B－45 ASSESSMENT OF DETECTING RECENT ENVIRONMENTAL CHANGE IN AN ANCIENT RESERVOIR FROM SRI LANKA'S WET ZONE USING SUBFOSSIL DIATOMS

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1. INTRODUCTION

Agricultural and domestic water requirements of 21 million human population of Sri Lanka have been fulfilled by 103 natural river basins and thousands of reservoirs since the ancient time. Water quality of many of the reservoirs is known to be affected negatively due to human activities[1),3)]. As a result water quality of some of the reservoirs has already become seriously affected especially in highly populated urban areas. Further, some reservoirs are threatened by salinisation[2)], which could severely affect agriculture within the country. The alterations in the chemical state of these reservoirs should result in changes of their aquatic communities[2),3)]. Already, diversions of rivers into reservoirs connecting the Wet Zone and the Dry Zone landscape have resulted in major limnological changes[3)].

Because of the importance of the understanding of the water quality, limnological studies have been promoted by governments, industry and individuals of Sri Lanka, especially during the past two decades [1),3),4)]. These studies were designed mainly to understand present limnological conditions and the impacts of dams and fish introductions[3)]. However, few studies have been carried out to assess if the aquatic communities be used to understand the water quality changes in Sri Lankan systems[1),2)]. As the long-term monitoring data are not available in Sri Lankan systems indirect measurements would be the only viable option. Thus, the uses of biological indicators to predict past environmental changes have started to draw attention of environmental scientists. Throughout the world, paleolimnological techniques have been used to reconstruct past environments based on the information of aquatic communities preserved in lake and reservoir bottoms[5),6),]. These environmental inferences can be qualitative and/or quantitative[7),]. Diatoms are useful bioindicators that can be used in paleolimnological research to infer limnolological changes such as eutrophication, salinisation and lake-level fluctuations both qualitatively and quantitatively[5),7)]. In addition, diatoms have been used to infer changes in habitat, including changes in the abundance of macrophytes, temperature and oxygen[7),]. Therefore, the current study was undertaken in order to assess the impact of urbanization on diatom assemblages (and indirectly water quality) in Kandy Lake located in the Wet Zone of Sri Lanka.

2. MATERIAL AND METHODS

(1) Study site

Kandy Lake was selected for the study based on the large changes that have occurred within the catchment during the recent history. The Lake was constructed during 1810 - 1812 as an ornamental lake. Geographically, it is situated between 80° 38' – 80° 39' E and 7°17' – 7° 18'N and at the elevation of 510m. The Lake covers an area of 18 ha. and the maximum depth is ~14m. It is fed mainly by a small stream that reach the south eastern corner and in addition several other natural and artificial streams bring loads of domestic and other effluents from the houses, schools, hotels and other residences located within the catchment. Past studies have shown that the lake exhibit a meromictic condition[2)].

(2) Field and laboratory methods

Sediment core of 127cm was retrieved from the Kandy Lake in May, 2000, using a modified K-B gravity corer[8]. Then the core sample was sub-sampled at 0.5-cm intervals and were analysed for diatoms. Additionally, environmental data of the Lake were also collected using, onsite measurements, laboratory analysis, and also through relevant authorities and documents.

For laboratory analysis water samples were collected 0.5m below the surface of air water interface closer to the location of the sediment sampling but prior to sediment retrievel. Preservation and analysis of water samples followed the APHA (American Public Health Association) standard methods for examination of water and wastewater (18^{th} edition). Samples were analysed for major anions, cations, DOC, DIC, TP, TKN, silica and Chlorophyll *a*. Onsite measurements were taken for temperature, specific conductance, pH and dissolved oxygen from 0.5m below the air water interface using portable field instruments. The Secchi depth of the reservoir was measured using a 22-cm diameter Secchi disk.

(3) Preparation of microfossils

Diatom valves were isolated from sediment samples using a standard acid-digestion technique prepared by Laird et al.[9]. The resulting aliquots were used to enumerate diatom taxa using a Leica DMRB light microscope (Leica, Wetzlar, Germany). To determine the relative abundance of rare diatom taxa, a second count of 500 diatom valves was performed. For each subsample the relative abundances of all diatoms (total diatoms) were calculated.

