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ASIAN JOURNAL OF SCIENCE AND TECHNOLOGY

ISSN: 0976-3376

Asian Journal of Science and Technology
Vol. 5, Issue 7, pp. 384-388, July, 2014

RESEARCH ARTICLE

CLIMATE CHANGE ON SAROORNAGAR LAKE, ANDHRA PRADESH, INDIA

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ARTICLE INFO

Article History:
Received 25th April, 2014
Received in revised form
09th May, 2014
Accepted 30th June, 2014
Published online 31st July, 2014

Key words:
Climate, Nitrites, p^H,
Phosphates,
Trophy.

ABSTRACT

This paper discussed clearly the range, average and seasonal variations of p^H, Dissolved Oxygen, Alkalinity, Bicarbonates, Chlorides, Nitrites, Phosphates and Oxidisable Orgnic Matter in Saroornagar Lake during the years September 2011 to August 2012. Progression of trophy was seen in p^H, Nitrites and Phosphates. p^H was shifting more towards acidic which may cause irritation to the organisms living in Saroornagar Lake. Nitrites increased 20,000 times and Phosphates 4,150 times. Steps must be taken to curb further encroachment by housing colonies and dumping of untreated sewage into the lake. This increase in nitrogen and phosphates add to eutrophication or trophy of the lake which in course of time cause death or disappearance.

INTRODUCTION

Climate is one of the key factors that affect the life, growth and development of lakes. In today's world we are experiencing a change in the climate, the day temperatures are becoming hotter and night temperatures warmer. Rahman et al. (2012) summarize trends in temperature and rainfall from 1981 to 2010 at Tadong (elevation 1350 m). They find that mean minimum temperature has increased by 1.95˚C. According to Deccan Chronicle 13th September 2005, it is given that the Andhra Pradesh State is experiencing longer spells of heat waves in certain parts and a marked increase in the average rainfall between 10 to 30 percent is also likely. This is all because of climate change. Even the highest rainfall region Chirrapunji, Meghalaya, India is not receiving the enough amount of rainfall and it clearly indicates the climate change. Climate change is an emerging and ongoing environmental challenge. Climate Change is having a significant impact on biodiversity, natural resources and society. Climate change is happening on a global scale and it is one of the defining issues of the 21st century. In 2009, after the Copenhagen Summit, steps are taken to keep any temperature increase to below 2˚C. Lakes are subjected to changes all over the world. In Science Daily (Jan, 13, 2009) reports Great Lakes water levels sensitive to climate change. Lake Erie Algae and Ice make a Nice Mix in winter was reported by Science Daily (Jan, 10, 2012).

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Mackay (1998) worked on Diatom succession trends in recent sediment from Lake Baikal and their relation to atmosphere pollution and to climate change. Plants, animals and human beings are experiencing change in climate – the recent flash floods in Uttarakhand in 2013 and floods from Godavari and Dhavaleswaram in July 2013 are the current examples of climate change. The chemical factors like p^H, Dissolved Oxygen, Nitrites and Phosphates are also subjected to changes. This impact of climate is seen in Saroornagar Lake. It was unique that changes in the chemical parameters were studied during the past thirty years. In the Himalayan region impacts of climate change on Glacial Lake Outbursts of Floods (GLOFS) was studied by Kumar and Prabhu, 2012. The melting of Himalayas and the cascading effects of Climate Change on Water, Biodiversity and Livelihoods were studied by Xu et al. 2009. The present work shows the Climate Change effect on Saroornagar Lake.

Climate change has complex effects on water supply and demand. Lakes are the natural gifts to human beings. Lakes and reservoirs serve as major water resources in India. Man is constructing reservoirs and dams to store the lake water and use it for irrigation, recreation and domestic purpose etc. Understanding the response of lakes to climate change is of great practical importance since year-to-year changes in weather patterns can influence lake water quality. The climate change alters the quality of the lakes. The changes in physico-chemical environment have direct impact on the biotic component of the water body. Saroornagar Lake is located at Hyderabad, Andhra Pradesh, India. Saroornagar Lake is at a

distance of 18km from Secunderabad railway station. It is one of the five major water bodies in Hyderabad Andhra Pradesh. From the year of its creation in 1626, the lake remained largely clean until 1956 when Hyderabad expanded. It is an artificial lake and spreads over an area of 99 acres (40 ha) with a depth of 6.1 meters (20 ft). It lies in the coordinates of 17.3561°N 78.5333°E. In 1626, the lake was created for agricultural and drinking purposes. After 1956 when Hyderabad became the state capital of the Andhra Pradesh, the city witnessed unprecedented population growth, industrialization and agriculture using synthetic fertilizers and insecticides. Inevitably, untreated domestic sewage, solid waste and industrial effluents entered into the catchment area of this lake. The lake was restored by the Hyderabad Urban Development Authority in 2003-04. After the restoration of the lake, migratory birds returned to the lake in big numbers a few years later. After the restoration, necessary steps were taken to treat the lake. However by 2009, the filtration unit of the sewage treatment plant stopped functioning properly. As a result of this, the lake was getting polluted with domestic waste. Denudation of the catchment area and discharge of untreated sewage into the Saroornagar Lake were endangering its very existence. At present, the lake is used for recreation purpose.

