PHYSICO-CHEMICAL PARAMETERS AND LAND USE PATTERNS OF PULICAT LAKE, TAMIL NADU, INDIA

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ABSTRACT

The Pulicat Lake is the second largest brackish water lake after Chilika Lake in India. The average area of the water spread is 461 sq km. During the monsoon Pulicat Lake receives freshwater through three major rivers namely, the Swarnamukhi, the Kalangi and Arani. The Pulicat Lake brackish water lagoon extends between 13° 20' - 13° 40' N latitude and 80° 14' - 80° 15' E longitude. Recent days, lakes are facing pollution threats due to various domestic and industrial wastes. The present study was carried out on ground water quality of Pulicat Lake in Thiruvallur District, Tamil Nadu. The ground water quality assessment has been carried out for Temperature, pH, Turbidity, Salinity, Dissolved Oxygen (DO), Biochemical oxygen demand (BOD), Chemical oxygen demand (COD), Alkalinity, Chloride (Cl), Fluoride (F), Total Dissolved Solids (TDS), Total Hardness (TH), Calcium (Ca), Magnesium (Mg), Sodium (Na), and Potassium (K). The spatial variations of physico-chemical properties of water were using GIS (Geographical Information System), Remote Sensing, and Global Positioning System (GPS) were used to assess the changes in the NDVI, NDWI, NDBI and land-use pattern in and around the Pulicat region. Satellite images of the IRS LISS-III images (2003-2017) and survey of India Toposheets were used to derive the Land-use Patterns. The physico-chemical parameters were carried out using Statistical analysis. The result indicated the clear cut information about the ground water quality of the study area.

KEYWORDS: Turbidity, Salinity, Global Positioning System (GPS), NDVI, NDWI, NDBI

1. INTRODUCTION

The Pulicat Lake brackish water lagoon declared as bird sanctuary formed out of backwaters of the Bay of Bengal, is the second largest brackish water lagoon in India having an area of approximately 600 km. Lakes are ideal grounds for unraveling a number of physico-chemical processes like evaporation, mixing, dissolution, precipitation of minerals and chemicals, and isotopic exchange between water, sediments and the atmosphere. There has been a general decline in the productivity of lakes, contributing to increased pollution levels due to an array of human-driven activities, pollution pressure and growing industrial. Indian lakes are being altered as a result of the disruption of natural processes by intensification of urbanization, agriculture and pollution. Lake Kolleru in Andhra Pradesh is choking to death from greed and over development. Pulicat Lake, a natural brackish-water lagoon, features a unique and interesting ecosystem, with diverse fauna and flora, housing several species of birds, serving as a nursery and breeding ground for many species of marine fauna and

supporting various commercial fishing activities, thus enriching the livelihood of many thousands of fisher folk.

This lake has experienced an accelerated decline in water quality. Siltation is a major problem affecting the lake soil erosion in the catchment area of the three rivulets is causing widespread siltation in the lake. Aqua culture, the use of destructive fishing gear by non-fishing communities, and limestone quarrying in the Venadu, Pemadu and Irakkam Island are among the other problems of concern in the lake. The southeast coast of India has been receiving industrial, agriculture and aquaculture and causing environmental pollution in the Bay of Bengal and surrounding coastal along the south Andhra coast receives lot of aqua and agricultural effluents and thus provides an ideal pesticides and fertilizers in both agriculture and aquaculture sectors along the coastal tracts east coast has been additionally responsible for increased effluent discharge into coastal water bodies of Arani and Kalangi, Uppateru rivers causing immense stress on around the pulicat lake.

2. STUDY AREA

Pulicat lake is located between $13^{\circ}20'-13^{\circ}40'$ N latitude and $80^{\circ}14'-80^{\circ}15'$ E longitude lying almost parallel to the Bay of Bengal. It extends over Thiruvallur District in Tamil Nadu and Nellore district in Andhra Pradesh and covers an area of about 461 km. The lake receives freshwater from the Kalangi and Arani rivers, and connected with the Bay of Bengal for its saline water input. The lake extends to about 60 km in north to south direction with a width of 0.2 to 17.5 km in east to west direction in the northern sector of the lake. The lake at its southern end, near north of pulicat town opens into the Bay of Bengal by a narrow pass and this is the opening of the lake into the sea thus functioning as the migratory routes of spawning animals like fish, prawn, and mud crab.

STUDY AREA

3. AIM AND OBJECTIVES

The pulicat lake serve as a nursery for shrimp fisheries, hence extensive areas have been converted for aquaculture practices. This recent conversion of the lake has resulted in the deterioration of the ground water quality and also has been significantly polluted by various human activities. This has resulted in the overall decline in coastal productivity and fishery resources. With these aspects in view, a detailed investigation of the Pulicat Lake has been taken up with the following objectives:

- * To determine the spatial and seasonal variations of physio chemical parameters in the ground water, to understand the current status of the pulicat lake.
- * To determine the chemical distribution in water and sediment in the lake, to assess the current pollution level.
- * To determine the changes in NDVI, NDWI, NDBI and Land- use patterns in and around the pulicat lake (2003-2017)
- * To assess the ground water quality impact of natural and anthropogenic activities on the lake with regard to its past history, current status and future.

