Heavy metals Assessment of Temple Ponds in Kanchipuram, Tamil Nadu, India

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Abstract. Heavy metals are a major environmental pollutant, they are slow, non-degradable material it affects the aquatic ecosystem. Heavy metal pollutant molecules arrive the pond water through anthropogenic activities, domestic waste, hospital wastes and temple wastes. The investigation was designed to study the seasonal spreading of specific heavy metals Iron (Fe), Copper (Cu), Lead (Pb), Arsenic (As) and Zinc (Zn)) in pond water. Seventeen pond water samples were collected during pre-monsoon (March 2017) and post-monsoon (January 2018) period. The concentration of Iron in the pre-monsoon greater than class A limit. The concentration of other prescribed heavy metal was less than central pollution control board standards in both the season. Hence pond water having a negligible amount of heavy metal pollution. This environmental observing and valuation research useful for managing and planning for the protection of pond.

Keywords: Heavy metals; Temple ponds; pre monsoon.

1. Introduction

The world is in the greatest problem due to lack of quality and amount of water. Water pollution is one of the universal problems, touching both the industrialized and the emerging nations [1]. The water pollution problems are different in many aspects. Toxic metals, acids, sediment, animal and human wastes, and synthetic organic compounds deposited in the waterway that causes the water pollution of developing nations [2]. Pollution changes the water chemistry which affects the water quality and upset the ecological balance in the aquatic ecosystem and disturbs the productivity. Most pollutants that move in the aquatic environment are chemical in nature and range from completely toxic substance such as agricultural pesticides, cyanide and salt of various heavy metals to nutrient such as phosphate, nitrate, fertilizer and organic matter of domestic and industrial origin [3]. The major role for water pollution is the presence of heavy metal. There are two main causes of heavy metals into the environment that are natural
process and anthropogenic. Recent days urban and industrial actions are growing heavy metals into the aquatic ecosystem, when they exceed standard concentration, they have toxic effects on living organisms also they decrease survival, growth and species diversity[4,5]. In certain condition heavy metal is high concentration they may have a negative impression on the receiving environment. Ponds are very significant water bodies in the country [6]. The various resources of the pollutions of the pond are washing the clothes, animals, dumping of the waste by unauthorized small scale units functioning in the surrounding of the pond [7,8]. These resources, create a passage for mixing heavy metal into the ponds [9]. The increased pollution level decreases the quality and quantity of water. Kanchipuram is holiest city having more temples and festivals. Many festivals conducted in ponds thepam, thirthavari, nadavavi etc. Ponds also act as a reservoir for storing rainwater, it will increase the water table level for surrounding area. At present it is the main target to measure the water pollution level and its impression on living organisms in the pond water. The present research work is the assessment of heavy metal components during pre-monsoon and post-monsoon period (March 2017 and January 2018) in temple ponds in Kanchipuram.

2. Study Area

This study is focused in the temple ponds present in the Kanchipuram. It is one of the eminent cities of temples in South India. Kanchipuram is a town in the northern portion of Tamil Nadu state. It is a traditional and visitor spot, with the population more than 170,000 people. The geographic location lies between 12º46’30” - 12º52’00” North Latitude and 79º39’00” - 79º46’20” East longitude. The sampling points in Kanchipuram cover residential, industrial, spiritual, low and high population areas. The study area shown in Figure 1.

![Figure 1. Study Area](image)

3. Sampling of Temple pond water

The pond water samples were collected at seventeen temples in Kanchipuram at pre monsoon (PRM), post monsoon(POM). The level of water in pond varies from low, medium and high. The samples were collected in well cleaned polythene bottles of one litter capacity. The pond water samples marked as P1, P2 up to P17. Then the sample was immediately taken to a laboratory for testing. The parameters pH, Total Dissolved Solids, Electrical conductivity, heavy metals Iron, Arsenic, Lead, Copper, Zinc were tested in the laboratory. The standard (CPCB & BIS) permissible limit for each measured parameter shown in Table 1.
Table 1. Standard permissible limits for each measured parameters

