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Macrophytes as Powerful Natural Tools for Water Quality Improvement

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ABSTRACT
In aquatic ecosystems including lakes and reservoirs, water quality gets affected by a number of factors such as natural degradation, processes of eutrophication and the impacts of human activities. These days' water quality problems are as severe as those of water availability and to this serious issue less attention is being paid, particularly in developing countries. With the view to mitigate the degradation of water quality additional sustainable ways are being researched currently throughout the world. Use of plants to address water quality problems especially water pollution i.e., phytoremediation is one of the serious efforts towards the sustainability. Macrophytes grow in aquatic environments and are well adapted to their surroundings. Presence of excessive nutrients in any water body is the root cause of eutrophication which can be checked by macrophytes as they have the potential to eliminate these excessive nutrients. Thus they have capability to improve the quality of water by absorbing nutrients with their effective root systems and hence function as powerful bio-filters. Present study was designed with the sole purpose of eliciting the precious wealth of information on the potentiality of macrophytes (*Potamogeton* spp.) in improving the quality of water by reducing its nutrient content. Purification of water through plants i.e., macrophytes is a good example of purification of water by natural means and hence results of this investigation indicated that *Potamogeton* spp., were capable of improving water quality by reducing its nutrient concentrations.

Key words: Macronutrients, *Potamogeton* spp., Upper lake, wastewater

INTRODUCTION
Several intrinsic properties of macrophytes make them an indispensable component of aquatic ecosystems. As a result of urban and agricultural activities, nutrients in sufficient amounts get added to aquatic ecosystems to cause a more serious problem of eutrophication which in turn results in the massive growth of the macrophytes and weeds. Thus rapid urbanization and anthropogenic pressure are the main causes of nutrient accumulation. Storm water runoff and discharge of sewage into the lakes are two common ways through which various nutrients enter the aquatic eco-system, resulting into the death of those systems (Sudhira and Kumar, 2000). The washing of large amount of clothes by dhobis and laundry workers, continued entry of domestic sewage and death and decay of macrophytes are posing pollution problems and hence, an imbalance in the

dynamics of water quality (Lone *et al.,* 2013). The water quality issues regarding lakes throughout the world are of great concern. Eutrophication of a water body signifies the aging of a lake. It is caused by the accumulation of nutrients, sediments, silt and organic matter in the lake from the catchment area (Dhote and Dixit, 2007).

The most important functions of macrophytes in relation to the treatment of wastewater are the physical effects brought about by the presence of the plants. Macrophytes stabilize the surface of the beds, provide good conditions for physical filtration, prevent vertical flow system from clogging, insulate against frost during winter and provide a huge surface area for attached microbial growth. Macrophyte-mediated transfer of oxygen to rhizosphere by leakage from roots increases aerobic degradation of organic matter and nitrification. Macrophytes have additional site-specific values by providing habitat for wildlife and making wastewater treatment systems aesthetically pleasing (Brix, 1994).

In any aquatic ecosystem macrophytic vegetation can be regarded as a huge bio-film and within this film gradients in different environmental patterns occur. Wind velocities are reduced which might be of importance in surface flow wetlands, as resuspension of settled material is thereby decreased. However, gas exchange is diminished by slow air movement which may not be desirable from the point of view of wastewater treatment. Light is attenuated, hindering production of algae in open water channels (Brix, 1994). This property is used in duckweed based systems, as algae die and settle out beneath the dense cover of duckweeds (Ngo, 1987). Insulation cover is another important role played by plants in any water body during winter. Plants that are live as well as already dead get covered by snow during winter to provide an effective insulation that helps keep the inner bed medium free of frost.

Accumulation of nutrients and acceleration of nutrient loading in the environment is one of the principal characteristics of macrophytes. Macrophytes have effective root systems that help them to take up nutrients from their surroundings. As macrophytes are very productive, they utilize considerable amounts of nutrients and produce large amounts of biomass. A number of emergent, free-floating and submerged macrophytes, can take up large amounts of Nitrogen (N) and Phosphorus (P) and this amount can be easily removed if the biomass is harvested. The highly productive water hyacinths have generally higher uptake capacities whereas the capacity of submerged macrophytes is lower (Brix, 1994). Thus macrophytic vegetation plays an important role in maintaining the ecosystem of any water body, by improving the quality of water since later is a prime natural resource, a basic human need and a precious natural asset.

