

Identification of the threat from Invasive Alien Terrestrial Floral Species in Bellanwila Attidiya Sanctuary

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ABSTRACT

Invasive Alien Species (IAS) are, a problem because they have capability to thrive and spread aggressively outside their natural range. Plant invaders decrease richness and abundance of native species by preventing seedling establishment, inhibiting growth and evolution, modifying plant-pollinator interactions, increasing above and below ground competition and swamping native gene pools *via* interbreeding with native species of the environment. Within last few decades' terrestrial and aquatic invasive alien species rapidly spread in Bellanwila Attidiya sanctuary. Identification of the threat of terrestrial flora species and preparation of a threat map for terrestrial invasive species are the objectives of this research. To achieve these objectives, Stratified Random Sampling Method, Geographical Information System (GIS), Participatory Mapping, Satellite image Comparing, Geographical Positioning System (GPS) technology and field observations were used in the main five sites with 100 random validation GPS points. *Annona glabra* was the main terrestrial invasive species of the Bellanwila Attidiya Sanctuary and *Lantana camara* and *Tithonia diversifolia* were partially present.

Key Words: Invasive alien plant species, Bellanwila Attidiya Sanctuary, *Annona glabra*, *Lantana camara*, Sri Lanka

INTRODUCTION

Sri Lanka is also facing the threat of extinction of its native flora and fauna similar to that which is taking place in the rest of the world. Many species of animals, plants and other organisms are disappearing due to impacts of direct or indirect human activities. The major activities that contribute directly to disappearance of biodiversity are loss of habitat, global warming, and Invasive Alien Species (IAS). Compared to other factors IAS appears to be largely responsible for loss of many populations of plants in Sri Lanka (Ratnayake, 2008). Alien plant species are defined as “taxa in a given area whose presence is due to intentional or unintentional human involvement or which have arrived there without the help of people from an area in which they are alien” (Pysek et al 2004). In plant ecology, the term invasion is commonly used for situations where the distribution and abundance of plants results from human activities. Where such changes take place under other conditions such as after the retreat of glaciations, the terms migration, spread, range expansion or range extension are used (Cohen and Goward 2004).

IAS CONTEXT IN SRI LANKA

There have been a few attempts to compile lists of invasive alien flora in Sri Lanka (Wijesundara 1999; Bambaradeniya 2002; Marambe 2000). The main drawback of these attempts is the lack of proper criteria to determine the invasive nature of the listed species. Others have either documented the spread of several invasive alien plants in a specific locality (Ratnayake 2008), or the spread of a single invasive alien plant species in different localities (Marambe et al 2000a, 2000b; Hitinayake et al 2000; Pushpakumara & Hitinayake 2001; Medawatte et al 2008). Sri Lanka is blessed with a wide array of vegetation types distributed in diverse climatic zones. Some IAS are specific to certain types of ecosystems or climatic zones while others are widely distributed.

According to the IUCN Invasive Species Specialist Group's (ISSG) Global Invasive Species Database, 82 potentially invasive species are present on the island. More than 60 of these species are known to have become invasive comprising nearly 40 species of invasive alien flora and 20 fauna. The major impacts of these IAS in Sri Lanka include direct exploitation or destruction of native species, superior competitors for resources, hybridization with native species, agricultural and other pests, increase fire hazards in natural areas, interference with ecosystem services and facilitation of the spread of other alien species (IUCN 2005).

The vegetation of Bellanvila Attidiya Sanctuary area is mainly composed of rooted emergents such as *Rhyncospora* sp., *Eleocharis* sp., and grasses such as *Brachiaria* sp., *Bacopa* sp. that grow extensively along the fringes of ponds. The water surfaces are covered with *Salvinia molesta*, *Eichhornia crassipes* and flowering ornamental species such as *Nymphaea* sp and *Nelumbo nucifera*. The margins of marshy areas and the banks of the canal are covered with a mixed vegetation of *Annona glabra*, *Cerbera manghas*, *Syzygium* sp., *Melastoma* sp. (Maduranga, 2005).

OBJECTIVES

Main objective of the study was to identify the threat of invasive alien terrestrial flora species in Bellanvila Aattidiya Sanctuary and to prepare a threat map for IAS (terrestrial flora) in selected areas.

METHODOLOGY

As there are no previous records on spatial distribution analysis of IAS terrestrial flora in Bellanvila Attidiya Sanctuary (BAC) using GIS (Geographic Information System), GPS (Global Positioning System) and Remote Sensing tools this is as far as we are aware the first such study.

To achieve the objectives, the data collection methods were divided into two main parts, one being a ground survey and the other a remote sensing analysis using Google images. Bellanvila Attidiya Sanctuary is a main biodiversity hotspot in wetland in western province. As well according to the field observation after 2010 invasive species rapidly growth, and this is the one of important wetland in the urban area therefor among the other wetland selected the Bellanvila Attidiya Sanctuary. This study was carried out from 2016 January to December and full of study area divided into five major sites according to the different land use patterns of study index calculation. Every identified sites of the Sanctuary were assessed via few approaches found in literature including diversity indices, Abundance Index and the important value index. Stratified random sampling of three 20 m x 20 m fifteen plots to cover the study area and three plots per sites was used for obtaining data on density, frequency and cover using the Braun-Blanquet cover abundance ratings of invasive alien shrubs (Mullellor-Dombois & Ellenburg 1974). Species composition of Invasive Alien Terrestrial Flora Species in the sanctuary also determined and listed.