| SLNo | Water Quality Parameters | Drinking after disinfection (A) | Bathing (B) | Drinking with treatment infection (C) | Fish Culture (D) | Irrigation (E) |
|------|--------------------------|---------------------------------|-------------|--------------------------------------|-----------------|---------------|
| 1    | pH                       | 6.5 – 8.5                       | 6.5 – 8.5   | 6.5 – 8.5                            | 6.5 – 8.5       | 6.0 – 8.5     |
| 2    | Electrical Conductivity  | -                               | -           | -                                    | -               | -             |
| 3    | Total dissolved solids   | 500                             | -           | 1500                                 | -               | 2100          |
| 4    | Iron                     | 0.3                             | -           | 50                                   | -               | -             |
| 5    | Arsenic                  | 0.05                            | 0.2         | 2                                   | -               | -             |
| 6    | Lead                     | 0.1                             | 0.1         | -                                    | -               | -             |
| 7    | Copper                   | 1.5                             | 1.5         | -                                    | -               | -             |
| 8    | Zinc                     | 15                              | 15          | -                                    | -               | -             |

4. Result and Discussion

4.1 Water Quality Parameters

The values of water quality parameters measured in selected sampling points are presented in Table 2.

Table 2. Water Quality Parameters values in sampling points

| Sl. No. | Name of the Temple                  | Sampling Point | pH  | TDS  | EC  |
|---------|-------------------------------------|----------------|-----|------|-----|
|         |                                     |                | PRM | POM  | PRM | POM  |
| 1       | Lakshmi Narayana Temple             | P1             | 7.44| 7.03 | 230 | 159  |
| 2       | Kamakshi Amman Temple               | P2             | 8.42| 7.32 | 382 | 744  |
| 3       | Kailasanathar Temple, Sevilimedu    | P3             | 7.47| 9.31 | 161 | 164  |
| 4       | Kasi Viswanatha Temple              | P4             | 7.42| 8.26 | 618 | 436  |
| 5       | Astabhujakoram Temple               | P5             | 7.40| 7.91 | 573 | 148  |
| 6       | Punniyakoteswarar Temple            | P6             | 7.47| 7.68 | 305 | 183  |
| 7       | Kosalakottam                        | P7             | 7.59| 8.04 | 306 | 744  |
| 8       | Kachapteswarar Temple               | P8             | 7.25| 6.86 | 159 | 114  |
| 9       | Varadharaja Perumal Temple, Front side | P9         | 7.85| 7.58 | 165 | 172  |
| 10      | Varadharaja Perumal Temple, Back side | P10        | 7.48| 7.62 | 424 | 740  |
| 11      | Sornavannam Saitha                 | P11            | 7.94| 7.80 | 932 | 1146 |
| 12      | Dharmalingeswarar Temple            | P12            | 9.07| 8.86 | 1326| 1160 |
| 13      | Ekambareswarar Temple               | P13            | 7.45| 7.52 | 132 | 117  |
| 14      | Santhaleeswarar Temple              | P14            | 7.76| 7.46 | 676 | 1076 |
| 15      | Vilakoli Perumal Temple             | P15            | 7.85| 7.45 | 835 | 750  |
| 16      | Kailasanathar Temple                | P16            | 7.96| 7.66 | 574 | 547  |
| 17      | Thamarai Kulam                      | P17            | 7.4 | 7.42 | 425 | 1204 |

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The pH value varies between 7.4 to 9.07 in PRM and 6.86 to 9.31 in POM. pH values of sixteen temple ponds are within the permissible limits, P12 in PRM, P3 in POM having greater pH value and it shows it is in alkaline nature. It is due to melted chemical composites and biological process in the solution [10]. The seasonal variation of pH values in all sampling points shown in Figure 2. TDS values vary between 159 mg/l to 1326 mg/l in PRM and 114 mg/l to 1204 mg/l in POM, both seasons all measured values were within the standard limit [11]. The greater value of Total dissolved solids reduces the purity of water, affects the photosynthesis process. The seasonal variation of TDS values in all sampling points shown in Figure 3. Electrical conductivity values varies between 203 mg/l to 2040 mg/l in PRM and 135 mg/l to 1853 mg/l in POM. EC depends on the presence of solid compounds, it may not cause a major effect on pond water [12]. The seasonal variation of EC values in all sampling points shown in Figure 4.