4. MATERIALS AND METHODS

The study has been made use of various data sets, including Survey of India (SOI) toposheets of 1:50,000 scale, IRS LISS-III data of 1:50,000 imageries and field measurements. Finally, a base map was prepared by using Toposheets 66C/1. The satellite datasets were downloaded from National Remote Sensing Centre (NRSC) handing Bhuvan website for the periods (2003-2017). Ground water quality assessment has been carried out for Temperatur, pH, Turbidity, Salinity, Dissolved Oxygen (DO), Biochemical oxygen demand (BOD), Chemical oxygen demand (COD), Alkalinity, Chloride (Cl), Flouride(F), Total Dissolved Solids (TDS), Total Hardness(TH), Calcium (Ca), Magnesium(Mg), Sodium (Na), and Potassium (K). The spatial variations of physio-chemical properties of water were plotted using GIS (Geographical Information System), ERDAS software and Global Positioning System (GPS) were used to assess the changes in the NDVI, NDWI, NDBI and land use pattern in and around the pulicat region. The physio chemical parameter was carried out using Statistical analysis.

5. RESULT AND DISCUSSION

The values for physical and chemical parameters of Pulicat lake during the study period from January 2016 to December 2017 are presented in Chart 1 to 4.

5.1 TEMPERATURE

In 2016 the temperature varied between 28.8° and 30.4°c among the pre and post monsoon seasons. In 2017 it varied between 29.1° and 30.4°c in both the years the highest temperature was recorded during post and pre monsoon. Temperature is an important limiting factor which regulates the biochemical activities in the aquatic environment.

5.2 pH

The pH ranged between 7.6 and 7.7 during post monsoon in 2016. In 2017 the pH ranged between 7.5to 7.3 during pre monsoon. The fluctuation in pH was not comparable during two years.

5.3 TURBIDITY

In 2016 the turbidity varied between 6.1 and 2.7. In 2017 it varied between 6.1 and 5.4. In the present study high turbidity was observed during post monsoon in 2016 whereas in 2017. It

was high. High turbidity may be due to input of sediments brought by freshwater inflow and tidal movement.

5.4 SALINITY

The salinity ranged between 31.8 and 31.7ppt during pre monsoon and post monsoon in 2016. In 2017 the salinity ranged between 31.0 and 31.1ppt during pre monsoon and post monsoon. Salinity is one of the important factors which profoundly influence the abundance and distribution of the animals in estuarine environment.

5.5 DISSOLVED OXYGEN

In 2016 and 2017 the dissolved oxygen varied between 2.3 and 2.4mg/L among the pre monsoon and post monsoon in both the years. Do in sea water plays a very important role with respect to marine life.

5.6 BIOCHEMICAL OXYGEN DEMAND

The BOD ranged between 50.6 and 38.6mg/L during post monsoon and pre monsoon in 2016. In 2017 the BOD ranged between 44.7 and 88.9mg/L during post monsoon and pre monsoon. BOD estimation is a vital aspect in assessing the organic pollution of aquatic ecosystem.

5.7 CHEMICAL OXYGEN DEMAND

In 2016 the COD varied between 291.1 and 352.3 mg/L during post and pre monsoon in 2016. In 2017 it varied between 271.1 and 288.4 mg/L. this may be due to decrease in freshwater inflow, land drainage, domestic sewage, industrial inputs, increase in salinity, temperature, phytoplankton productivity and microbial utilization of oxygen at the time of decomposition. Low COD may be due to the presence of heavy river run-off, decreased mixing of agricultural and domestic wastes, land drainage into the estuary and decreased biological activity due to decreased salinity and temperature. The elevated levels of COD indicate an increased load of organic and inorganic pollution that require more oxygen to oxidize under increased thermal conditions.

5.8 ALKALINITY

The alkalinity ranged between 147.9 and 138.0mg/L during post monsoon and pre monsoon in 2016. In 2017 the alkalinity total ranged between 176.2 and 16.7mg/L during post monsoon and pre monsoon. In both the years the highest alkalinity total was recorded during post monsoon.

5.9 CHLORIDE

In 2016 the chloride varied between 10991.9 and 12098.7mg/L among the post monsoon and pre monsoon. In 2017 it varied between 13346.5 and 12434.5mg/L. The possible reason for lower concentration of chloride may be due to the lesser input from the industrial activity while, higher concentration of it may be due to sea water intrusion coupled with huge influx of sewage and industrial waste water.

5.10 FLUORIDE

The fluoride ranged between 0.5mg/L both during post monsoon and pre monsoon in 2016 and also in 2017.

5.11 TOTAL DISSOLVED SOLIDS

In 2016 the TDS varied between 21337.2 and 22982.0mg/L during post monsoon and pre monsoon and in 2017 it varied between 22428.0 and 25912.4mg/L variation in TDS may be due to the inflow of industrial, animal and agriculture wastes and also by evaporation and less rainfall.

