International Journal of Research in Advent Technology, Vol.6, No.11, November 2018
E-ISSN: 2321-9637
Available online at www.ijrat.org

Nutrients Load and Eutrophication: An Overview of Bengaluru Urban Lakes

Veenashree[1], Nandini, N[2], Kumar, M[3]
[1]DST-INSPIRE Fellow-JRF, [2]Professor, [3]Teaching Faculty, Department of Environmental Science, Bangalore University, Jnana Bharathi Campus, Bengaluru- 560056, Karnataka, India
E-mail: veenashreekumar@gmail.com; nandini.sai@rediffmail.com; kumarenvi@gmail.com

Abstract- The rapid increase of populace alongside urbanization has resulted in the deterioration of lake water ecosystems particularly in developing city like Bengaluru and human beings are blamable for choking numerous lakes to death. Excess nutrients, specifically phosphorus and nitrogen are the primary pollutants that contribute to the cultural eutrophication of lakes. In addition to eutrophication, warming in the past half century has also extensively influenced harmful algal blooms communities in lake ecosystems. Therefore, powerful control and management strategies like community perceptions and priorities are needed relating to lake water management. This article emphasizes the nutrient loads and lake water eutrophication in Bengaluru.

Index Terms- algal blooms; eutrophication; lakes; people participation; pollution.

1. INTRODUCTION

The most precious and vulnerable human resource in present era is fresh water globally and earth is usually known as 'blue planet' as water on the earth covers about 75% of the globe, out of which less than 5% of water is fresh and rest of the water is saline. Fresh water bodies like lakes, in broad-spectrum are self-sustaining ecosystem and if not disturbed they maintain reasonable water quality (Ramesh and Krishnaiah, 2013). Since the beginning of the 20th century, the water consumption has hyperbolic around sevenfold Globally, Water shortage and water quality are therefore likely to be the most prevailing water problem in the forthcoming century. consistent with WHO, concerning eightieth of all diseases and one third of all deaths in developing countries are regarded as water-related diseases, such as diarrhea, malaria, dengue, river blindness, Guinea worm, and others which kill human existences (Zbigniew, 2009). Growing technical, party-political, and community attention has engrossed on climate change and its effect on ecosystems, particularly lake ecosystems (Deng, 2017). Eutrophication isn't a brand new issue; it came to prominence within the middle of the last century. In the intervening period, its impacts became intensive worldwide, occurring where structure agriculture is intensive and human populations are dense (Matthew *et al.*, 2018). The rapid climb of population along with urbanization has resulted in the deterioration of water resources particularly lakes are deteriorating due to serious pollution stresses inflicting the scarceness of water resources (Ramesh and Krishnaiah, 2014). In some countries lakes have become repositories for an awful assortment of wastes, as well as untreated or partially treated municipal waste, venomous industrial effluents, and harmful chemicals that are leached into surface and ground waters from agricultural activities. The hyperbolic industrial activities, urban runoff and agricultural activities are considered as the major contributors, gradually contaminating the sources of surface water and ground water.

2. BENGALURU LAKES

In recent years, lakes are being polluted hysterically and are being vanished in the name of encroachment significantly in growing metropolis like Bengaluru. In earlier days, Bengaluru was popularly known as 'The City of Lakes'. However, now it is poorly referred to as 'The City of Vanishing Lakes'. Lakes of the metropolis play a couple of roles in an urban setting, and they are regarded as the ecological barometer of the health of the city. They regulate the microclimatic of any urban center. The presence of the lake, in any location significantly impacts the lives of human beings residing adjacent to it (Aboud *et al.*, 2008), lakes additionally provide environmental facilities and are used for irrigation as well (Jamwal, 2017). Apart from the above advantages, lakes furthermore offer treasured habitats to plants and animals, moderate hydrological cycles, influence microclimate, beautify the cultured beauty of the landscape and expand many recreational opportunities to humankind (Ramesh and Krishnaiah, 2014). Hence, it is crucial to repair, restore and hold the physical, chemical and biological integrity of lakes to attain the specific water quality, which ensure protection and propagation of fish, wildlife, plants and additionally the recreation in and around water (Pattusamy *et al.*, 2013).