3. RESULTS

(1) Diatom Data

In total, remains of 91 species of diatoms recovered from the Kandy Lake sediment core. However, only 12 species were abundant and appear to qualify for paleolimnological reconstructions (Table 1). Among these *Aulacoseira granulata, Aulacoseira granulata* (Large), *Cyclotella stelligera* (Large)-1, *Cyclotella stelligera* (Striae folked)- 3, *Cyclotella stelligera* -2, *Achnanthes lanceolata, Fragilaria brevistriata, Rhizosolenia* sp. and *Thalassiosira* sp. occurred more than 20 subsamples and could be considered as the most abundant taxa. In some intervals they were dominant and recorded as more than 70 % of the relative abundance. However, Some species such as *Aulacoseira granulata, Cyclotella stelligera* (Large)-1, *Cyclotella stelligera* (Striae folked) -3 and *Thalassiosira* sp. were abundant and recorded throughout the sediment core except in some intervals where no organism were recorded. *Fragilaria* species became abundant in the subsamples which represent the most recent history that represented by the upper part of the sediment core.

Table 1. Abundant Diatom Taxa and Number of intervals

Scientific Name	Number of intervals occurred
Achnanthes sp 1	17
Achnanthes lanceolata	46
Aulacoseira granulata	60
Aulacoseira granulata (Large)	51
Rhizosolenia sp.	44
Cyclotella stelligera (Large) -1	61
Cyclotella stelligera - 2	34
Cyclotella stelligera (Striae folked) -3	60
Fragilaria brevistriata	29
Fragilaria caparima	7
Fragilaria tenura	16
Thalassiosira sp.	60

(2) Physicochemical Data

Environmental data collected show that the Lake is small comparatively deep, productive, freshwater body. Physicochemical measurements show that the reservoir is eutrophic but showing nitrogen limited conditions (Table 2).

Table 2: Important Environmental data of the study reservoir

Variable	Measurement
Age (yrs)	185
Surface Temperatue (°C)	29.7
Specific Conductance (SC) (μS/cm)	247.9
Dissolved Oxygen (DO) mg/l	7.3
pH	7.7
Secchi depth (cm)	130
Total Phosphorus (μg/l)	38.7
TKN (μg /l)	594
TKN:TP	15.3
DIC (mg l^{-1})	11.5
DOC (mg l^{-1})	3.3
CATCH (km^2)	7.8
Chl.*a* (μg l^{-1})	40.6
Silica (mg l^{-1})	3.6

4. DISCUSSION

Subfossil remains of diatoms in sediments of Kandy Lake provide important information of the changes in diatom community structure during the recent past of the lake and the surrounding environment. The remains of the majority of diatoms are pelagic and known to prefer wider environmental conditions. *Cyclotella* species recorded throughout the sediment core known to respond to total phosphorus, conductivity and surface temperature [10]. However at different stratigraphic intervals these dominant taxa fluctuated showing the ability to respond to the environmental changes. In addition to *Cyclotella* sp., *Thalassiosira* sp. also recorded throughout the sediment core however at relatively low abundances. *Thalassiosira* species known to respond to nutrients and also pelagic in nature[10]. Thus, the time period that the sediment core represents appear to host pelagic diatoms. In addition according to the bathymetry of the reservoir, steep slopes also not provide favorable habitats even for benthic taxa. Therefore the lack of benthic diatoms at high abundances is also not surprising. When compare the community turnover, although *Cyclotella*, *Aulacoseira*, and *Thalassiosira* dominated throughout the core, *Fragilaria* species started to appear and become sub dominant especially at the surface and subsurface sediments. Surface sediments known to represent the most recent history and water quality analysis at the time of sampling indicate that the Kandy Lake was eutrophic. Therefore the changes of diatom community towards *Fragilaria* dominant condition could be an indication of nutrient enrichment of the reservoir during the recent history. Thus the most likely explanation for the main and abrupt change of diatom communities could be related to the nutrient enrichment of the reservoir.

In addition, introduction of exotic fish into the reservoir during the past few decades also could increase the nutrient level of the reservoir because the harvesting of fish is prohibited due to social and religious reasons. Studies of nutrient loading in natural lakes through the migration of Sockeye salmon (*Oncorhynchus nerka*) have also been identified using the analysis of diatom community dynamics[11]. Kandy Lake also may have experienced a similar situation of nutrient enrichment due to increase of fish populations. Further, as the fish fry of the introduced fish species, *Oreochromis niloticus* and *Oreochromis mossambicus* feed on planktonic organisms, including phytoplankton and zooplankton. Thus, the dominance of tiny pelagic diatoms could also be a result of the high grazing of larger planktons by the introduced fish in the reservoir.

Consequently the study provides some insights into the environmental changes of the study area through diatom community dynamics showing the potential for using diatom as indicator organisms which can be applied in qualitative environmental studies. However dating of the sediment core is essential for quantitative environmental predictions which need to be done in the future.

5. CONCLUSION

Distinctive variations of diatom species composition were observed throughout the sediment core of the Kandy Lake. These changes were more likely to be associated with chemical (e.g. nutrients) factors. Therefore the current study signify the potential use of diatoms to infer past environmental conditions in Kandy Lake, Sri Lanka.

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