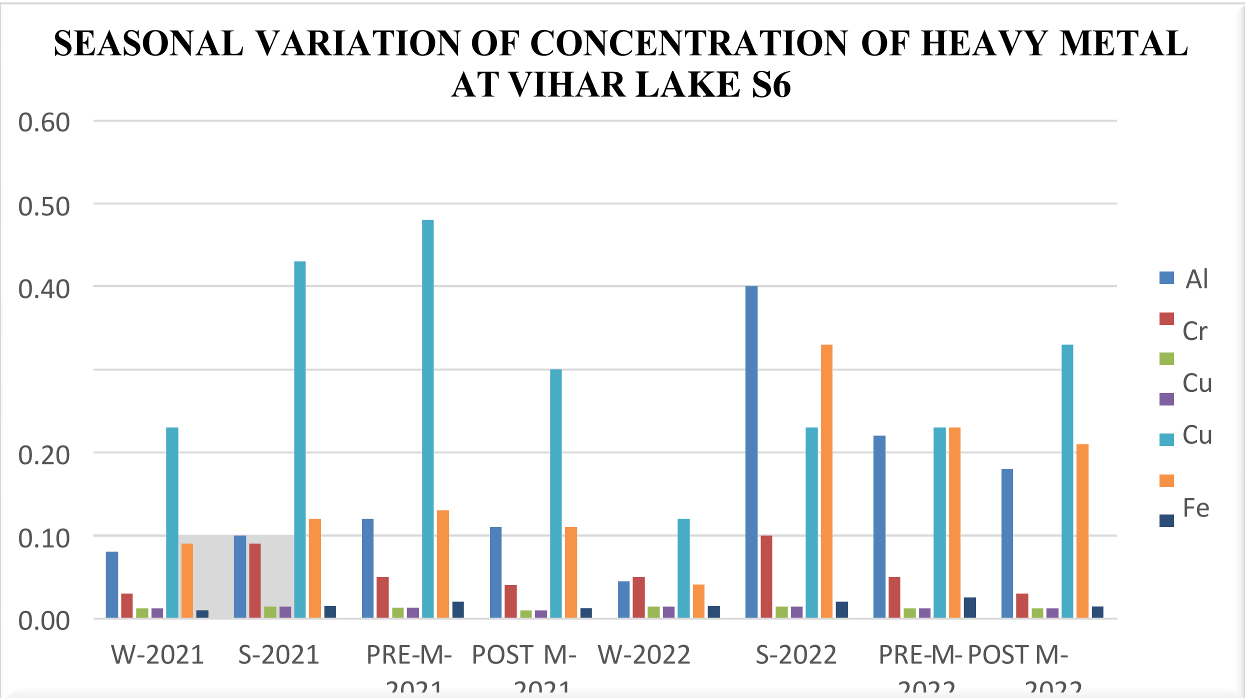

FIGURE 6: RELATIVE CONCENTRATION OF HEAVY METALS IN POWAI LAKE (S6)