4.2 Heavy metal distribution

Five heavy metals Fe, As, Pb, Cu, Zn was assessed for the concentrations in seventeen selected stations. The observed results were presented in Table 3.
Table 3. Heavy metal values in Sampling Points

| Sl. No. | Sampling Point | Fe (mg/l) | As (mg/l) | Pb (mg/l) | Cu (mg/l) | Zn (mg/l) |
|---------|----------------|-----------|-----------|-----------|-----------|-----------|
|         |                | PRM       | POM       | PRM       | POM       | PRM       | POM       |
| 1       | P1             | 0.54      | 0.07      | < 0.1     | < 0.1     | < 0.1     | < 0.1     |
| 2       | P2             | 0.67      | 0.09      | < 0.1     | < 0.1     | < 0.1     | < 0.1     |
| 3       | P3             | 0.72      | 0.04      | < 0.1     | < 0.1     | < 0.1     | < 0.1     |
| 4       | P4             | 0.82      | 0.03      | < 0.1     | < 0.1     | < 0.1     | < 0.1     |
| 5       | P5             | 0.68      | 0.08      | < 0.1     | < 0.1     | < 0.1     | < 0.1     |
| 6       | P6             | 0.53      | 0.03      | < 0.1     | < 0.1     | < 0.1     | < 0.1     |
| 7       | P7             | 0.46      | 0.08      | < 0.1     | < 0.1     | < 0.1     | < 0.1     |
| 8       | P8             | 0.37      | 0.02      | < 0.1     | < 0.1     | < 0.1     | < 0.1     |
| 9       | P9             | 0.42      | 0.07      | < 0.1     | < 0.1     | < 0.1     | < 0.1     |
| 10      | P10            | 0.54      | 0.07      | < 0.1     | < 0.1     | < 0.1     | < 0.1     |
| 11      | P11            | 0.74      | 0.03      | < 0.1     | < 0.1     | < 0.1     | < 0.1     |
| 12      | P12            | 0.82      | 0.02      | < 0.1     | < 0.1     | < 0.1     | < 0.1     |
| 13      | P13            | 0.65      | 0.03      | < 0.1     | < 0.1     | < 0.1     | < 0.1     |
| 14      | P14            | 0.65      | 0.05      | < 0.1     | < 0.1     | < 0.1     | < 0.1     |
| 15      | P15            | 0.58      | 0.06      | < 0.1     | < 0.1     | < 0.1     | < 0.1     |
| 16      | P16            | 0.46      | 0.04      | < 0.1     | < 0.1     | < 0.1     | < 0.1     |
| 17      | P17            | 0.67      | 0.07      | < 0.1     | < 0.1     | < 0.1     | < 0.1     |

Figure 5. Seasonal Variation EC in Sampling Points
4.2.1 Iron, (Fe)

The heavy metal iron is a nutrient for human consumption. Maximum metabolic processes are going with the presence of iron [13]. It is a necessary component of hemoglobin and myoglobin, important for doing the movement of peroxides, cytochromes and other hemoprotein and flavoprotein enzymes [14,15]. In the sampling points, the variation of iron shown in Figure 5. The value of iron in PRM period ranges from 0.37 mg/l to 0.82 mg/l and POM period ranges from 0.02 mg/l to 0.09 mg/l. The present data show fluctuations of values in PRM and POM period. In PRM period considering Class A the values greater than the standard limit, According to WHO (1984),the safe condition for iron value 0.3 mg/l in drinking water and it varied between 1.94-5.76 mg/l in pond water. Considering other classes the values are below the standard limit. In POM all the sampling points having less value than the prescribed standard limit.

4.2.2 Arsenic, (As)

The heavy metal Arsenic is an essential compound for animal species; it plays a major role in protein synthesis. It is a dietary mineral for humans, it can take from food the limited concentration is 15-25µg. Arsenic mixing in the environment through mining, burning of fossil fuels, mixing in ground water through the dissolving of weathered rock, soil. Humans may absorb arsenic from water, food, air and skin contact with soil, water. Plants absorb arsenic easily it creates the presents of arsenic in food. The concentration of inorganic arsenic present in surface water is high, it can consume for plants in water, plant eating organisms, fish. Consumption of excessive inorganic arsenic cause health effects, like less production of white, red blood cells, stomach irritation, lung irritation, skin changes, development of cancer cells and damage DNA. In the study area, Arsenic concentration for PRM and POM period was less than the prescribed standard limit.

4.2.3 Lead, (Pb)

Lead is a non-necessary component. Deposition of leaded gasoline and industrial sources contaminate soil. Lead is brought from certain jobs welding, cutting, painting, demolition of buildings, industrial mineral activities mining, and extraction [16]. It found in some foods, traditional medicines. In drinking water lead mix from lead pipes, fittings. The contaminated drinking water is linked to hip fracture, damage to kidneys and it creates hypertension for human beings. The natural organic modules, like garlic oil and vitamin E, act as a depleting agent to lead in the human body. The acceptable limit for lead is 0.01 mg/l (BIS 2012). In the study area, lead concentration for PRM and POM period was less than the prescribed standard limit.