Bengaluru has no natural lakes, however have many man-made lakes which had been constructed to meet the hydrological needs (Krishna and

Ramachandra, 2008) and these lakes are shaped along three major valley systems nam ely Hebbal Valley, Koramangala and Challaghatta Valley and Vrishabhavati Valley with series of lakes connected to it. Almost all the above mentioned valleys are moderately or highly polluted due to heavy nutrients masses from urban infrastructure development and are developed into eutrophic condition by anthropogenic activities and humans are blamable for choking several lakes to death (Ram and Mohan, 2008). And causative sources contributing to decline of Bengaluru lakes are storm water runoff, discharge of untreated or partially treated sewage, fertilizers and pesticides runoffs, discharge of agricultural wastes and small scale industrial effluents into the lakes are common ways that various nutrients enter the aquatic ecosystems resulting in the death of those systems (Dixit *et al.,* 2005). And Converting wetlands for residential, commercial and agricultural purposes have additionally been a part of the mosquito eradication program of the Bangalore Development Authority (Deepa *et al.,* 1997). Remaining lakes are dying quick, as they are filled with solid waste materials and sewage.

3. NUTRIENT LOAD AND EUTROPHICATION

According to the U.S. Environmental Protection Agency (EPA), excess nutrients load is the major reason for impaired water quality in the urban lakes and uncontrolled human activities in and around the lakes resulted in waters enriched with nutrients (Ram and Mohan, 2008). And Eutrophication has turn out to be of exceptional global, national and regional concern because of its economic and ecological consequences, such as frequent outbreaks of algal blooms threatening the dependable supply of clean water. Accumulation of excessive nutrients has led to the formation of a hypoxic environment and deterioration of water quality (Xia et al., 2016). Subsequently excess nutrients, specifically phosphorus and nitrogen, have long been recognized as the primary pollutants that contribute to the cultural eutrophication of lakes and are considered to be 'causal variables' because in excessive amounts, they may cause proliferation of primary producers. Therefore, there is a clear and pressing need to reduce anthropogenic nutrient inputs to the lake ecosystem in order to protect water resource and to reduce eutrophication, along with the proliferation of harmful algal blooms and to redeem the 'dead zones' of these ecosystems to standard conditions (Conley, 2009).

Bellandur lake

Byramanagala lake

Lakkenahalli lake

Eutrophication has dramatically affected phytoplankton biomass in lakes. To an extreme situation, harmful algal blooms might also arise inflicting extreme social economic expenses. Eutrophication outcomes frequently propagate as much as higher trophic stages ensuing in modifications to the zooplankton community. In addition to eutrophication, warming in the past half century has also drastically influenced phytoplankton as well as zooplankton communities in lake ecosystems. Moreover, eutrophication and warming regularly have synergistic effects on whole lake ecosystems. For this reason, eutrophication and climate change are two processes that may promote the proliferation and expansion of harmful algal blooms like *cyanobacteria*, *Microcystis*, *Anabaena*, *Cylindrospermopsis* (O'Neil *et al.,* 2012).

Growing nutrient inputs and increasing temperatures generally tend together to exaggerate eutrophication signs (Brian *et al.,* 2011). Eutrophication is highly-priced (Dodds *et al.,* 2009). The solution is to reduce nutrient inputs, typically phosphorus but often also nitrogen (Elser *et al.,* 2009). However, restructuring the ecosystem, through elimination or treatment of sediment or manipulation of the aquatic community, especially the fish community generally become scarcer with eutrophication, and the ultimate effect, through an increase in foraging fish and a decline in zooplankton grazers, is an increase in algae (Brian *et al.,* 2011).

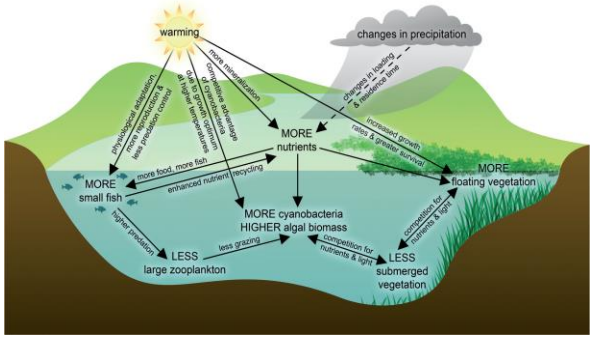

Fig. 1: Some relationships now established that link climate change and eutrophication symptoms. (Source: Brian *et al.,* 2011)