TABLE 7 SEASONAL VARIATION OF CONCENTRATION OF HEAVY METAL AT VIHAR LAKE S7

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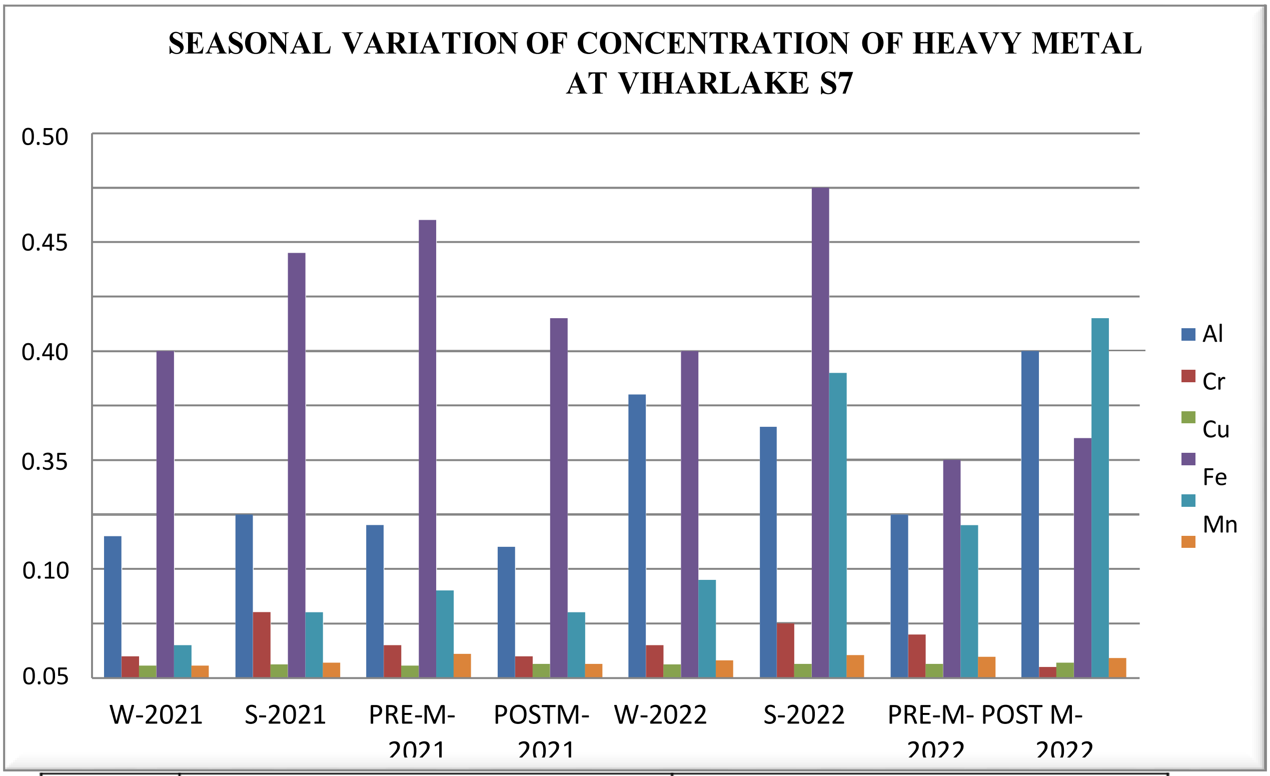

	2021				2022			
Heavy Metals	S	W	PRE-M	POST-M	S	W	PRE-M	POST-M
Al	0.13	0.15	0.14	0.12	0.26	0.23	0.15	0.30
As	ND	ND	ND	ND	ND	ND	ND	ND
Cd	ND	ND	ND	ND	ND	ND	ND	ND
Co	ND	ND	ND	ND	ND	ND	ND	ND
Cr	0.02	0.06	0.03	0.02	0.03	0.05	0.04	0.01
Cu	0.011	0.012	0.011	0.013	0.012	0.013	0.013	0.014
Fe	0.30	0.39	0.42	0.33	0.30	0.45	0.20	0.22
Hg	ND	ND	ND	ND	ND	ND	ND	ND
Mn	0.03	0.06	0.08	0.06	0.09	0.28	0.14	0.33
Ni	0.011	0.014	0.022	0.013	0.016	0.021	0.019	0.018
Pb	ND	ND	ND	ND	ND	ND	ND	ND
Zn	ND	ND	ND	ND	ND	ND	ND	ND

FIGURE 7: RELATIVE CONCENTRATION OF HEAVY METALS IN POWAI LAKE (S7)

Aluminum: Seasonal variations of Aluminum concentration in the Powai and Vihar Lake water during the study period were presented in **Table 1-7**. Maximum Al concentration of 0.48 mg/L was observed at S2 during summer seasons (2021) at Powai Lake. The minimum Al concentration of 0.13 mg/L was observed at S1 in winter season, (2022) at Powai Lake.