4.2.4 Copper, (Cu)

The heavy metal copper is an important portion of various enzymes, it is necessary for the synthesis of hemoglobin. Copper in the water due to heavy mounting vehicle traffic. In the stagnant water, the copper ions interact with organic species from industrial wastes having the potential appearance, ability to precipitate a complex system, deposit on the river basin and percolate to the water table. The maximum concentration of copper in the water is poisonous to the human health and causes hypertensions and produces pathological variations in brain tissues [17]. In the study area, copper concentration for PRM and POM period was less than the prescribed standard limit.
4.2.5 Zinc (Zn)

Zinc is an essential nutrient, it shows a significant role in the physiological and metabolic progression of many organisms. Melting of Zinc ores is the leading source of contamination of Zinc [18]. Other sources are municipal waste, automobiles and farming use of pesticides and fungicides having the zinc sulfate are the supplementary sources of ecological pollution due to Zinc. The highest concentrations of zinc toxic to health. Humans need a required level of Zn, less concentration causes infections, anemia and birth defects in pregnant women. In the study area, Zinc concentration for PRM and POM period was less than the prescribed standard limit.

5. Conclusion

The concentration of heavy metals and water quality parameters from seventeen sampling points was determined. The results showed that there was a less concentration of Arsenic, Lead, Copper, and Zinc in pre monsoon and post monsoon period. The concentration of Iron in the pre monsoon greater than standard limit comparatively to class A and below the limit for the remaining classes, in the post monsoon below the standard limit for all classes due to dilution of pond water by rain. Analyzing all the parameters the pond water was not directly used for drinking, it can useful for bathing, irrigation, fish culture etc.

6. References

[1] Mercy M and Dhanalakshmi B 2017 Int Res J Pharm 8 41-45
[2] Banerjee P and Prasad B 2018 J of App Chem 11 01- 05
[3] Sridhar S G D, Sakthivel A M, Sangunathan U, Balasubramanian M, Jenefer S, Rafik MM and Kanagaraj G 2017 Appl Water Sci 7 4651–4662
[4] Silambarasan K, Senthilkumar P and Velmurugan K 2012 Eur J of Exp Bio 2 2192-2198
[5] Ramachandran A, Krishnamurthy R R, Jayaprakash M and Balasubramanian M 2018 J of App Geo and Geophy 6 29-35
[6] Maurya A, Negi T and Negi R K 2018 Asia j Anim Sci 12 16-22
[7] Giri S and Singh A K 2014 Water Qua. Expo Health 5 173–182
[8] Bhatnagar A and Devi P 2013 Int J of Environ Sci 3 1980-2009
[9] Tapashi Gupta and Mrinal Paul 2013 Curr. World Env. 8 127-131
[10] Bhuyan MDS, Bakar MA, Rashed-Un-Nabi M D, Senapathi V, Chung SY and Islam MDS 2019 Appl Water Sci 9 1-13
[11] Goher ME, Hassan AM, Ibrahim B, Abdel-Moniem, Fahmy AH and El-sayed SM 2014 Egyp J of Aquatic Res 40 225–233
[12] Sisira S, Withanachchi, Ghambashidze G, Kunchulia I, Urushadze T and Ploeger A2018 Int J Environ Res Pub Health 15 1-37
[13] Flowra FA, Ghosh JK, Sayed Jewel MDA, Tumpa AS and Hussain MA 2012 J Life Earth Sci 7 115-117
[14] Adeyemi MM and Ugah 1A 2017 J of Env Sc. Toxi and Food Tech 11 39-43
[15] Armid A, Shinjo R, Ruslan R and Fahmiati 2017 IOP Conf. Ser Mater Sci and Engg 172 012002
[16] NguyenNTT and Volkova IV 2018 IOP Conf Ser. Mater Sci and Engg 451 012203
[17] Goher ME, El-Rouby WMA, El-Dek SI, El-Sayed SM and Noaemy SG 2018 IOP Conf Series Mater Sci and Engg 464 012003
[18] Jiao Z, Li H, Song M and Wang L 2018 IOP Conf Ser Mater Sci and Engg 394 052055