Table 1. Showing Range and Average of Physical and Chemical Parameters in Saroornagar Lake

S. No	Parameters	Range	Average
1.	p^{H*}	8.0 – 9.5	8.54
2.	Dissolved Oxygen (mg/L)	0 – 4	1.7
3.	Alkalinity (mg/L)	505 – 860	624
4.	Bicarbonates (mg/L)	115 – 659	555
5.	Chlorides (mg/L)	202.1 – 308.5	250.9
6.	Nitrites (mg/L)	5.88 – 25.0	13.09
7.	Phosphates (mg/L)	35 – 850	248.96
8.	Oxidisable Organic Matter (mg/L)	0.53 – 5.62	3.51

*no unit

Table 2. Showing Seasonal Variations of Physical and Chemical Parameters in Saroornagar Lake

S.No	Parameters	Monsoon	Winter	Summer
1.	p^{H*}	8.375	8.875	8.375
2.	Dissolved Oxygen (mg/L)	1.925	1.35	1.825
3.	Alkalinity (mg/L)	586	530	756
4.	Bicarbonates (mg/L)	435	622	609
5.	Chlorides (mg/L)	222.9	256.2	273.5
6.	Nitrites (mg/L)	16.84	8.5	13.94
7.	Phosphates (mg/L)	451.88	63.75	231.25
8.	Oxidisable Organic Matter (mg/L)	3.03	4.12	3.39

*no unit

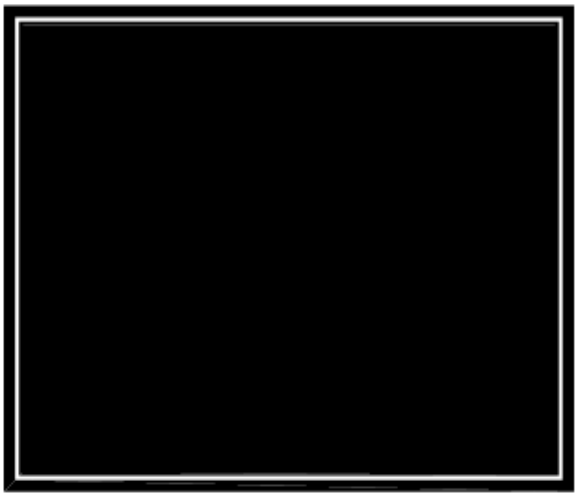

Fig. 1. Saroornagar Lake, Hyderabad, A.P.

MATERIALS AND METHODS

Water samples were collected from Saroornagar Lake at monthly intervals from September 2011 to August 2012. Water samples were collected according to APHA (1995) and the specific procedures are as follows.

- p^H – Universal indicator
- Dissolved Oxygen & Total Alkalinity – Trivedy, Goel & Trishal (1987)
- Bicarbonates & Chlorides – Wilcox and Hatcher (1950)
- Oxidizable Organic Matter – Thresh, Beale and Suckling (1949)
- Phosphates & Nitrites – APHA (1995)

RESULTS AND DISCUSSION

p^H: p^H is a measure of hydrogen ion concentration in water and indicates whether water is acidic or alkaline. p^H was also

reported to play an important role in formation of algal bloom. Decreasing volume of water due to evaporation was accompanied by progressive changes in p^H (Adoni 1975). In the present study p^H ranged from 8.0 – 9.5 and averaged to 8.54. In Saroornagar Lake in monsoon it was 8.375, in winter 8.875 and in summer 8.375. p^H concentrations altered with seasons. The p^H values are higher during winter and lower during summer. Similar observations were made by Deshmukh and Ambore in 2006. The waters of Saroornagar Lake were alkaline with a p^H of 9.0 in 1980, 8.9 in 1990, 8.30 in 2010 and 8.54 in 2012. p^H was above 7.8 with alkaline – bicarbonate type. The waters were alkaline in nature for the past three decades.