Whereas maximum and minimum Al concentration of 0.45 mg/L at S6 in summer season (2022) and 0.40 mg/L at S6 in winter (2022) was observed at Vihar Lake respectively. Mean Concentration of Al was 0.283 mg/L and 0.0878 mg/L at Powai and Vihar Lake respectively.

Results of Two-way ANOVA of Powai Lake demonstrate that Al had a significant effect between seasons (F=8.698 P<0.01) as well as between sampling stations (F=5.711 P<0.01). Whereas results of Two-way ANOVA of Vihar Lake demonstrate that Al had insignificant effect between seasons (F = 0.943) as well as between sampling stations (F= 0.162).

Arsenic (As): The presence of as was not found in the samples taken throughout the study period from Powai and Vihar Lake water.

Cadmium (Cd): The presence of Cd was not found in the samples taken throughout the study period in the water from Powai and Vihar lakes.

Chromium (Cr): Seasonal variations of Chromium concentration in the Powai and Vihar Lake water during the study period were presented in **Table 1-7**. The concentration of Chromium in the lake water sample of Powai and Vihar Lake varied from 0.05 to 0.210 and 0.010 to 0.10mg/L respectively. The maximum and Cr appeared in Powai Lake is 0.191 mg/L in Powai Lake at S1 in summer, and minimum of 0.06 mg/l appear post monsoon at S2.

The maximum concentration in Vihar Lake is 0.1 mg/L only at S6 in winter, minimum concentration of Cr in Vihar has been observed as 0.01 mg/L S7 post-monsoon. Mean concentration of Cr was found 0.126 mg/L and 0.043 mg/L respectively.

Results of two-way ANOVA of Powai Lake demonstrate that Cr had a significant effect between seasons (F = 60.640 P<0.01) as well as between sampling stations (F = 19.657 P <0.01), whereas results of two-way ANOVA of Vihar Lake demonstrate that Cr had a significant effect between seasons (F = 45.706 P<0.01) as well as between sampling stations (F = 14.529 P <0.01).

Cobalt (Co): The presence of Co was not found in the samples taken throughout the study period from Powai and Vihar Lake water.

Copper (Cu): Seasonal variations of copper concentration in the Powai and Vihar Lake water during the study period were presented in **Table 1 to 7.** The concentration of copper in the lake water sample of Powai and Vihar Lake varied from 0.009 to 0.019 and 0.010 to 0.015 respectively. Mean concentration of Cu was found 0.0098 mg/L and 0.012 mg/L respectively.

Results of two-way ANOVA of Powai Lake demonstrate that Cu had a significant effect between seasons (F = 60.266 P<0.01) as well as between sampling stations (F = 7.642 P <0.01). Whereas results of two-way ANOVA of Vihar Lake demonstrate that Cu had insignificant effect between seasons (F=1.822) as well as between sampling stations (F = 1.300).

Iron (Fe): Seasonal variations of Iron concentration in the Powai and Vihar Lake water during the study period were presented in **Table 1-7** Maximum concentration of Fe in Powai Lake water sample was found as 1.67 mg/L during pre-monsoon season 2021 at S1, Minimum concentration of Fe in the Powai Lake water sample were recorded during post monsoon season 0.68 mg/L at S2. In a water sample from Vihar Lake, the greatest Fe contraction of 1.07 mg/L was noted at S5 during the summer of 2022.The

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concentrations of Fe in the Vihar Lake water samples were observed to be minimum 0.12 mg/L at S6 during winter season (2022).

Results of Two-way ANOVA of Powai Lake demonstrate that Fe had a significant effect between seasons (F = 6.941 P<0.01). Whereas results of Two-way ANOVA of Vihar Lake demonstrate that Fe had insignificant effect between seasons (F= 2.10 4) as well as between sampling stations (F = 0.1599)

Mercury: Hg was not found in the samples of lake water taken throughout the study period from Powai or Vihar.

