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AN ENVIRONMENTAL DISASTER: A CASE STUDY OF PALLIKARANAI WETLANDS CHENNAI, TAMIL NADU

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Abstract: *Wetlands are transitional lands between terrestrial and aquatic systems where the water table is usually at or near the surface or the land is covered by shallow water. Starting about thousands of years in urban areas of the world and typically a few hundred years ago in most of the coastal areas, humanity has profoundly impacted, degraded or destroyed many coastal wetlands worldwide by direct physical degradation and pollution. Wetlands are altered by pollutants from up streams or local runoff and, change the quality of water flowing out of them. Metals or toxic organic compounds can kill wetland vegetation. This article is mainly concerned with assessing the prevailing environmental condition of Pallikaranai Wetland, data relating to water quality and solid waste using Remote Sensing and GIS techniques. Twenty-four sample points were taken from Pallikaranai wetland and the parameters such as pH, EC, TDS, TH, Ca, Mg, Na, K, Cl, SO_4, NO_3. Also, the presence of Metals like Cr, Cu, Fe, Mn, Ni, Zn and Al were plotted with the help of IDW Method to find the concentration of the Metal in the sample. From the study, it can be inferred that the concentration of most of the metals and organic compounds exceeds the permissible limits prescribed by Bureau of Indian Standards due to the increase in the dumping of solid waste. The overall scenario of Pallikaranai Wetland is and it is thus recommended to take necessary steps at the earliest to save the wetland from complete destruction.*

Keywords: Wetlands, Sewage disposal, Heavy metals, Geo-informatics

Introduction

Wetlands are transitional lands between terrestrial and aquatic systems where the water table is usually at or near the surface or the land is covered by shallow water (Cowardin et al., 1979). The Millennium Ecosystem Assessment conceptual framework for ecosystems and human well-being has recognized the importance of wetlands not only in the context of human wellbeing but also in terms of providing a framework that supports the promotion and delivery of the Ramsar Convention's "wise use" concept (MEA, 2005). Starting about thousands of years in urban areas of the world and typically a few hundred years ago in most of the coastal areas, humanity has profoundly impacted, degraded or destroyed many coastal wetlands worldwide by direct physical degradation and pollution (Streever, 2001; Zong et al., 2007; Wolanski, 2007). The degradation and loss of wetlands is more rapid than that of other ecosystems (MEA, 2005). Similarly, the status of both freshwater and coastal wetland species is deteriorating faster than those of other ecosystems. Generally, wetlands are altered by pollutants from up streams or local runoff and, change the quality of water flowing out of them (Mitsch and Gosselink, 2007). Physical and economic water scarcity and limited or reduced accesses to water are major challenges facing society and are key factors limiting economic development in many countries (MEA, 2005). However, many water resource developments undertaken to increase access to water have not given adequate consideration to harmful trade-offs with other services provided by wetlands. World Bank (1982), stated that the haphazard disposal of solid waste was not safe for human health, and can spread disease.