MATERIALS AND METHODS

To study the role of macrophytes in improving the quality of water, two species of *Potamogeton* (submerged macrophyte) were taken from one of the oldest man-made lakes of India known as Upper lake of Bhopal, Madhya Pradesh. Upper lake is locally called “Bada Talab”, (77°18'-77°24' E, 23°13'-23°16' N) and is surrounded by Vanvihaar National Park on the south, human settlements on the east-north and agricultural fields on the west (Fig. 1). It is a source of drinking water to urban populations and miscellaneous purposes viz., aesthetic, recreational, industrial purposes etc (Lone and Bhardwaj, 2011).

Submerged plant biomass samples of the two *Potamogeton* species viz., *Potamogeton crispus* L. commonly known as Curly pondweed and *Potamogeton pectinatus* L. commonly called as Sago pondweed were collected from the three sites of the lake viz, Ahmadabad site with man made pollution, (Longitude 77°22' 51.2" and Latitude 23°15'31.0"), Central site with no pollution,

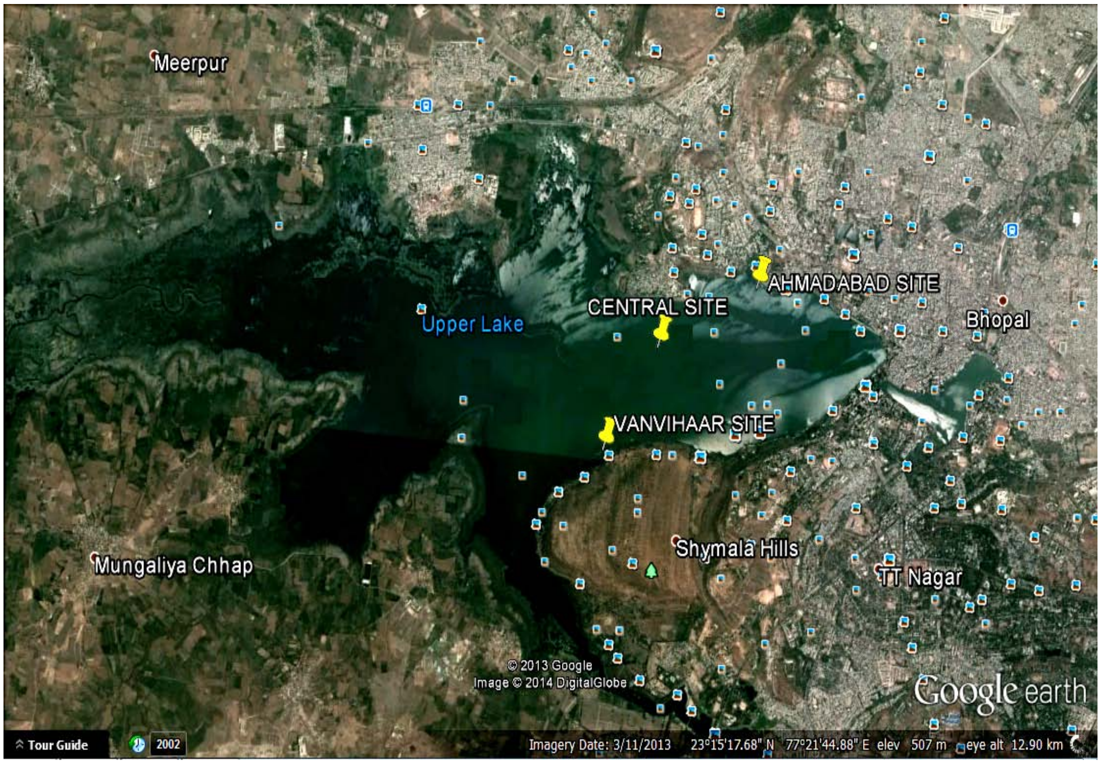

Fig. 1: Location map of study area

(Longitude 77°22' 07. 9" and Latitude 23°15' 05. 4") and Vanvihaar site with natural pollution, (Longitude 77°21' 45. 01" and Latitude 23°14' 27. 05") after a duration of every two months from December 2008 to April 2009. Collected plants were identified by employing the use of important works like water plants of world (Cook *et al.*, 1974) and water and marsh plants of India and Burma (Biswas and Calder, 1984).

After collection, samples were brought to the laboratory in polythene bags and ice boxes, washed several times with water and then with 0.2% detergent solution to remove any waxy coating and adhering soil particles. This was followed by washing with 0.1 N HCl to remove metallic contamination and finally with deionised water to wash the previous two solutions. The two species of *Potamogeton* were then dried separately in oven at 60°C for 48 hours. Dried samples were homogenized and ground to yield fine powder. A standard procedure for water and aquatic plants was used to prepare plant material for chemical analysis (APHA, 1999; Tandon, 1993). The total phosphorous was assayed spectro-photometrically by Ammonium-Vavnadate-Molybdatye method while as the concentrations of sodium and potassium were determined flame-photometrically.