CONCLUSION

water analysis study using inductive coupled plasma atomic emission spectrophotometer revels that the water sample from two lakes i.e., Powai Lake and Vihar Lake does not contain Mercury, Cobalt, Cadmium, and Arsenic. However, the Iron (Fe), Copper (Cu) and Aluminium (Al) present in the Powai lake's water sample shows significance effect of Season and sampling station on its concentration, but the concentration is not affected by season and sampling station in the samples of Vihar Lake.

Chromium is the only heavy metal which shows significant effect of season and sampling station in both the lakes.

REFERENCES

1. https://www.hindustantimes.com/mumbai-news/pollution-level-at-powai-lake-8-times-above-safe-standards-environment-ministry/story-taR1xJhKWm0QislDpYiOOK.html
2. ***C. Mitter,*** Assessment of Water Quality of Powai Lake, Mumbai, India, International Journal of Science and Research,7,1,2018, 1138-1139.
3. ***"Water" (2006***) Mumbai, World Water Day MEA and Brihan Mumbai Licensed plumbers Association (BMLPA).
4. ***Politer Center*** Issue- "water and sanitation" (2016) News Hour, the common language project and the under – Told stories project – support provided by the larid Norton Family Foundation individual donors
5. ***Salaskar P.B Yeragi.S. G.and Ratrick G. (2007)*** "Environmental Status of Powai Lake Mumbai India "Proceedings of Taal 12Th world lake conference pp 1650-1654.
6. ***Lane TW, Morel FM.*** A biological function for cadmium in marine diatoms. Proc Natl Acad Sc. . . . 200 ;9) [Last cited on 2009 Aug 13]. pp. 462–31.
7. ***Jessica Briffa*** , Emmanuel Sinagra, Renald Blundell, Heavy metal pollution in the environment and their toxicological effects on humans, Heliyon, 6,9,1-26
8. ***C.H. Walker, R.M. Sibly, S.P. Hopkin, D.B.P.,*** in: Principles of Ecotoxicology; Group, T. And F., Ed.; 4th Edition, CRC Press, 2012.
9. ***Steven J Hill, Toyon*** A, Arowolo S Cresser, Chrish Harington, Douglas L Miles, Atomic spectroscopy update environmental analysis, J. Anal. At. Spectrom, 11, 2003, 170-202
10. ***Owen T. Butler, Warren R. L. Cairns, Jennifer M. Cook and Christine M. Davidsond;*** Atomic spectrometry update. Environmental analysis; J. Anal. At. Spectrom., 2013,28, 177-216
11. ***Butler, O. T., Cairns, W. R. L., Cook, J. M., & Davidson, C. M. (2012).*** Atomic spectrometry update. Environmental analysis. Journal of Analytical Atomic Spectrometry, 27(2), 187-221.
12. ***Butler, Owen T.; Cairns, Warren; Cook, Jennifer M.; Davidson, Christine M. 2010*** Atomic spectrometry update: environmental analysis. Journal of Analytical Atomic Spectrometry, 25 (2). 103-141.

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13. ***Gajek R, Choe K-Y.*** Determination of ultra-trace elements in human plasma or serum by ICP-MS using sodium in the presence of carbon as a single calibration matrix-match component. J Anal at Spectrum. 2015; 30:1142–53.
14. ***Olivares JA, Houk RS***. Suppression of analyte signal by various concomitant salts in inductively coupled plasma mass spectrometry. Anal Chem. 1986; 58:20–5.
15. ***Fraser MM, Beauchemin D.*** Evidence supporting the occurrence of Coulomb fission during conventional sample introduction in inductively coupled plasma mass spectrometry. J Anal at Spectrum. 2009; 24:469–75.
16. ***Houk RS, Fassel VA, Flesch GD, Svec HJ, Gray AL, Taylor CE***. Inductively Coupled Argon Plasma as an Ion Source for Mass Spectrometric Determination of Trace Elements. Anal Chem. 1980; 52:2283–9.