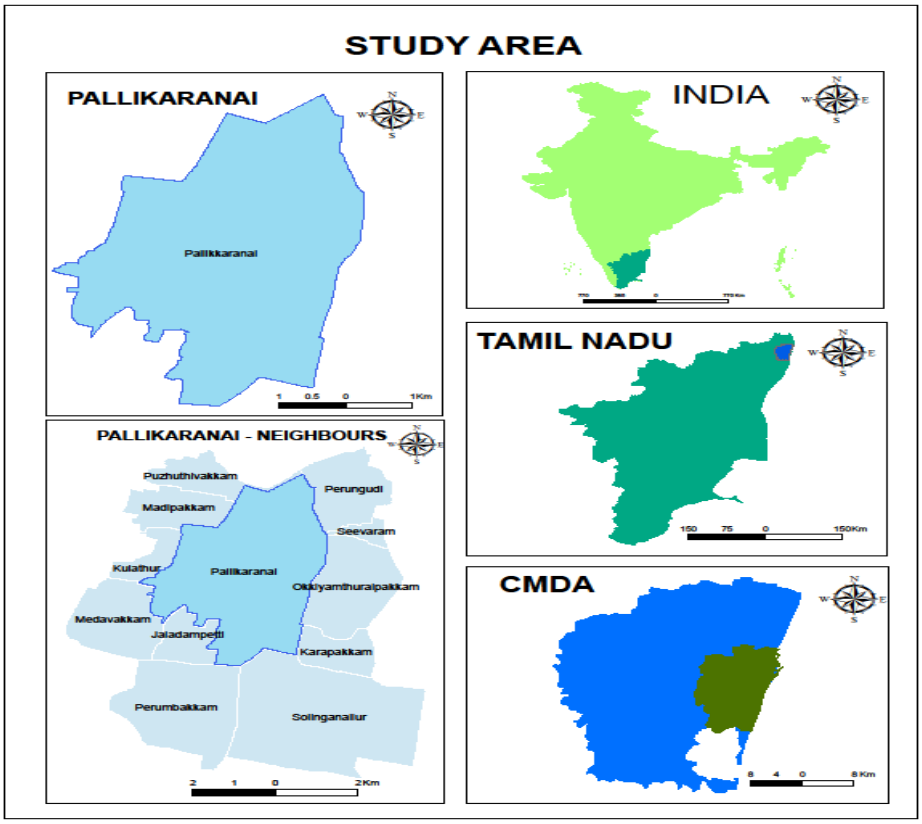
This research paper is mainly concerned with assessing the prevailing environmental condition of Pallikaranai Wetland, data relating to water quality and solid waste were collected and analyses were done using Remote Sensing and GIS techniques to evaluate the extent of

damage caused to the wetland. Wetlands are of great importance to man and nature as it purifies water, reduces flood, stores water, prevents soil erosion and supports varied biodiversities (Smith et al., 1994; Massel et al., 1999). Starting about thousands of years in urban areas of the world and typically a few hundred years ago in most of the coastal areas, humanity has profoundly impacted, degraded or destroyed many coastal wetlands worldwide by direct physical degradation and pollution (Zong et al., 2007; Wolanski, 2007). Ironically, reduced coastal wetland increases threat to human lives and at the same time the shoreline development exposes population to coastal hazards such as tsunamis, erosion, flooding, storm and waves surges. Added to this, these wetlands are store house of vivid biodiversity (Neill, 1958).

Study Area

The Pallikaranai Town Panchayat is located between (12° 54' 29" N to 12° 58'13" N latitude and 80° 11' 32" E to 80° 13' 59" E longitude). It falls under Perungudi and Pallikaranai villages in the Kancheepuram district of Tamil Nadu. The total area of Pallikaranai Town Panchayat is 17.35 sq.km and it houses the famous Pallikaranai Wetland which has numerous varieties of flora and fauna. Major Part of the Wetland 3.17 sq.km is declared as Reserve forest and is under Tambaram Range. The marsh land is occupied by Perungudi, Seevaram, Okkiyamthuraipakkam, Karapakkam in the East, Shollinganallur and Jaladampatti in the south, Medavakkam, Kulathur, Madipakkam, Puzhuthivakkam in the West and Vellachery and Chennai in the North (Fig. 1).

Figure 1: Pallikaranai Location Map



Methodology: Water Analysis

To test the level of pollution in the area in comparison to BIS (1991), twenty-four points were selected and water samples were taken from them in January, 2011 and inverse distance weightage (IDW) method was adopted to map the area for the spread of the pollution from the point source to the surrounding area. The parameters tested were pH (Hydrogen Ion Concentration), EC (Electronic Conductivity), TDS (Total Dissolved Solids), TH (Total Hardness), Ca (Calcium), Mg (Magnesium), Na (Sodium), K (Potassium), Cl (Chlorine), SO_4 (Sulphate), NO_3 (Nitrate). Also, the presence of Metals was plotted with the help of IDW Method to find the concentration of the Metal in the sample. Some of the Metals which were analysed are Cr (Chromium), Cu (Copper), Fe (Iron), Mn (Manganese), Ni (Nickel), Zn (Zinc) and Al (Aluminium).

The mapping was done in ARC GIS environment and the presence of these pollutants were plotted as Very High, High, Average, Low to very Low to show the spread of the pollutants in the water.

Results & Discussion

Water analysis

The Physio-chemical parameters and heavy metal concentration in groundwater and surface water samples collected during January, 2011 collected for the analysis. In all the samples the heavy metals such as cadmium, cobalt, mercury and lead were found to be below detectable level.

