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Review Articles

Research Articles

Research Article

AN ASSESSMENT ON ABUNDANCE OF AQUATIC INVASIVE PLANTS AND THEIR MANAGEMENT IN BEESHAZAR LAKE, CHITWAN

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ABSTRACT

Biological invasion have been a serious threat to global biodiversity, leading to global environmental change. These scenarios are well reflected even in the protected lakes. Invasion by the alien species has been the second leading problem, first being draining the water in Beeshazar Lake, Chitwan. The excessive growth of these species is probably due to the high nutrients level in the lake. Under these circumstances, this study was carried out to prepare checklist of alien invasive species, appraise species-wise status of aquatic invasive species, and document existing practices for controlling them in the Beeshazar Lake, Chitwan. Systematic sampling was used in which 39 plots, each with size of 1m × 1m, to count the grass species, were laid out at 58m interval. This process was facilitated by Arc GIS software. Frequency, relative frequency, and abundance of species were calculated to find the status of species. A total of six species were recorded among which *Eichhornia* was the most frequent (F=79.4; RF=35.6) and abundant, (A=18). As this research was done during dry season, species found during wet season were not considered. Mechanical control measure could be possible to control weeds whereas invasive plants were pulled out manually, or by machine. However, growth of *Ludwigia* amd *Lemna* were challenged by this removal activity; *Azolla* and *Argeratum* were more or less affected whereas *Eichhornia*, *Leersia* and *Cyperus* were not affected by this measure.

Key words: Aquatic invasive species, beeshazar lake, frequency, abundance, management.

INTRODUCTION

Biological invasion have been a serious threat to global biodiversity leading to global environmental change. Many human activities accelerates the intentional and accidental spreads of species (agriculture, aquaculture, recreation, transport), disturbing the natural phenomena of dispersal (Vitousek et al. 1997). Control, prevention and eradication of biological invasions are the main factors to consider for the conservation of the environment worldwide.

Invasive species disperse widely- colonizing and invading the native ecosystem, becoming very abundant and causing harm to the ecosystem; to its goods and services. The invasive alien species has ecological and evolutionary as well as economic impacts, especially in agriculture and forestry (Pimentel et al., 2000). Likewise, the alien species such as water hyacinth (*Eichornia crassipes*), Kumbhika *(Pistia stratiotes*), Karaute Jhar (*Leersia hexandra*), Mothe (*Cyperus* sp.) are the major hindrance for conservation of wetland in Nepal.

Beeshazar and associated lakes is the important Ramsar area listed wetland, situated in the buffer zone of Chitwan National Park (CNP), adjacent to Khageri Irrigation Canal, within the Barandabhar forest patch. Invasion by the alien species has been the second leading problem in the lake. Major part of the lake is visibly covered by these invasive species Public recreation opportunity and experiences have been severely degraded by rapid infestation of invasive species (Thomas, 2003). The lake therefore demands concerted attention towards a clear understanding of its ecosystem in order to mitigate further deterioration

Many of the research and conservation are focused on the terrestrial invasion elsewhere. There is, currently, little information available about wetland invasive plants. This research focuses on creating the baseline for further research regarding quantification of invasive species, and for the updated information to the planners and policy makers for future planning. The main objective of this research was to recognize and list out the invasive plants encountered on the surface of the wetland; assess abundance of invasive plants contained in the lake, and determine their management practices implemented in the study area focusing to the Beeshazar Lake, Chitwan.

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MATERIALS AND METHODS

Study Area

This study was carried out in Beeshazar Lake which is situated in Gitanagar, Chitwan occupying about 100 ha. of land. It is an extensive, typical oxbow lake system of the tropical Nepal inner Terai, lying inside buffer zone of Chitwan National Park, a World Heritage Site situated in Gitanagar, Chitwan. The Khageri River is the main natural drainage of the Beeshazaar and Associated Lakes. The main source of water throughout the year is Khageri canal and during monsoon season, precipitation increases the water level. The overall catchment area of the lake helps in ground water recharge.