5.12 TOTAL HARDNESS

The total hardness ranged between 3999.1 and 5122.4mg/L mg/L during the post monsoon and pre monsoon in 2016. In 2017 it ranged between 4703.8 and 4625.9mg/L during post monsoon and pre monsoon. Total hardness is used to describe the effect of dissolved minerals determining suitability of water for domestic, industrial and during our purpose attributed to presence of bicarbonates, sulphates, chloride and nitrate of calcium and magnesium.

5.13 CALCIUM

In 2016 the calcium varied between 1334.0 and 1547.6mg/L among the post monsoon and pre monsoon. In 2017 varied between 1386.5 and 1640.0mg/L. In the present study, high values of calcium were recorded the pre monsoon.

5.14 MAGNESIUM

Magnesium ranged between 370.7 and 471.0 during post monsoon and pre monsoon during 2016. In 2017 it ranged between 379.8 and 478.6mg/L during post monsoon and pre monsoon. The normal amount of magnesium present in water is about 1300mg/L. Magnesium present in pulicat lake water was much lower.

5.15 SODIUM

In 2016 the sodium varied between 4404.1 and 5475.0mg/L among the post monsoon and pre monsoon. In 2017 it varied between 4833.3 and 5041.6mg/L. High values of sodium were recorded during the pre monsoon season in both the years. Minimum values were reduced during post and pre monsoon in both the years.

5.16 POTASSIUM

The potassium ranged between 505.0 and 562.5mg/L between post monsoon and pre monsoon during 2016 and in 2017 it ranged between 515.0 and 429.1mg/L between pre monsoon and post monsoon. The normal amount of potassium in seawater is 392mg/an L. High value of potassium was recorded in Pulicat Lake during two years of study.

6. LAND USE PATTERNS IN PULICAT LAKE (2003-2017)

6.1 LAND USE LAND COVER CLASSIFICATION 2003-2017

6.2 LAND USE AND LAND COVER CHANGES DURING 2003

During the year 2003 the land use/ land cover categories have been classified into 7 classes as per NRSA level 1 classification. The categories are Salt pan, Barren land, Agriculture, Marsh land, Build up, Lake, and Forest. It covers 35% percentage of Agriculture of total area. With

this land use land cover agriculture covers in larger area in the Pulicat lake in the year of 2003.

LAND USE LAND CLASSIFICATION-2003		
Class Name	Area in Hectare	Area in percentage
Salt pan	96800	6%
Barren land	13504	1%
Agriculture	612328	35%
Marsh land	333137	19%
Build up	241193	14%
Lake	374193	21%
Forest	77744	4%
Total	1748899	100%

6.3 LAND USE AND LAND COVER CHANGES DURING 2010

During the year 2010 the land use/ land cover categories have been classified into 7 classes as per NRSA level 1 classification. The categories are Salt pan, Barren land, Agriculture, Marsh land, Build up, Lake, and Forest. It covers 29% percentage of Agriculture of total area. With this land use land cover agriculture covers in larger area in the Pulicat lake in the year of 2010.

LAND USE LAND CLASSIFICATION-2010		
Class Name	Area in Hectare	Area in percentage
Salt pan	173157	11%
Barren land	186913	1%
Agriculture	440673	29%
Marsh land	175728	12%
Build up	290957	19%
Lake	379698	25%
Forest	52236	3%
Total	1699362	100%

6.4 LAND USE AND LAND COVER CHANGES DURING 2017

During the year 2017 the land use/ land cover categories have been classified into 7 classes as per NRSA level 1 classification. The categories are Salt pan, Barren land, Agriculture, Marsh land, Build up, Lake, and Forest. It covers 36% percentage of Buildup of total area. With this land use land cover Buildup covers in larger area in the Pulicat lake in the year of 2003.

LAND USE LAND CLASSIFICATION-2017		
Class Name	Area in Hectare	Area in percentage
Salt pan	3387	0%
Barren land	70253	4%
Agriculture	225664	14%
Marsh land	99079	6%
Build up	607258	36%
Lake	384005	23%
Forest	279999	17%
Total	166645	100%

7. CONCLUSION

The Pulicat Lake is the second largest brackish water lake after Chilika Lake in India. The average area of the water spread is 461 sq km. In this study, the water quality properties in terms of its Pulicat Lake, South East coast of India were assessed. The values obtained for Temperature, pH, Turbidity, Salinity, Dissolved Oxygen (DO), Biochemical Oxygen Demand (BOD), Chemical Oxygen Demand (COD), Alkalinity, Chloride (Cl), Fluoride (F), Total Dissolved Solids (TDS), Total Hardness (TH), Calcium (Ca), Magnesium (Mg), Sodium (Na), and Potassium (K) were within the recommended values of the World Health Organization (WHO). Satellite remote sensing and GIS is a powerful tool for mapping and evaluating the land use patterns in Pulicat Lake. The Pulicat Lake changes during the past 14 years mainly due to population growth, commercial and industrial activities. The map shows the major changes in the Pulicat landforms, i.e., increase in Built-up lands. Water logged area has been decreased due to anthropogenic activities.

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