Hydrogen Ion Concentration – pH

The high concentration of pH value was recorded in the western section of the study area which was measured around 8.8 and it exceeded the permissible limit of drinking water of 6.5 to 8.5 levels (BIS, 1991). Low Value of pH was found to be around 6.6 and it was present in the eastern section of the study area. Average value of pH was concentrated in the north and southern part of the study area, the average value of pH was recorded to be around 7.38 which were well within the permissible limit. The pH value in the study area (Fig. 3a) was more or less in the permissible limit and the value indicated that the water was more basic and it may be due to various reasons from dumping of solid waste which had more of basic substances in it.

Electric Conductivity –EC

The permissible limit of EC recommended by United States Public Health Service is 300 µs/cm. The highest conductivity recorded was 12,800 µs/cm, the average value measured was 4027.5 µs/cm and the lowest value measured was 800 µs/cm, all values were above the permissible limit. The highest conductivity was found in water samples in the central and in the western section of the study area. The high concentration in this area is because the surface water source is highly polluted by the wastes coming from the residences concentrated in this area. It can be seen that western section has highest to medium concentration of EC. Low to lowest conductivity is seen in the northern and southern section of the study area (Fig. 3b).

Total Dissolved Solids – TDS

The amounts of TDS recorded were maximum (7789 mg/L) in the eastern section near the eastern boundary of Pallikaranai south of Seevaram between Pallikaranai and Okkiyamthuraipakkam boundary (Fig. 3c), the average value of 2466.5 mg/L was mainly distributed in a small section in the eastern region and the lowest value of 489 mg/L was recorded only in a small portion in the southern section which does not exceeds the permissible limit of 500 mg/L (BIS, 1991). From the observation of TDS, it can be easily inferred that the TDS in the study is too high and is independent of the parent rock as value is constantly fluctuating. The leachate from the solid waste dump site, sewage from the settlements and huge amount of decaying of vegetative and non-vegetative matter add to the TDS in the Study Area.

Total Hardness – TH

The average value of the total hardness recorded was 652 mg/L which was just near the permissible limit (600 mg/L, BIS, 1991), but the highest value was measured to be around 1700 mg/L, whereas, the lowest value was 150 mg/L which was found in a small section in the southern tip of the study area. The highest values were concentrated in the eastern section in the border between Pallikaranai and Okkiyamthuraipakkam (Fig. 3d). From the study of total hardness, it can be inferred that though some area has too high concentration of Ca and magnesium salts the overall scenario is not alarming as far as TH of water is considered in the study area.

Calcium - Ca

According to the Bureau of Indian Standards the Permissible limit of Ca is 200 mg/L (BIS, 1991). The maximum value recorded was 300 mg/L and the minimum was 18 mg/L. Two points of high location was found as shown in the map, one in the east and the other in the west. Major area in the map (Fig. 3e) has average concentration (93.6 mg/L) of Ca. The average spread indicates that Ca and other metals are diffusing through the area.