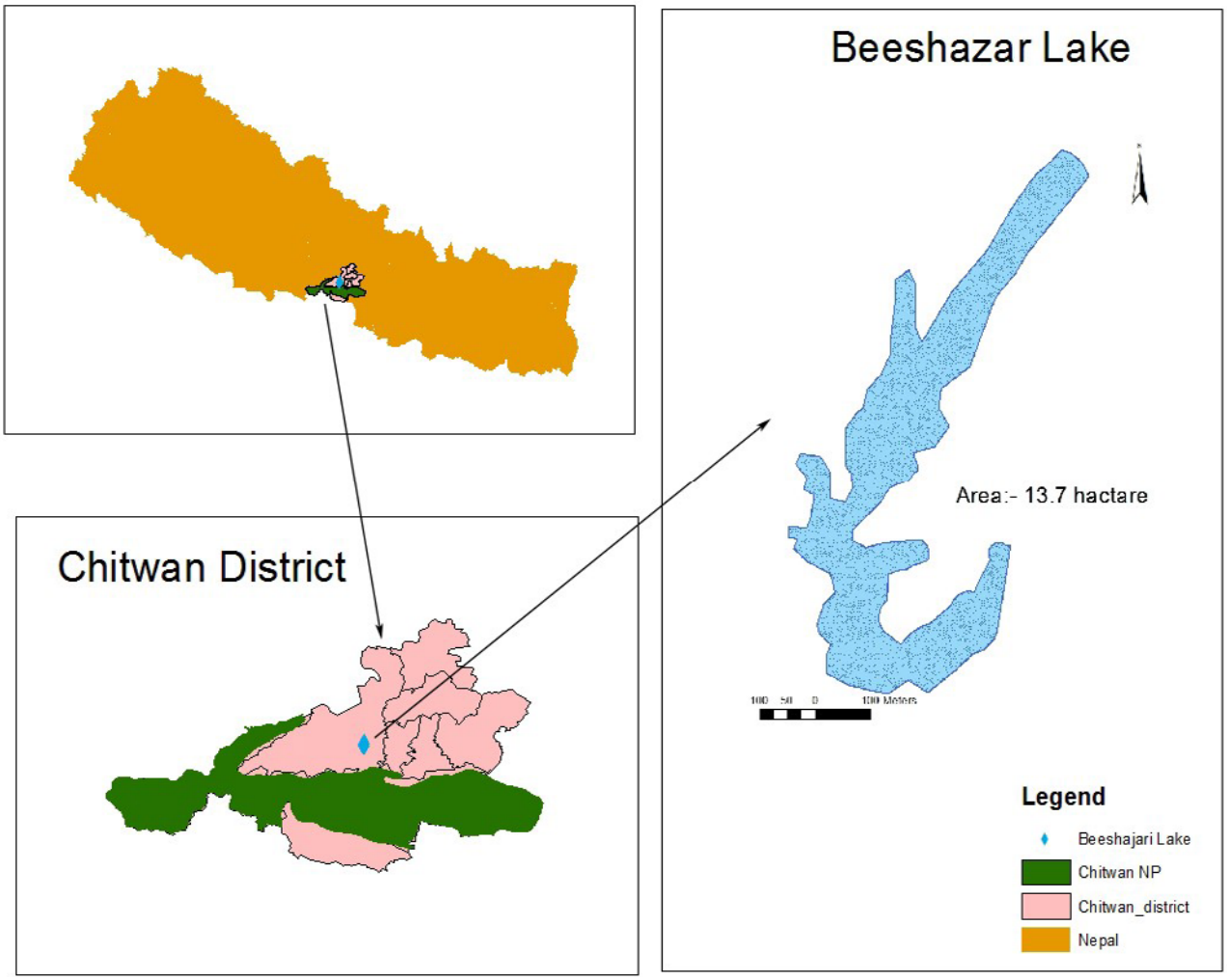

Figure 1. Map of Beeshazar Lake

Data collection

Both primary and secondary data were collected in this study. Primary data were collected by direct field observation and key informants' interview. Applying point intercept method, systematic sampling was done covering total of 3% area, using 1m × 1m sized quadrate, which was used by following wetland resource inventory guidelines (Krebs, 1999). There were a total of 39 quadrates, each in 58 meters gap (Figure 2). Number of quadrates and spacing between them were adjusted with the help of Arc GIS software. Likewise, secondary data related to this study were collected through relevant literature survey- journals, publications, and reports of Beeshazar and associated lakes.