RESULTS AND DISCUSSION

Phytoremediation process involves the use of green plants and their biomass to degrade or render harmless environmental contaminants. Currently, a wide range of plants are being studied to check their use in phytoremediation processes and a large number of plant species have been already found to be efficient in phytoremediation of organic pollutants. Thus phytoremediation is a fast remediation technique to clean contaminated sites. It has been accepted and utilized widely as an effective and environmental friendly green technology for permanent removal of pollutants (Chen *et al.,* 2009). Phytoremediation, when compared to physical and chemical remediation, shows several advantages as it helps: (1) In preserving the natural properties of soil, (2) Acquiring energy mainly from sunlight and (3) Maintaining high levels of microbial biomass in the rhizosphere (Huang *et al.,* 2004).

Sodium (Na), Potassium (K) and Phosphorus (P) are three essential macronutrients that are responsible for the sound growth and development of plants. Plants such as aquatic macrophytes absorb these nutrients through their effective root systems from ambient environments such as soil/sediment and water and automatically retain them in particular body parts. This process is called rhizofiltration. Thus the plants are known to serve as tools for lake management (Melzer, 1999) and a number of studies have demonstrated that a large reservoir of nutrients can accumulate in aquatic macrophytes in lake ecosystems (Howard-Williams and Lenton, 1975; Howard-Williams and Junk, 1977; Carpenter and Adams, 1977). The concentration of above cited three macronutrients obtained in the present study is presented in the Fig. 2, 3 and 4, respectively.

From the Fig. 2, 3 and 4 it is obvious that the average stock values of Na, K and P in both macrophytic plant species viz., *Potamogeton crispus* L. and *Potamogeton pectinatus* L. were reported higher at Ahmadabad site rather than at Cental and Vanvihaar sites.

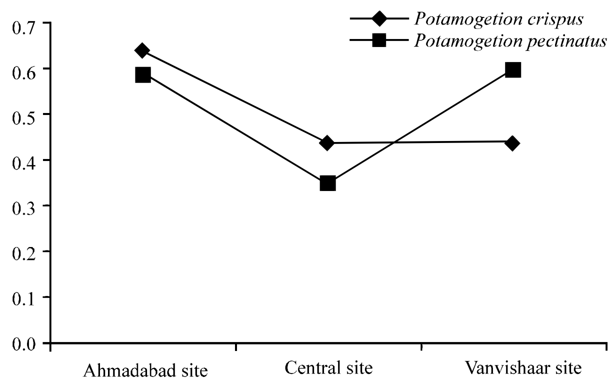

Fig. 2: Percent sodium values of *Potamogeton crispus* L. and *Potamogeton pectinatus* L.

