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Impact Assessment of Invasive Alien Plant Species on Chimdi (Barju) Lake of Eastern Nepal

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Abstract

The present study has been carried out to evaluate the impact assessment of invasive alien plant species on Chimdi Lake using focus group discussion method. Chimdi (Barju) Lake is an important wetland in Eastern Nepal, faces ecological challenges due to the rapid spread of invasive alien plant species. Assessing the impact of these species is essential to understand their effects on the lake's biodiversity and ecosystem services and to develop effective management strategies for the conservation of the lake. The lake was found to be dominated by two aquatic IAPS, *Pontederia crassipes* followed by *Ipomoea carnea.* Additionally, eight other terrestrial IAPS (*Ageretina adenophora*, *Chromolaena adorata*, *Lantana camara*, *Mikania micrantha*, *Mimosa pudica*, *Senna occidentalis., Senna tora*, and *Xanthium strumarium*) were also recorded from the lake. Apart from these, there were several more macrophytes and hydrophytes, such as *Nelumbo nucifera, Nymphaea alba, Ipomoea aquatica,* etc., which created a thick layer of peat over lake water. These IAPS characteristics encourage growth and cover in water bodies, which block sunlight, change the chemistry of the water, and also reduce the habitat quality of native water animals and plants.

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Keywords: Ecosystem**,** Focus Group Discussion, Habitat Quality, *Pontederia Crassipes*, Wetland

INTRODUCTION

Wetlands are among the most productive and vulnerable ecosystems in the world, have fundamental ecological functions, and play an irreplaceable role in the maintenance of biodiversity and human development (Söderqvist et al., 2000; Vélez et al., 2018; Chen et al., 2019). Despite the relevant departments' efforts to restore natural wetlands for human well-being (Wang et al., 2012), global change and intense anthropogenic pressure have destroyed more than half of global wetlands during the last century (Davidson, 2014). The impacts of invasive plant species on wetland ecosystem may be more severe as they increase both in numbers and extent, and as they compete for diminishing resources such as water and soil minerals. Invasive alien plant species can threaten those basic needs and compromise ecosystem functions by taking advantage of habitat disturbance, species under stress, and other weaknesses in otherwise healthy systems. This affects the multiple roles of ecosystems in providing provisioning, regulating, supporting and cultural services (MEA, 2005). Therefore, global efforts are being made to control these invaders. Whatever the cost may be, the unintended spread of invasive species continues unabated, despite the earnest efforts are being made to manage them (Sankaran et al., 2005).

Nepal is rich in wetlands and consists of almost 5358 wetlands distributed in different ecological belts and altitude; 51% lakes are recorded in lowland (<500m), 42% lakes above 3000m and 7% lakes in between 500m to 2999m (Bhuju, et al., 2009). Among these wetlands, 10 wetlands are designated as Ramsar sites of international importance (MoFE, 2018). These wetlands are rich in biodiversity and equally known for spectacular environment (Gautam et al., 2014). Invasive Alien Plant Species (IAPS) are known to lead to the fragmentation, destruction, alteration and even the complete replacement of habitats often resulting in consequences to the functional collapses of the native ecosystem. They are recognized as the 2nd greatest threat to the biodiversity in homogenizing the world's flora and fauna, and widely known to be one of the major agents of changing native biodiversity (MEA, 2005) resulting to enormous economic losses (Mooney & Hobbs, 2000).

Invasive alien plants in Pokhara Valley wetlands have disrupted ecosystem services and economies, causing a loss of essential plants, reduced biodiversity, and discouraged tourism, emphasizing the need for proper management and restoration (Pathak et. al., 2021). The study of nineteen wetlands in Kanchanpur district, Nepal, identified four invasive alien plant species (IAPS) in nineteen wetlands, with *Eichhornia crassipes* being the most frequent. The majority were invaded, with the main pathway being intentional introduction to feed fishes (Bhatt & Shrestha, 2021). Like these studies, in order to provide crucial information for sustainable management and ecosystem conservation, the study has been designed to assess the effects of invasive species on the biodiversity and local communities of the Barju Lake in Sunsari, Nepal.

MATERIALS AND METHODS

Study area

The study was conducted in Chimdi (Barju) Tal which is located in Barju Village Rural municipality of Sunsari district of Nepal; 15 km west from Biratnagar metropolitan city of Morang district (Figure 1). It has an area of about 101.6 hectare. Its geographical coordinates are 87°10'51.3" E longitude and 26°29'23.5" N latitude. It is situated at an elevation of 70m above mean sea level. It is approximately 12 km west of the Biratnagar, the capital of Koshi province. It is located 70 m above the mean sea level (Das, 2017).