Fig. 3a

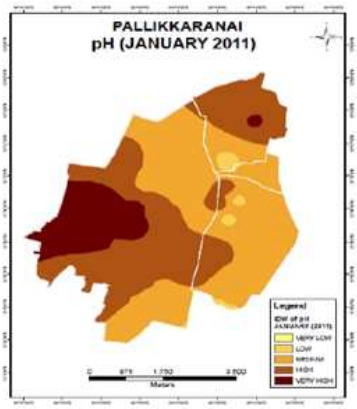


Fig. 3b

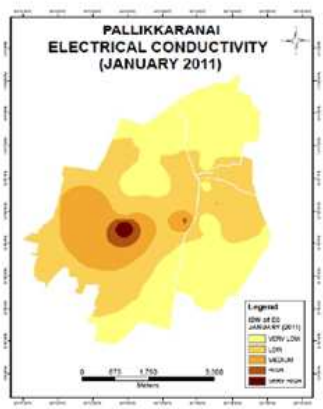


Fig. 3c

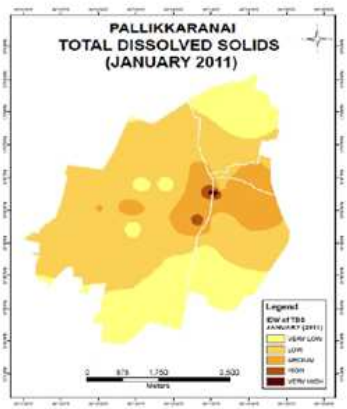


Fig. 3d

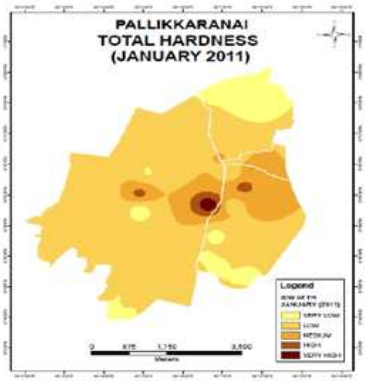


Fig. 3e

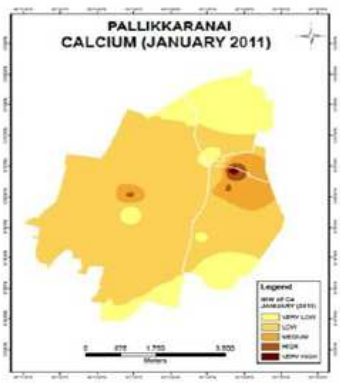


Fig. 3f

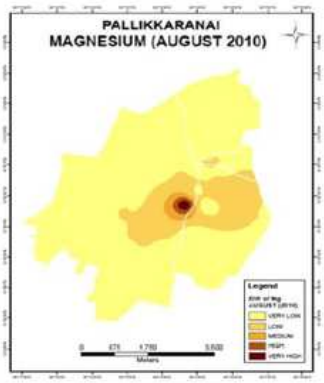


Fig. 3g

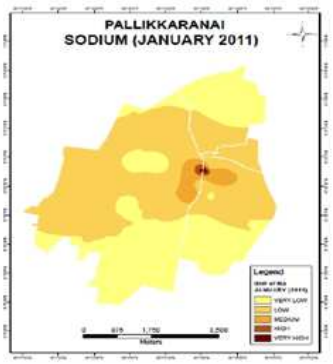


Fig. 3h

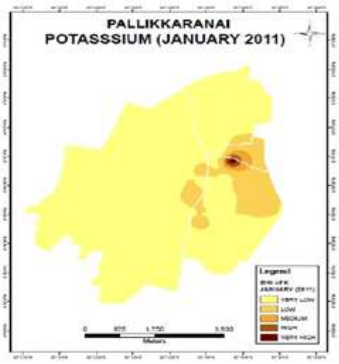
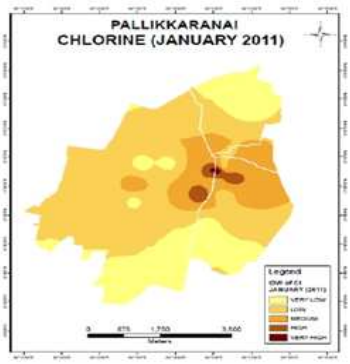


Fig. 3i



Magnesium – Mg

Fig. 3f clearly shows very high concentration (340 mg/L) of Mg in the eastern section and it might be due to industrial location in that region. The average value of 101 mg/L which is just near the permissible limit of 100 mg/L (BIS, 1991) was found near the high concentrated area. Low to very low of 24 mg/L was concentrated in major portion of the study area. Low concentration was distributed in the central, eastern and western section whereas very low concentration was distributed in a small section in northern and southern sections of the study area. In major part of the study area, the level of Mg is far below the permissible limit and that is not an area of concern from health point of view.

Sodium – Na

The amount of Na in water sample is a matter of concern as Na is easily leached into the soil. The maximum value recorded (2650 mg/L) was found in eastern border region of Pallikaranai. It

was distributed in a very small area, and surrounded by high to medium Na value which was found to be around 677 mg/L, and was totally confined to the eastern section covering a small area. The whole of central, eastern and the western section had a low concentration of Na distribution, with small section in the central, a small part in the northern and major section in the southern section having very low concentration of Na (Fig. 3g). The lowest value of Na recorded was 133 mg/L and it is below the permissible limit of 150 mg/L assigned by the Bureau of Indian standards (BIS, 1991).

