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Study of Floral Biodiversity of Water Bodies near HSR Layout, Bangalore, to Evaluate Water Pollution

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Abstract Lakes and ponds sustain a rich diversity of large flora and fauna. A reason for biodiversity depletion is destruction of these natural habitats due to urbanization and pollution. Study of biodiversity facilitates in understanding the current scenario and accordingly take action plans to prevent and preserve further environment depletion. The present investigation aimed to study the floral diversity of three lakes of Bangalore - Agara, Madiwala and Kaikondrahalli. Some aquatic plants are sensitive to pollution and used as bioindicator. All the three lakes had abundant growth of *Eichhorina carassipes, Ricinus communis* and *Cynodon dactylon.* Excessive growth of *E. carassipes* and *C. dactylon* indicated metal pollution and salinity of water, respectively. The leaf colour of *R. communis* in Madiwala lake was observed to be pale yellow indicating the pollution of the area more compared to Agara region. The establishment of lake restoration projects have restored habitats and biodiversity to some extent. However, a joint effort by ecologists, hydrologists, policy makers, and local residents is required to minimize negative human impacts, maximize the effectiveness of nature reserves and lake restoration.

Keywords: *biodiversity, lake, bioindicators, pollution, Bangalore*

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1. Introduction

The freshwater ecosystems in cities serve as reservoirs for sustaining native flora and fauna. It includes all types of inland wetlands like lakes, rivers, ponds. Lakes provide critical habitat for fish, algae, crustaceans, molluscs, amphibians, birds, mammals, insects and aquatic plants. The species diversity of plants and algae, in these freshwater bodies, are concentrated in the littoral zone, near the shore, where abundant light is available for photosynthesis [1]. Human communities that live around these lakes depend heavily on lake biodiversity. Life of all species are interconnected. Less biodiversity, weaken these connections and sometimes break, harming all the species in the ecosystem.

In recent years, there has been depletion of biodiversity in various ecosystems, around the world. Many species have become endangered or extinct due to destruction of natural habitat by excessive human interferences. Pollution, disappearing fields, forest and wetlands, overhunting, urbanization are few reasons for depletion of biodiversity. Diversion of lake water for human use, contamination of water by sewage water, agricultural runoff, untreated effluents from industries significantly threatens lake ecosystems.

The city of Bangalore (Karnataka, India) was once famous for its beautiful lakes. These lakes met the drinking water, irrigation and fishing needs of the community and had a positive impact on the ecology and microclimate of the city. The wetlands in the city are now dying due to rapid growth and unplanned urbanization resulting in discharge of sewage and industrial effluents in water bodies. Urbanization, encroachments, siltation and eutrophication from domestic and industrial effluent has lead to pollution or extinction of city lakes [2,3,4].

The present study focused on studying the floral biodiversity of three lakes- Agara lake, Madiwala lake, Kaikondrahalli lake, located around a leading residential area in South-east suburb of Bangalore, HSR Layout (Hosur-Sarjapur Road Layout) (Figure 1).

2. Materials and Methods

2.1. Field Equipment

Ball pen, Camera, Notebook, Plant based app Plant Net and Plant Snap

Figure 1. Satellite view of Madiwala lake, Agara lake, Kaikondrahalli lake, Bangalore, India

Figure 2. Satellite image and site images of selected lakes around HSR Layout, Bangalore (A1, A2) Agara Lake; Madiwala Lake (B1, B2) (C1,C2) Kaikondrahalli Lake