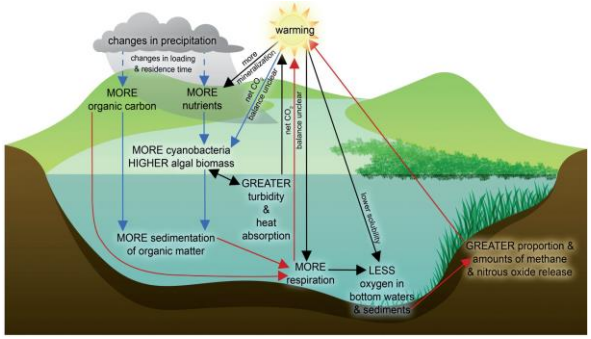

Fig. 2: Current indications of feedback effects of eutrophication on climate change. Blue arrows indicate carbon sequestration routes; red arrows indicate carbon emission routes; black arrows indicate other climate effects. Because CO_2 uptake and release may both increase with eutrophication, net CO_2 balance is unclear. The increase in methane and nitrous oxide is more probable. Dashed arrow indicates that changes in precipitation regimes may either lead to more or less organic carbon loading, depending on local and regional circumstances. (Source: Brian *et al.,* 2011)

The water quality of Bengaluru lakes has exaggerated due to the consequent changes and urbanization. Total Dissolved Solids, Phosphates and Nitrogen are exceeding their limits in most of the lakes leading to eutrophication. Despite of some conservation efforts made by the authorities the lakes are threatening immeasurably. Thus, Continuous monitoring of lakes and conservation strategies should be adopted properly to overcome these situations (Borecki, 2016). During recent years, the potential effect of climate change on water eutrophication is attracting more environmental concern (Xia *et al.,* 2016). It has also been predicted that, the occurrence of algae blooms will likely increase in a changing climate with rising levels of atmospheric greenhouse gases.

4. PEOPLE PERCEPTION

Assessment of local people's perceptions and priorities of lentic basin water governance overall performance is a beneficial measurement barometer for citizen involvement and participation due to the fact, throughout many developing nations, decision-making on day-to-day water use and management issues is in the responsibility of the local community. Nearby people are continually the most important contributors in participative water resource management because they provide key information related to neighbourhood water resources (Peter *et al.,* 2015).

While interacting with a neighbourhood resident named Muniyappa, he stated earlier the lakes had been clean and frequently visited with the aid of fishermen for fishing, the lakes had been full of existence with birds chirping everywhere and shepherds used to rear their cattle's and sheep's around the lake shorelines, however from past few years, due to many condominium encroachments at the lakebeds and draining off all the residential and commercial waste into the lakes, the lakes are dying a gradual death with extreme contamination, fishing has been stopped and no active aviary seen around the lakes. He also added saying" our health conditions are also dwindling eventually as we are residing near these lakes inhaling the foul smelling polluted air".

Programmes and applications of satellite remote sensing have also given powerful vision to the study of marine and freshwater ecosystems, providing refined and sophisticated data information for the management of water resources. Satellite measurements are particularly helpful for the detection of phytoplankton because of the distinctive spectral characteristics of photosynthetic pigments. Thus far flung sensing can provide regular, synoptic coverage of algal blooms over huge regions for nearby tracking applications at resolutions not possible via field measurements (Adam, 2012).

5. CONCLUSION

Effective management strategies and powerful control techniques are needed to maintain the human interests relating to lake water management. With urban expansion and water quality deterioration, there

is a pressing need for municipalities to devise water management through protection of water at the source or remedy of water to keep its best. Thus, it's far worthwhile to assess public expertise knowledge and opinion relating to water and see how that influences participation. Environmental focus and awareness programmes can significantly assist in the safety of the water bodies in which endorsed participation of communities and voluntary corporations will help significantly in the conservation, protection, and safety of lakes.

ACKNOWLEDGMENTS

The authors would like to thank Ministry of Science and Technology, Department of Science and Technology, Government of India for awarding INSPIRE Fellowship under INSPIRE program to conduct the research work.

REFERENCES

[1] Aboud S. Jumbe and Nandini, N. 2010. Physico-chemical and heavy metals evaluation of polluted urban wetlands of Bangalore. *Research journal of chemistry and environment*, 14(2): 22-35.

[2] Adam Trescott. 2012. Remote Sensing Models of Algal Blooms and Cyanobacteria in Lake Champlain. *Environmental & Water Resources Engineering*, 2, 1-54.