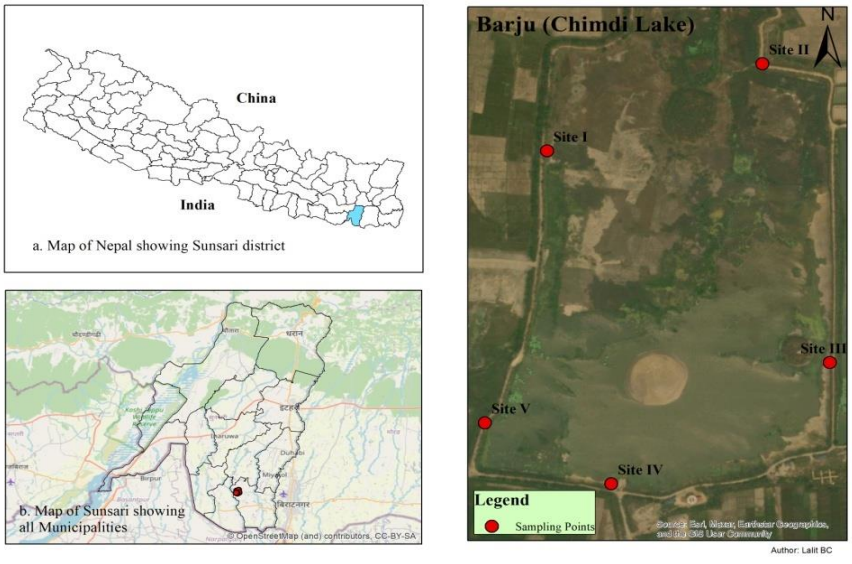


Figure1: Map of Barju Lake of Sunsari, Nepal

Data collection:

Focus Group Discussion (FGD) for Invasive Alien Plant Species

One of the most important information collection methods in qualitative investigation has been the focus group discussion (Dilshad & Latif, 2013). The focus group discussions (FGDs) methods have been used to learn how locals perceived the effects of IAPs and to record any efforts made by the community to help Nepal's government prioritize the management of IAPs. FGDs are often conducted with groups of five to ten people who have comparable backgrounds or experiences, concentrating on a small number of subjects to highlight the variety of their viewpoints (Taylor et al., 2016). Participants in the FGDs were first given information about invasive species and their possible effects on the environment and way of life before the FGDs, which were conducted in Nepali with the help of 26 IAPs' colour photo. FGDs were conducted among local communities and board members of the "Chimdi Barju Lake Wetland Development and Conservation Committee " (CBLWDCC) of the municipality.

For the documentation of IAPS from Barju Lake, samples of each IAPS were gathered to prepare the herbarium for confirmation and identification. The identification of the herbarium specimens down to the species level was made possible with the help of applicable publications (Tiwari et al., 2005). The significance of invasive species and its possible impacts on the environment and way of life were first explained to the participants in the FGDs, which were done in Nepali language and local language with the help of color photos of 26 IAPs (Shrestha, 2016).

The following topics have been addressed in-depth during the FGDs: 1) general awareness of IAPs, the number and names of IAPs found in agro- and natural ecosystems, 2) the detrimental effects of these identified IAPs, 3) the uses and benefits of IAPs, 4) the management efforts made by local communities to control IAPs, 5) prioritization of the top three problematic IAPs in agro and natural ecosystems based on impacts and management need, and 6) willingness to manage IAPs.

RESULTS AND DISCUSSION

The present study has been carried out to access the impacts of invasive plant species on the Chimdi lake of Sunsari district. The lake was found to be dominated by two

aquatic IAP species, *Pontederia crassipes* Mart. which falls on the list of 100 worst invasive species in aquatic system followed by *Ipomoea carnea* Jacq. Additionally, eight terrestrial IAPS (*Ageretina adenophora* (Spreng.) King & H. Rob., *Senna occidentalis* (L.) Link, *Chromolaena adorata* (L.) R. M. King & H.Rob., *Lantana camara* L., *Mikania micrantha* Kunth, *Mimosa pudica* L., L., *Senna tora* (L). Roxb. and *Xanthium strumarium* L.) were also recorded from the lake (Table 1). In addition to these, there were several more macrophytes and hydrophytes, such as *Nelumbo nucifera* Gaertn, Nymphaea *alba* L., and *Ipomoea aquatic* Forssk etc. which act as a thick layer of peat over lake water.

Table1. List of IAPS plants reported from the Chimdi Lake

Scientific name	Common name	Local name	Family	Native	Reported in Nepal*
Ageretina adenophora (Spreng.) King & H. Rob.	Krofton weed	Kalo banmara	Asteraceae	Mexico	1952
Chromolaena adorata (L.) R. M. King & H.Rob.	Siam weed	Seto banmara	Asteraceae	Mexico, C & S America	1825
Ipomoea carnea Jacq	Bush morning glory	Besharam	Convolvulaceae	Mexixo, C & S. America	1966
Lantana camara L.	Lantana	banfada	Verbenaceae	C & S America	1848
Micania micrantha Kunth	Mile-a-minute weed	Lahare banmara	*Asteraceae*	C & S America	1963
Mimosa pudica L.	Sensitive plant	Lajjawati	Fabaceae	Mexico to S America	1910
Pontederia crassipes Mart.	Water hyacinth	Jal kumbhi	Pontederiaceae	South America	1966
Senna occidentalis (L.) Link	Coffee senna	Thulo tapre	Fabaceae	Tropical America	1910
Senna tora (L). Roxb.	Sickle pod senna	Sano tapre	Fabaceae	Central America	1910
Xanthium strumarium L.	Rough cockle-Bur	Bhede kuro	Asteraceae	America	1952