Potassium - K

According to the background document for the development of World Health Organization guidelines, for drinking water quality (WHO, 1990), it was not considered necessary to establish a health-based guideline value for K in drinking water. The highest value of K recorded was 213 mg/L and it was concentrated in a small section in Seevaram town panchayat east of Pallikaranai. In this region (Fig. 3h), moderate concentration of 32 mg/L of K was measured. In all other sections the concentration of K was as low as 1 mg/L of water might be due to the vegetation in the dump yard which absorbs the Potassium for its growth.

Chlorine – Cl

A small portion of area had high concentration of Cl which was present in two small pockets in the eastern section, which was recorded to be 3687 mg/L and it was higher than the permissible limit (1000 mg/L, BIS, 1991). Low concentration of 1086 mg/L is concentrated throughout the study area which is close to the permissible limit and very low concentration of 39 mg/L is present in a small portion of the southern section (Fig. 3i). Cl does not spread by the movement of underground water and the high level of Cl recorded in few areas may be due to localized reasons and for a short period of time.

Sulfate – SO_4

The prescribed limit of SO_4 in drinking water is 400 mg/L set by the Bureau of Indian Standards (BIS, 1991). The distribution of sulfate in the study area shows high concentration (900 mg/L) of sulfate salt in the eastern section just south of Seevaram and is concentrated in a small area. The average of all samples collected was 343 mg/L and it was found only near the high concentrated region. Throughout the study area, low to very low concentration of sulfate was distributed. Low value of about of 35 mg/L was recorded in the eastern and northern section (Fig. 4a).

Nitrate – NO_3

The highest value of nitrate found in the water sample was 370 mg/L, the average of the entire water sample was 54 mg/L and the lowest value recorded was 11 mg/L, whereas the permissible limit is 45 mg/L (BIS, 1991). Though the maximum value of nitrate concentration in a particular region has increased, the distribution of salt is highly localized in one particular area. The entire study area (Fig. 4b) has very low distribution of nitrate except for the small region east of Pallikaranai, where high concentration of nitrate was recorded and is confined to a small area near Seevaram.

Chromium - Cr

The prescribed limit of Cr VI in drinking water set by the Bureau of Indian Standards is 0.05 mg/L (BIS, 1991). In major number of samples (Fig. 4c) the level of Cr was found to be below detectable limit, only in seven samples of the twenty-four samples Cr was detected. The highest value detected was 0.07 mg/L and the lowest value detected was 0.013 mg/L. The average value was found to be 0.03 mg/L which was below the permissible limit. Highest value of Cr was only detected in one small area in the central section which was just above the permissible limit. Other area showed less to very less value of Cr which was found to be below the desirable limit.

Copper - Cu

The central portion of Pallikaranai (Fig. 4d) showed high concentration (0.018 mg/L) of Cu which was too low as per the Bureau of Indian Standards which has set 1.5 as the permissible limit in the water (BIS, 1991). The average concentration of Cu in the study area is 0.012 mg/L. Thus, we can easily infer that the area is free from Cu pollution.

Ferrous - Fe

The permissible limit of Fe according to the Bureau of Indian Standards in drinking water is 1 mg/L (BIS, 1991). High concentration (0.57 mg/L) of Fe can be seen in two regions of Pallikaranai, one in the eastern section and the other in the central portion. One region extreme

east of Pallikaranai (Fig. 4e) also showed high concentration of Fe. In all other areas, average to low (0.012 mg/L) concentration of Fe was recorded. The average value of Fe in water was found to be 0.225 mg/L which is far less than the desirable limit.