Dissolved Oxygen

Dissolved Oxygen concentration is one of the fundamental and important factors influencing the aquatic environment both chemically and biologically. Dissolved Oxygen affects the nutrient availability resulting in the altered productivity of the entire water. In the present study the Dissolved Oxygen ranged from 0 to 4 mg/L and averaged to 1.7 mg/L. In monsoon season its concentration was 1.925 mg/L, in winter 1.35 mg/L and in summer 1.825 mg/L. Similar observations were made by Sudha in 1998. Dissolved Oxygen concentration was 6.51 mg/L in 1980, 6.2 mg/L in 1990, 5.79 mg/L in 2010 and 1.7 mg/L in 2012. The Dissolved Oxygen values are declining. This may be due to the utilization of dissolved oxygen by the phytoplankton, aquatic organisms, zooplankton, and bacteria etc, which are present in the lake along with the untreated sewage entering into the lake.

Alkalinity: Alkalinity is a measure of the quantity of compounds that shift the p^H to the alkaline side of neutrality or it is a measure of the capacity of water to neutralize acids. In the present study alkalinity ranged from 505 – 860 mg/L and averaged to 624 mg/L. Seasonal averages were recorded as 586 mg/L, 530 mg/L and 756 mg/L in monsoon, winter and summer seasons respectively. The alkalinity values were highest in summer. Similar observations were made at Manhrul Dam, Jalgaon district, Maharastra by Jawale and Patil, 2009. The lowest values were observed in winter. Similar observations were made by Pawar and Khobragade, 2009.

Bicarbonates: Bicarbonates constitutes the major anions in the inorganic carbon complex which is available to the photosynthetic organisms thus influences the aquatic ecosystem. They act as buffers in regulating the p^H of the water. Bicarbonates were the dominant inorganic carbon in Saroornagar Lake. They varied from 115 mg/L to 659 mg/L and an average to 555 mg/L in this lake. Seasonal averages recorded were 435 mg/L, 622 mg/L and 609 mg/L in monsoon, winter and summer respectively. Lowest values were recorded in the monsoon season and highest in winter. Similar observations were made by Sudha 1998 in Nadimi Lake. The bicarbonates of Saroornagar Lake were 371.8 mg/L in 1980, 493.5 mg/L in 1990, 573.78 mg/L in 2010 and 555 mg/L in 2012.

Chlorides: Chlorides along with the bicarbonates constitutes the major anions in the aquatic ecosystem. Chlorides from pollution sources can modify natural concentration to a great extent (Ownbye and Kee, 1967). In the present investigation chlorides ranged between 202.1 mg/L to 308.5 mg/L and averaged to 250.9 mg/L. The seasonal averages recorded were 222.9 mg/l, 256.2 mg/L and 273.5 mg/L in monsoon, winter and summer respectively. The lowest values were recorded in the monsoon season and the highest values are seen in the summer season. Similar observations were made by Cynthia 1980, Johnson 2004 and Reddy et.al., 2009. Chlorides varied from 249.1 mg/L in 1980, 382.7 mg/L in 1990, 336.21 mg/L in 2010 and 250.9 mg/L in 2012.

Nitrites: Nitrites form an intermediate oxidation state of nitrogen both in the reduction of ammonia and nitrates. In the present investigation nitrites ranged between 5.88 mg/L to 25.0 mg/L and averaged to 13.09 mg/L. The seasonal averages in Saroornagar Lake were 16.84 mg/L, 8.5 mg/L and 13.94 mg/L in monsoon, winter and summer seasons respectively. Maximum values were recorded in the monsoon seasons. This could be attributed to the increased inflow from catchment area. Similar observations were made by Cynthia 1980, Kodarkar et. al., 1989 and Sudha 1998. Nitrogen and phosphorus compounds play a significant role in algal nutrition. Human-induced pollution through the impacts of excessive fertilizer use, untreated wastewater effluents, and detergents significantly increases nutrient loading into lakes, accelerating eutrophication beyond natural levels and generating deleterious changes to the natural ecosystem (Litke 1999). Nitrites were 0.0007 mg/L in 1980, 13.1 mg/L in 2012. From 1980 to 2012 nitrites were increased by 20,000 times which is alarming. If the condition prevails, the waters may not be even used for recreation purpose. The lake is becoming more eutrophic and in course of time may become unfit and can gradually disappear.