*Source: Shrestha (2019)

Impacts of IAPS on Wetland

FGD identified the effects of IAPS on wetland. IAPS effects, such as their high economic cost to remove, influence on native flora and fauna, loss of biodiversity, difficulty fishing, impact on recreational values, and decrease of appetite in some animals, can be considered during FGD (Shrestha *et al.*, 2019). These IAPS traits promote growth and cover in water bodies, which prevent sunlight from entering the water and alter its chemistry (Bassett et al., 2012; Mujere, 2016). Additionally, this decreases the available habitat for local aquatic plants and wildlife (Sharma and Bachheti, 2013). According to Zimmels et al. (2006), the thick mat in the aquatic body produces a breeding ground for pathogens and mosquitoes that is detrimental to the spread of human illnesses.

Dispersal Pathways and Control Measures

Pontederia crassipes Mart. and *Ipomoea carnea* Jacq were primarily introduced to reduce Lake Bank erosion before about 40 years ago. It was therefore regarded as the most significant channel for the spread of invasive plant species in Barju Lake. Due to their lovely flowers and decorative purposes, these species were introduced to Nepal (Tiwari et al., 2005). IAPS multiply quickly and reproduce both sexually and asexually (Zhu et al., 2015; Gopal, 1987).

IAPS can have beneficial impacts in their use can also have negative consequences, creating a conflict of interest in how they are managed. Due to the severity of their effects on the environment, economy, society, and aesthetics, harmful IAPS must be managed. Eradication is very difficult and expensive in extreme situations of invasion when IAPs exhibit significant vegetative reproduction and are dispersed across vast regions. Therefore, it should be a top priority to contain invasive populations and prevent their spread through efficient measures.

The three primary methods for managing invasive species are control, eradication, and prevention (Radocevich et al., 2009). Prevention entails limiting the entrance of potentially invasive alien species and necessitates stringent quarantine and continuous observation. Eradication is the total elimination of an invasive species from its native habitat or geographic area, and it is only achievable when the species is restricted to a limited area. However, because invasive species grow quickly and cover wide regions, by the time management recognizes the issue and begins to take action, it is frequently too late

to eradicate the problem. Control entails limiting the number of invasive species in the area that has been invaded and halting their spread to lessen their negative effects on the ecology and economy. It may or may not lead to the eradication of some species from a certain area.

Physical removal of IAPS has been used in wetlands. For instance, with varying degrees of success, *Pontederia crassipes* is routinely eradicated from the Bishajari lake system (a Ramsar site) in Chitwan, Taudaha of Kirtipur Municipality in the Kathmandu valley, Phewa and Begnas lakes of the Pokhara valley, etc. A local women's organization in the Pokhara valley has exploited the biomass of *E. crassipes* to create handcrafted products like pen holders, handbags, dust bins, etc. (Anonymous, 2015). Due to widespread water diversion, invasive species introduction, excessive harvesting, industrial pollution, and climate change, half of the world's wetlands have been destroyed, and the remaining ones are being deteriorated (Carpenter et al., 2011).

CONCLUSION

The lake was found to be dominated by *Pontederia crassipes* Mart. which falls in the list of 100 worst invasive species in aquatic system (Lowe *et al*., 2000) followed by *Ipomoea carnea* Jacq. Based on the results of this study, it can be said that immediate action is needed to take effective steps to stop the further entry as well as to remove all the IAPS from the habitat of Chimdi Lake. A significant number of different macrophytes and hydrophytes, such as *Nelumbo nucifera* Gaertn, Nymphaea *alba* L., and *Ipomoea aquatic* Forssk etc**.** present as a thick peat should be removed for the betterment of aquatic life as well as the quality of lake water. The proliferation of these species has disrupted the lake's natural ecosystem, leading to a decline in native biodiversity and degradation of water quality. The invasive plants have altered habitats, threatening both aquatic and terrestrial life by outcompeting native species for resources such as sunlight, nutrients, and space. This ecological imbalance has further strained ecosystem services, such as water purification and fishery resources, impacting the livelihoods of local communities who depend on the lake for sustenance and income.

Additionally, the study underscores the urgent need for effective management and control measures to mitigate the spread of invasive species. Public awareness and community engagement are critical in controlling these species and restoring the lake's

ecological health. Restoration efforts should focus on the removal of invasive plants, rehabilitation of native species, and the implementation of long-term monitoring programs. Without timely intervention, the degradation caused by invasive species will continue to accelerate, posing long-term threats to both the environment and the socio-economic well-being of the surrounding population. The findings emphasize the importance of integrated approaches to biodiversity conservation, ecosystem management, and sustainable development of Chimdi Lake.

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