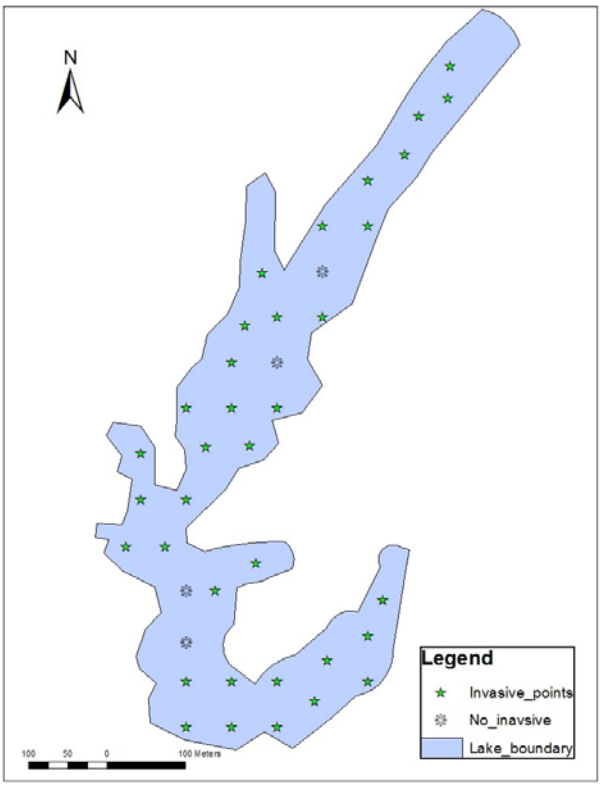

Figure 2. Distribution of the sample plots in the study area

Data analysis

For each species, data were analyzed to find frequency, relative frequency, and abundance. Quantitative parameters of floating invasive plants of Beeshazar Lake were determined (Curtis and McIntosh,1950).

$$\text{Frequency (F)} = \frac{\text{No. of sample units where the species occured}}{\text{Total no. of sample units}} \times 100\%$$

$$\text{Relative Frequency (RF)} = \frac{\text{Frequency of one species}}{\text{Sum total of all frequencies}} \times 100\%$$

$$\text{Abundance (A)} = \frac{\text{Total no. of individual of the species}}{\text{No. of sample plots in which they occur}}$$

RESULTS AND DISCUSSION

A total of six invasive species, belonging to the six different genera were recorded in the study area (Table 1). Out of six species, three species, viz. *Cyperus*, *Trapa* and *Azolla* were native whereas remaining three species were alien (Table 2).

Table 1. List of aquatic invasive species, in Beeshazar Lake, Chitwan

Botanical name	Local name	Common name	Status	Family	Inference
Eichhornia crassipes	Jalkumbhi	Water hyacinth	WG	Pontederiaceae	-
Leersia hexandra	Karaute jhar	southern cutgrass	WG	Poaceae	-
Cyperus spp.	Mauth jhar	Sedge	W	Cyperaceae	-
Trapa quadrispinosa	Singada	Trapa	WG	Trapaceae	-
Azolla imbricate	Bandaa jhar	Water velvet	WG	Salviniaceae	-
Argeratum conyzoides	Gande	Goat weed/ white weed	W	Asteraceae	Appear on boggy surface

Note: WG, Water grass; G, grass; W, Weed

Table 2. Origin of the species in Beeshazar Lake, Chitwan

Species	Origin
Eichhornia crassipes	Alien (native to the Amazon basin)
Leersia hexandra	Alien (native to Asia-Tropical, Africa, Southern America, Australia, Northern America and Asia-Temperate)
Cyperus sp.	Native
Trapa quadrispinosa	Native
Azolla imbricate	Native
Argeratum conyzoides	Alien(native to Tropical America, especially Brazil)

(Source: GRIIS, 2017; GON, 2016)

Frequencies of aquatic invasive species

Eichhornia and *Leersia* were found the most frequently occurring species followed by *Cyperus* throughout the lake. *Trapa* was occasionally found whereas *Azolla* and *Argeratum* were rare (Table 3).