2.2. Study Area

a. Agara lake, 42° 2' 19.637" N 43° 49' 27.473" E, is located close to Koramangala and HSR layout in Bangalore (Figure 2 - A1, A2). The lake is spread across an area of about 98 acres. The lake was once a location for several migratory birds. A huge catchment area surrounds the lake. The lake receives the water that overflows from the Madiwala Lake. The excessive water of the Agara Lake overflows and reaches the Bellandur Lake. The Karnataka lake conservation and development authority has restorated the Agara lake [5].
b. Madiwala lake is one of the biggest lakes in Bangalore, India spread over an area of 114.3 hectare. It is situated in the BTM Layout at 12° 54' 28" North, 77° 37' 0" East in Bangalore city (Figure 2 B1, B2). The lake comes under the administration of Karnataka State Forest Department which carries out the routine maintenance of this lake [6]. Legend has it that the lake was built by the cholas, in a day.
c. Kaikondrahalli lake spread over 48 acres, on Sarjapur Road (Figure 2 C1, C2), south-eastern periphery of Bangalore city, is a bio-diverse ecosystem. Earlier maintained by local village community, the lake had been site of illegal encroachments, disposal of city sewage, toxic industrial effluents human and animal defecation.

2.3. Collection Methods

For studying floral diversity, specimen collections were also done. During the specimen collection, all details related to each plant species were recorded in the field notebooks including the date of collection, habit and habitat, locality of the collection, local name and scientific name of species, family, and local use.

Figure 3. (1): *Eichhorina carassipes* (2): *Ricinus communis* (3): *Tanacetum parthenium*, (4): *Amaranthus spinosus* (5): *Sedum lineare*, (6): *Zoysia* [Madiwala Lake]

3. Result and Discussion

The flora diversity found in the survey, in and around the Agara lake, Madiwala lake, Kaikondrahalli lakes are summarized in Table 1 and Figure 3 – Figure 6. The three lakes showed difference in the type and population of different flora. *Ricinus communis* and *Eucalyptus globules* was found in all the three sites. The flora at Madiwala and Agara lake showed dominance of *Eichhorina carassipes*, *Amaranthus spinosus* and *Cynodon dactylon*. *Tanacetum parthenium* was found in abundance in Agara and Kaikondrahalli Lake. All these dominant plants are considered as bioindicators for the presence of heavy metals.

*E. crassipes (*water hyacinth), is a free-floating perennial, invasive aquatic plant (hydrophyte) (Figure 3:1). It has broad, thick, glossy, ovate leaves, that may rise above the surface of the water and is an excellent source of biomass. It has been successfully used as indicators of heavy metal pollution [7]. It is capable of bioconcentrating toxic metals like Chromium (Cr), Copper (Cu), Cobalt (Co), Nickle (Ni), Zinc (Zn), Lead (Pb), Cadmium (Cd) and Arsenic (As) in its root system [8,9]. The uptake of heavy metals in *E. crassipes* is stronger in the roots than in the floating shoots.

R. communis (castor bean) (Figure 3:2), a oleaginous plant was observed in plenty in all the three locations. It is considered as a potential bioindicator (ecological indicator) owing to rapid growth and large leaves, making it an excellent option as a living biosensor of environmental quality [10]. Significant differences in morphological characters like size of leaf and root and leaf colour can be observed in plants growing in polluted area. *R. communis* growing in polluted area have been observed to have lower concentrations of chlorophyll a [11]. The leaves of *R. communis* in Madiwala lake were pale yellow in colour, compared to Agara region, indicating the water to be more polluted.

Tanacetum sps. (Figure 3:3), have been reported to accumulate chromium and iron in roots, and manganese and zinc in leaves [12]. Similarily, *A. spinosus* (Figure 3:4), is capable of accumulating *barium (Ba), aluminium (Al), magnesium (Mg), lithium (Li), antimony (*Sb), strontium (Sr) and zinc (Zn) [13]. *C. dactylon* (Bermuda grass) (Figure 4:7), can accumulate high concentration of Pb, Fe and Zn [14]. *E. globulus* (Figure 6:19), is a potential candidate for bioaccumulation of cadmium (Cd), arsenic (As) and lead (Pb) from contaminated areas [15,16,17].

Figure 4. (7): *Cynodon doctylon*, (8): *Capparis spinosa* (Madiwala Lake), 9(a): *Thunbergia erecta* (leaf), 9(b) :*Thunbergia erecta* (flower) (Kaikondrahali Lake), (10): *Tecoma stans*, (11): *Laurus nobilis*, [Agara Lake]

Aquatic habitats and vascular plant species serve as a reliable index for biological monitoring of pollution load. Their ability to accumulate toxic substances, make them a potential bioindicator to show the presence of pollutants at very low concentrations. In many sensitive species, morphological and structural changes induced by specific heavy metals can be indicative for assessing the presence of specific metals [18].