Fig. 4a

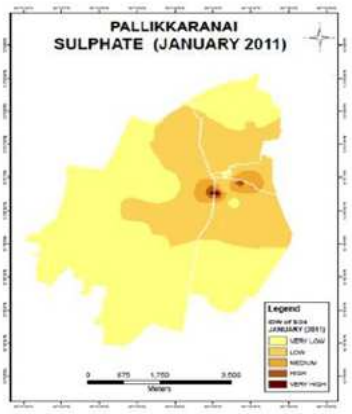


Fig. 4b

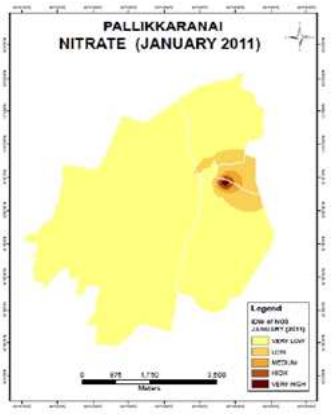


Fig. 4c

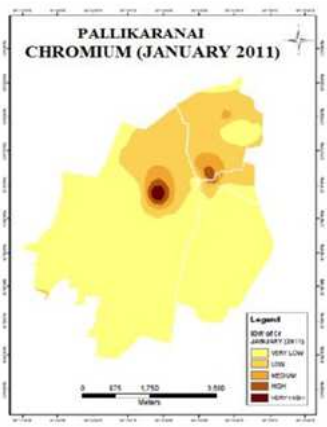


Fig. 4d

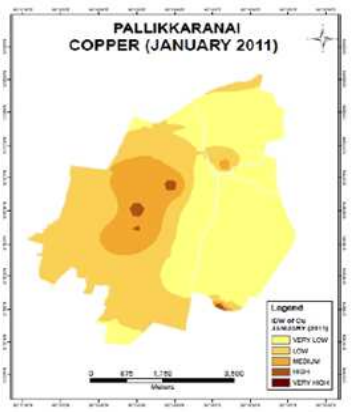


Fig. 4e

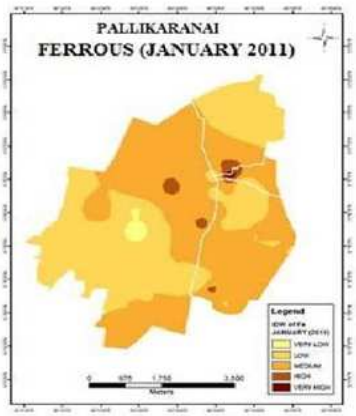


Fig. 4f

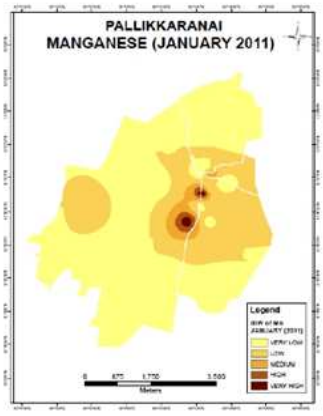


Fig. 4g

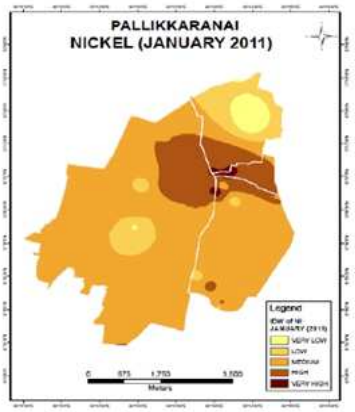


Fig. 4h

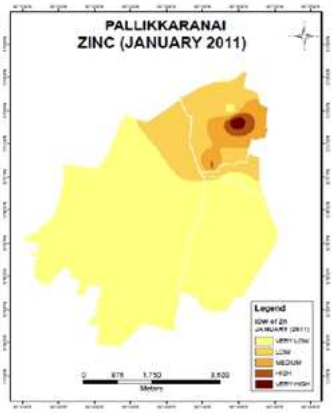
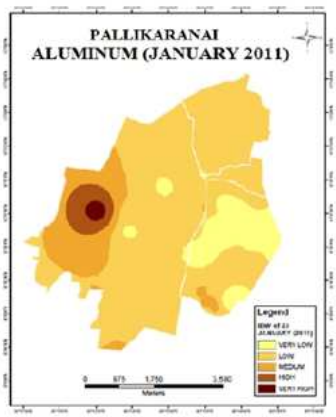


Fig. 4i



Manganese – Mn

Mn was found in 20 samples and in 4 samples it was below the detectable level. The maximum value recorded was 2.507 mg/L whereas, the minimum value recorded was 0.008 mg/L. The average calculated was around 0.505 mg/L. High concentration was isolated only in two small sections in the eastern section of the study area. Moderate to low concentration of Mn was

distributed in these sections only. One small patch of low concentration area was found in the western section (Fig. 4f). In all over the study area, the concentration was least, ranging between 0.5 mg/L and above, which was well above the permissible limit of 0.3 mg/L (BIS, 1991). It can be inferred from the study that even the region with the lowest concentration of Mn has values in excess of the permissible level and it may lead to Mn poisoning if the level keeps increasing in future.