[3] Borecki, J., Dunlop, R., Kerford, A., & Wang, J. 2016. Public Perception of Water Management and Understanding of the Watershed: A Case Study of Calgary, Alberta. *University of Calgary, Canada*. 1-29.

[4] Brian Moss., Sarian Kosten., Mariana Meerhoff., Richard W. Battarbee., Erik Jeppesen., Néstor Mazzeo., Karl Havens., Gissell Lacerot., Zhengwen Liu., Luc De Meester., Hans Paerl., & Marten Scheffer. 2011. Allied attack: climate change and eutrophication. *Inland Waters*, 1, 101-105.

[5] Conley, D. J., Paerl, H. W., Howarth, R. W., Boesch, D. F., Seitzinger, S. P., Havens, K. E., ... & Likens, G. E. 2009. Controlling eutrophication: nitrogen and phosphorus. *Science*, *323*(5917), 1014-1015.

[6] Deepa, R. S, Kiran, R, and Ramachandra, T. V. 1997. Status of Wetlands in Bangalore -An Overview was presented at the International Seminar on Ecorestoration, Biodiversity Conservation and Sustainable Development", organized by the Environmental Research Academy, Vishakapatnam and International Socio-Environmental Awareness Studies Bangalore, held at Bangalore during December 1997.

[7] Deng, J., Zhang, Y., Qin, B., Yao, X., & Deng, Y. 2017. Trends of publications related to climate change and lake research from 1991 to 2015. *Journal of Limnology*, *76*(3). 439-450.

[8] Dixit, S., Gupta, S. K., & Tiwari, S. 2005. Nutrient overloading of fresh water lake of Bhopal, India. *Electronic Green Journal*, *1*(21). 1-8.

[9] Dodds, W. K., Bouska, W. W., Eitzmann J. L., Pilger T. J., & Pitts, K. L. 2009. Eutrophication of U.S. freshwaters: analysis of potential economic damages. *Environ Sci Technol.*, 43, 12–19.

[10] Elser, J. J., Andersen, T., Baron, J. S., Bergstrom, A. K, Jansson, M., Melack, J., & Downing, J. A. 2009. Shifts in lake N:P stoichiometry and nutrient limitation driven by atmospheric nitrogen deposition. *Science*, 326, 835–837.

[11] Jamwal, P. 2017. Fate of nutrients in human dominated ecosystems. *Resonance*, *22*(3), 279-290.

[12] O'neil, J. M., Davis, T. W., Burford, M. A., & Gobler, C. J. 2012. The rise of harmful cyanobacteria blooms: the potential roles of eutrophication and climate change. *Harmful algae*, *14*, 313-334.

[13] Pattusamy, V., Nandini, N., Kumar, V. M., & Bheemappa, K. 2013. Water quality studies of Bellandur Lake, Urban Bangalore, Karnataka, India. *International Journal of Advanced Research*, *1*, 77-82.

[14] Peter Emmanuel Cookey., Rotchanatch Darnswasdi., & Chatchai Ratanachai. 2015. Local people's perceptions of Lake Basin water governance performance in Thailand. *Ocean & Coastal Management*, 120, 11-28.

[15] Ram, H. K., & Mohan, M. R. 2008. Water quality status of Hebbal lake, Bangalore, Karnataka. *Environment and Ecology*, *26*(4C), 2350-2356.

[16] Ramesh, N., & Krishnaiah. 2013. Scenario of Water Bodies (Lakes) In Urban Areas- A case study on Bellandur Lake of Bangalore Metropolitan city. *Journal of Mechanical and Civil Engineering*. *7*(3): 06-14.

[17] Ramesh, N., & Krishniah, S. 2014. Assessment of trophic status of Bellandur Lake, Bangalore. India by using USEPA technique. *International Journal of Current Engineering and Technology*, *4*(5), 3467-3472.

[18] Xia, R., Zhang, Y., Critto, A., Wu, J., Fan, J., Zheng, Z., & Zhang, Y. 2016. The potential impacts of climate change factors on freshwater eutrophication: implications for research and countermeasures of water management in China. *Sustainability*, *8*(3), 229.

[19] Zbigniew W. Kundzewicz. 1997. Water resources for sustainable development, Hydrological Sciences Journal, 42:4, 467-480.