The Bengaluru's lakes movement had created a wave of lake rejuvenation processes throughout the city. After 2008, many of Bengaluru's lakes were handed over the BBMP (Bruhat Bengaluru Mahanagara Palike), after being rejuvenated by Bengaluru Development Authority (BDA). Many Bengaluru-based NGO Environment Support Group and private organizations had also been a part of it. However, many gaps in the current rejuvenation path have been well document and many lake water systems are not suitable for supply of drinking water [19]. Community-based conservation and development initiatives with the help of local citizens and residents are required for rejuvenation of these lakes. Identification of bioindicators for assessing the state of aquatic systems are required for assessing and predicting environmental changes. Plant species due to their immobility adapt to their natural environment. The effect of pollutants on the morphological, biochemical and cellular parameters of plant species can be utilized for evaluation of the extent and type of pollution.

Figure 5. 12: *Caesalpinia pulcherrima*, 13: *Celosia argentea*, 14: *Viola tricolor*, 15: *Convlvulus arvensis* (Agara Lake), 16: *Chenopodium album*, 17*: Junlans regia* (Kaikondrahalli Lake)

Figure 6. (18) *Contoneaster franchetii*, (19): *Eucalyptus globules* (20): *Curcurbita foetidissima*, (21): *Araujia sericifera*, (22): *Albizia julibrissin* [Kaikondrahalli Lake], (23): *Mimosa pudica* [Agara lake]

Table 1. Representation of flora found in and around Agara Lake, Madiwala Lake, and Kaikondrahalli Lake, Bangalore

SN. No.	Plants Name	Agara Lake	Madiwala Lake	Kaikondrahalli Lake
1	*Eichhorina carassipes*	+++	++++	0
2	*Ricinus communis*	+++++	+++++	+++++
3	*Tanacetum parthenium*	0	++++	+++
4	*Amaranthus spinosus*	++++	+++++	++
5	*Sedum lineare*	+	+++	0
6	*Zoysia*	++	++++	++
7	*Cynodon dactylon*	+++++	+++++	++
8	*Capparis spinosa*	++++	+++	0
9	*Thunbergiae recta*	+++++	++	+++++
10	*Tecoma stans*	++++	0	++
11	*Laurus nobilis*	+++	0	0
12	*Caesalpinia pulcherrima*	++++	++	+++
13	*Celosia argentina*	+++++	0	++
14	*Viola tricolor*	++++	++	0
15	*Convolvulu s arvensis*	+++	0	0
16	*Chenopodium album*	0	0	+++++
17	*Eucalyptus globules*	+++++	++++	+++++
18	*Curcurbita foetidissima*	+++	0	++
19	*Araujiase ricifera*	0	0	++++
20	*Albizia julibrissin*	++	++	+++
21	*Juglans regia*	++	0	++++
22	*Contoneaster franchettii*	0	0	++++

+++++: Abundant; ++++ : High; +++: Moderate; ++: Less; + : Few; 0 : Absent.

4. Conclusion

Study of biodiversity helps to understand the relation between ecosystems, flora and fauna. It helps us to keep an account on species which are abundantly present in an area, getting endangered, and those having biological importance to the biodiversity. It helps us to assess the condition that is causing to be endangered and remedial ways to be followed to prevent eradication.

The three lakes of Bangalore i.e., Agara lake, Madiwala lake, Kaikondrahalli Lake were the part of the present study. Due to rapid urbanization the three lakes have been polluted. The dominant flora seen in these sites are bio-indicators of metal pollution in lake water. It was abundantly seen in both the lakes (Agara lake, Madiwala lake). Kaikondrahalli Lake was found to be least polluted one when compared to the other two lakes. Even though all the three lakes have been renovated, Agara and Madiwala are still being neglected by the visitors coming to the lake. Proper prevention and awareness among the communities can help to rejuvenate these lakes.

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