Table 3. Frequency of species in Beeshazar Lake, Chitwan

Species	Frequency	Relative Frequency (%)
Eichhornia crassipes	79.4	35.63
Leersia hexandra	74.3	33.33
Cyperus spp.	51.2	22.99
Azolla imbricate	5.1	3.45
Trapa quadrispinosa	7.6	2.29
Ageratum conyzoides	5.1	2.29
Total	**223.08**	**100**

Abundance of aquatic invasive species

Eichhornia and *Leersia* were highly abundant species in the lake. Moderate presence of *Cyperus* sp. was found whereas *Trapa, Azolla* and *Argeratum* were rarely present (Table 4). These species were more abundant towards the bank and side of lake, and less present in the centre where the depth of water was more. Decreasing water depth increases the presence of aquatic plants as well as marsh and wet meadow species in shallower waters, representing appropriate conditions for all species groups. Similar result was also found in the study done by Khanday (2015).

Table 4. Abundance of species in Beeshazari Lake, Chitwan

Species	Abundance
Eichhornia crassipes	18
Leersia hexandra	13.8
Cyperus sp.	8.9
Trapa quadrispinosa	2
Azolla imbricate	3.5
Argeratum conyzoides	2.5

Management efforts

Management activities were performed by Beeshazar lake management committee and the National Park for more than 10 years. Physical removal of grass by labour was done, daily in Satrahajari and Beeshazar lakes. Two labors were hired for this work; they used to enter in the water on boat and manually pull the grass towards the bank. Boating is strictly prohibited inside the lake; it is done only for cleaning purpose. Removed grass from the water used to keep in the bank of lake, and some portion used to take for organic company, Jagatpur. These residues were used for making organic fertilizers, biochar. Budget for these activities came from donation of various organizations and the entry fee by the visitors. Annually, 10/12 hack of grass used

to remove. Removal by machine was very rare activity, due to lack of humanresource and techniques.

According to the key informant interviewed, "the lake was highly covered with these species until last 3 years; water hyacinth being the main covering species. However, at present, lake area is more open due to the daily removal activity.

In wetlands of Tarai, Siwalik and Mid Hills, *Eichhornia crassipes* is the most problematic invasive alien plant species, disturbing the biodiversity and beauty of many Ramsar listed, or other wetlands (Shrestha, 2016); as is in the case of this study, where Beeshazar lake is mostly invaded by *Eichhornia.* This fact is also supported by Burlakoti (2006) in his study. E. crassipes was not reported in the earlier studies of Beeshazar Tal (BPP 1995, Bhandari, 1998a & 1998b). Its current dominance may be ascribing to its invasive nature and also its preference for highly eutrophic and stagnant water.

Earlier studies revealed the fact that site management plan of Beeshazar lake (GON, 2010) and biodiversity profile of Beeshazar and associated lakes, Chitwan (Lamichhane et al.,2016) were equally dominated by other floating plants like *Nelumbo nucifera* (Red Kamal), *Ipomoea carnea* (Morning glory), and *Ludwigia adscendens, Lemna sp*. (Duckweed). But, in the case of winter period, as revealed from this study findings, the plants grown in wet season were not encountered. *Ipomea carnea* which only grows in wet season, was not present during this study period. According to Herbal Resource (2018), *Lemna sp*. (Duckweed) floats on the surface during the summer months, but sinks to the bottom in the fall and then rises to the surface when spring comes. The other two, in spite of being the perennial species, were absent due to the effect of management, i.e, they were removed faster than their germination period.

CONCLUSION

A total of six species of aquatic invasive plants were found in the Beeshazar Lake. These species are floating plants on the surface. *Eichhornia* and *Leersia* were the most frequently occurring as well as highly abundant species with high invasion. Considering the whole lake scenario, *Azolla* and *Argeratum* were rarely found. The findings reveal that the most important species to be managed in the area are water hyacinth, *Leersia*, and sedge. High growth of these species reveals the productive nature of the lake, and decomposition of these species reduces the water quality as well as the core area of the lake, and promotes the encroachment of littoral vegetation. However, growth of some species (*Ludwigia, Lemna*) are challenged by removal activity- *Azolla, Argeratum* were more or less affected in their existence whereas *Eichhornia, Leersia;* and *Cyperus* species were not affected by this measure. This clearly signifies that current management practice is not sufficient for reduction of invasion by these species.

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