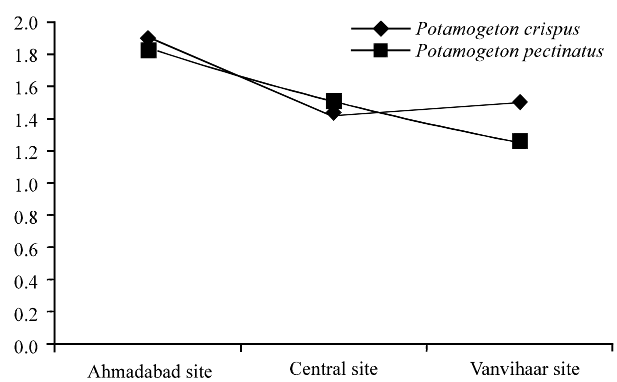

Fig. 3: Percent potassium values of *Potamogeton crispus* L. and *Potamogeton pectinatus* L.

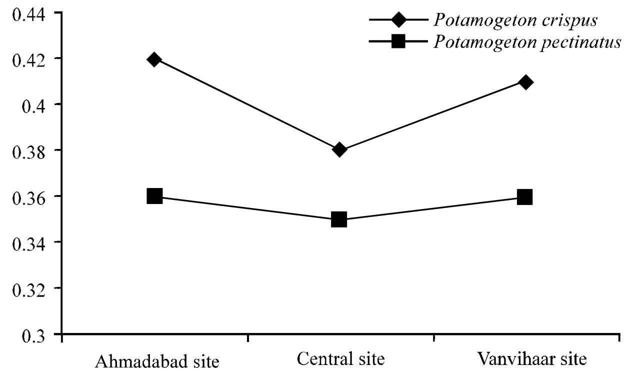

Fig. 4: Percent phosphorus values of *Potamogeton crispus* L. and *Potamogeton pectinatus* L.

Generally it is said that plants absorb more nutrients from nutrient rich sites and that is what we observed in our study.

As plant biomass was collected from three different sites namely Ahmadabad site, Cental site and Vanvihar site with man-made pollution, no pollution and pollution by natural means, respectively. Ahmadabad site was highly polluted only because of entry of sewage from the catchment area as well as decomposition of densely growing macrophytes. Domestic sewage is a source of various luxuriant plant growth supporting nutrients including sodium, potassium and phosphorus. There was no pollution at central site on account of neither sewage entry nor fast death and decomposition of macrophytes, since the density of macrophytes at this site was reported less. But when it comes to Vanvihaar site it was naturally polluted firstly because of surface runoff and secondly there was dense growth of macrophytes which upon natural death and decomposition added a great concentration of nutrients to the lake water and sediments (Lone *et al.,* 2013). The decomposition rates of submerged and floating leaved macrophytes are more than those of floating and emergent species (Kulshreshtha and Gopal, 1982; Sharma and Goel, 1987) and because of this more nutrients are added to environment and hence become available to the growing plants. Thus, the occurrence of dense growth of macrophytes at Ahmadabad and Vanvihaar sites than at the Central site was probably due to the availability of more nutrients at these sites. Results indicated that both species were capable of improving water quality by accumulating more nutrients in their tissues at nutrient rich sites and hence reducing nutrient concentration in polluted water. Since, the level of estimated nutrients was comparatively found high in *Potamogeton crispus* L. it, also became evident from our results that *Potamogeton crispus* L. was comparatively more efficient in accumulating nutrients and hence had more purification efficiency than *Potamogeton pectinatus* L. This finding is in agreement with Ho (1979) and Lone *et al.* (2013).

CONCLUSION

In conclusion, authors can say that macrophytes play a very important role in improving the quality of water by absorbing various nutrients from the later. Since, a good enough research has been done to check the water purification efficiency of free-floating and emergent macrophytes, there is little amount of information available in published format regarding the same aspect of submerged macrophytes and therefore they should also be studied in detail to reveal some promising results concerning their use as potential bio-filters.

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