Phosphates: The most significant form of inorganic – phosphate is ortho-phosphate. It is the only directly utilizable form of soluble inorganic phosphorus. Phosphate ranged from 35 – 850 mg/L and averaged to 248.96 mg/L during the study period. In monsoon season its concentration was 451.88 mg/L, in winter 63.75 mg/L and in summer 231.25 mg/L. Maximum concentration of phosphates is seen in the monsoon season. Similarly in monsoon season high phosphate content was seen in Banjara Lake (Sudha 1998) and in Pakhal Lake (Reddy et.al., 2009). This is because of the inflow of rainwater mixes with domestic sewage from the surrounding residential colonies along with the used water from the lawns and plants maintained by the parks and houses. Phosphates were 0.06 mg/L and 249 mg/L in the year 1980 and 2012 respectively. That is, there is a tremendous increase of about 4,150 times from three decades. The increase in nitrogen and phosphates are adding to the eutrophication of lake which may describe Saroornagar as one of the biggest lake nearing to death.

Oxidisable Organic Matter: Oxidisable Organic Matter regulates micronutrient availability and controls to some extent the growth and multiplication of planktonic organisms. Oxidisable Organic Matter ranged from 0.53 mg/L to 5.62 mg/L and averaged to 3.51 mg/L in Saroornagar Lake. Seasonal averages were 3.03 mg/L in monsoon, 4.12 mg/L in winter and 3.39 mg/L in summer seasons. Maximum concentration of Organic Matter was seen in winter season. These values could be attributed to

Table 3. Comparision of Physico – Chemical Parameters of Saroornagar Lake during 1980 – 2012

S.No	Parameters	1980 Khanum	1990 Swarnalatha	2010 Phalguni	2012 Olive
1.	pH*	9.0	8.9	8.30	8.54
2.	Dissolved Oxygen (mg/L)	6.51	6.2	5.79	1.7
3.	Alkalinity (mg/L)				624
4.	Bicarbonates (mg/L)	371.8	493.5	573.78	555
5.	Chlorides (mg/L)	249.1	382.7	336.21	250.9
6.	Nitrites (mg/L)	0.0007	-	0.69	13.09
7.	Phosphates (mg/L)	0.068	0.89	0.32	248.96
8.	Oxidisable Organic Matter (mg/L)	3.97	9.4	29.95	3.51

*no unit.

the autochthonous organic matter due to the death of *Eichhornia crassipes* and *Achyranthes triandra* that was abundant in the lake. Similar observations were made by Sudha, 1998 and Cynthia, 1980. Oxidisable Organic Matter concentration was 3.97 mg/L in 1980 and 3.51 mg/L in 2012.

Progression of trophy

In table 3, it clearly indicated that the p^H of Saroornagar are becoming acidic i.e., from 9.0 in 1980 to 8.9 in 1990 to 8.3 in 2010 to 8.54 in 2012 and may harm the organisms dwelling in the lake. There is a drastic decline in the Dissolved Oxygen from 1980 to 2012 i.e, 6.51 mg/L in 1980, 6.2 mg/L in 1990, 5.79 mg/L in 2010 and 1.7 mg/L in 2012. Bicarbonates, Chlorides and Oxidizable Organic Matter did not fluctuate sharply during the years 1980, 1990, 2010 and 2012. The two chemical parameters nitrites and phosphates which contribute to the progress of trophy varied significantly. Nitrites increased 20,000 times and Phosphates 4,150 times. This increase in nitrites and phosphates was alarming. If steps are not taken immediately the lake will become more eutrophic and in course of time become unfit even for recreation purpose and finally disappear. The catchment area of Saroornagar which was free from housing colonies etc in the year 1980 is now occupied by many houses. This is due to increase in population and encroachment with extension on urbanization on this lake. Agricultural fields which were present in 1980 have now completely disappeared and in its place residential complexes have developed.

Conclusion

Climate change is the current worldwide burning problem. The water sources are very important for irrigation and recreational purposes. At present, the increase in population and spread of urban colonies is having an impact on the rich water resources i.e, Lakes. Human- induced eutrophication has heavily degraded freshwater systems worldwide by reducing water quality and altering ecosystem structure and function. Population growth, industrialization, and entering of untreated sewage have resulted in disproportionate amounts of phosphorus and nitrites in lakes. Protection of lakes from human encroachment is important. Therefore, finding steps to reduce the effects on water resources is important. If at all these lakes are not protected within few years these natural water resources may completely disappear like Masab Tank, which was now occupied by Chacha Nehru Park. Lake Saroornagar is encroached by human settlement i.e., housing colonies and complexes and dumping of untreated sewage causing the lake to become unfit even for recreational purpose. Hence, advanced research is needed to protect these natural resources which are being exploited by increasing population and urban encroachment.

Acknowledgements

The authors are thankful to the Head, Department of Botany, Osmania University College for Women, Koti, Hyderabad for the facilities given. Olive Kezia Ruth is thankful to her guide Prof. Mary Esther Cynthia for her constant help and encouragement and the UGC, New Delhi for the fellowship.

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