Nickel - Ni

The highest value of Ni recorded in the water sample was 0.227 mg/L and the lowest value was 0.083 mg/L. In the study area (Fig. 4g), the north-east section showed high concentration of Ni. In the rest of the study area the average concentration of around 0.16 mg/L of Ni was distributed. The central section covering a small area had less concentration of Ni. It can be inferred from the study, that the study area has a concentration of Ni which is far more than that prescribed (0.02 mg/L) by the Bureau of Indian Standards (BIS, 1991) and it may be due to dumping of solid wastes and sewage coming from the hospitals and households located in and around the Pallikaranai marsh land.

Zinc - Zn

According to Bureau of Indian Standards, the permissible limit of Zn in drinking water is 15 mg/L (BIS, 1991). Larger areas have very low concentration of Zn, but the concentration of Zn has increased in the northern section and the overall average has decreased to 0.008 mg/L which is far below the desirable limit. The highest amount of Zn in the sample was recorded to be 0.239 mg/L which is also far too less than the permissible limit (Fig. 4h).

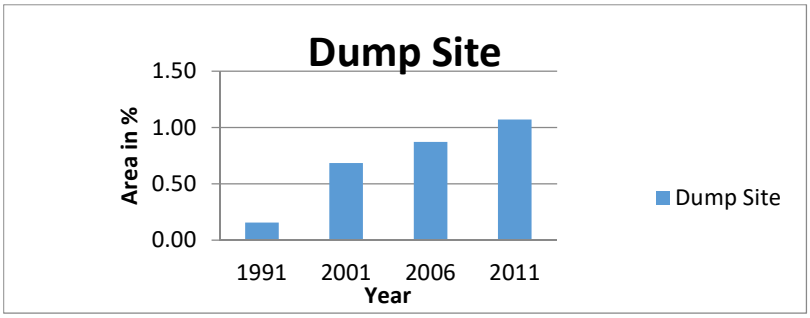
Aluminum - Al

The amount of Al in water in the study area varied between 0.176 to 0.02 mg/L. The average amount of Al in the study area (Fig. 4i) was found to be 0.108 mg/L which far exceeds the permissible limits. The concentration of the metals in the map shows high concentration in the western side, it is the area where thick population is concentrated. In other areas the concentration is average but it is far above the permissible limit of 0.03 mg/L (BIS, 1991). The western area showing very low concentration has 0.02 mg/L which is just 0.01 mg/L low than the permissible limit. Thus, we can conclude beyond doubt that the area under study is polluted with Al.

Change Detection – Dump Site

The area under dump site saw a consistent increase from the year 1991 to 2011. The wetland in the north-eastern section had been continuously used by the Chennai Municipality for dumping Municipal Solid Waste (MSW) being generated in the city. The dumping of MSW has not only led to the reduction in the area under wetland but it has also polluted the water of the wetland. During rainy season, the leachates from the dump site flow into the wetland and release harmful chemicals into it. These chemicals pollute the wetlands and are a serious threat for the survival of the living organism which finds its shelter in the wetland. The water quality of the adjacent area has also been polluted due to the mingling of the polluted water with the underground water table wetland (Fig. 5).

Figure 5: Dump Site



Conclusion

Wetlands are water-filters, and it has the inherent capacity to purify water. Pallikaranai Wetland too fell in the same league in the past. From the study, it has been inferred that the wetland is shrinking in size and is gasping for its survival as it has been heavily polluted by the contaminants from different sources. The Chennai Municipal Corporation has been continuously dumping the

MSW in the Wetland. Adding to this the sewage from the settlements is drained to the Pallikaranai Wetland, which has polluted the wetland to such an extent that the BOD of the wetland in some area is as high as 750 mg/L and the COD is 2261 mg/L. Thus, it can be concluded that the Pallikaranai Wetland water is highly polluted and immediate action should be taken to save this wetland and its Biodiversity. It is thus recommended to take necessary steps at the earliest to save the wetland from complete destruction. The most important step will be to stop using the wetland as dumping site and realize it utility and change the perception of wetland and its rich biodiversity from a place to be used as a dumpsite to a place which can save humanity.

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