Site number 01 consist with the Bellanvila temple, part of the wetland, shops and some sheltors and site number 02 and 04 consist with the home gardens and abundance land. Site number 03 consisted of home garden, some factories, and Rathmalana Air port and abundance lands. Sites number 05 consist with the full of wetland. According to these variations; will be calculate how the invasive species consist the diferance land types.

The primary and secondary data were used for this research. Ground survey data were obtained as primary data. Google images and 1:50000 data were used as secondary data. The data were subjected to diversity analyses using the indices below.

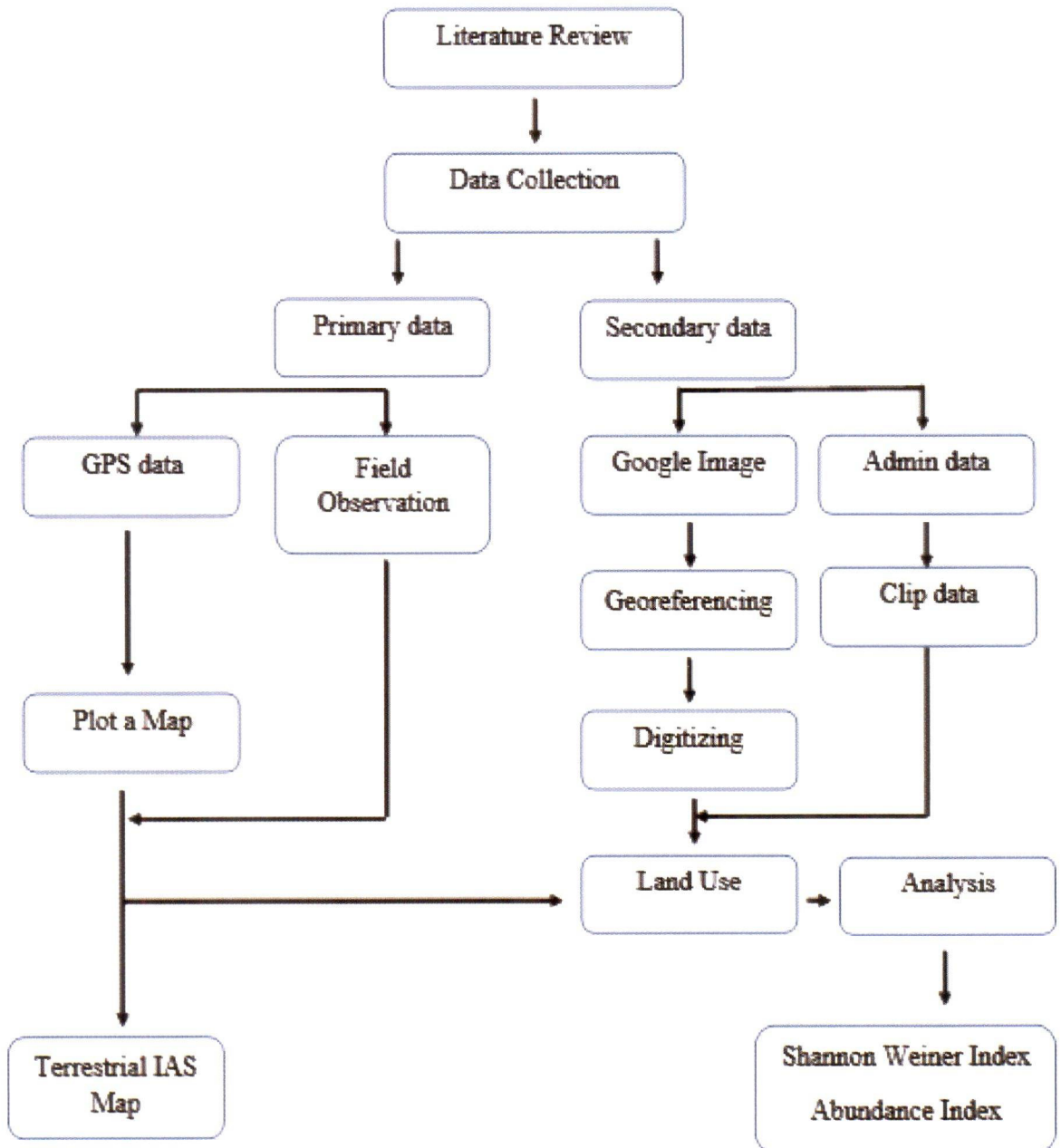
$$\text{Shannon Wiener Diversity } e^H = - \sum_{i=1}^S \left(\frac{n_i}{N} \right) \ln \frac{n_i}{N}$$

Shannon evenness indices = $E = H / \ln S$

Where, S = number of IAS, N = total number of individuals of IAP, n_i = number of individuals of i^{th} invasive plant in each study zone (Mullellor- Dombois & Ellenburg 1974).

Further, Abundance Index (AI) of each invasive shrub species was calculated according to Moeini, Baghestani, & Mashhad (2008). Three quantitative measures (frequency, field uniformity and mean field density) were used to determine AI.

Figure 01 - Flow Diagram of Methodology



The margins of marshy areas and the banks of the canal are covered with mixed vegetation of *Annona glabra*, *Cerbera manghas*, *Syzygium sp.*, *Melastoma sp.*, and also exotic species such as *Lantana camara* (Goonatilake, 1994). The data from Google Image software were used to identify *Annona glabra*, *Chromolaena odorata*, *Lantana camara*, *Panicum maximum* and *Tithonia diversifolia* in the Bellanwila Attidiya Sanctuary. For obtaining *Annona glabra*

historical status, Google Images and participatory mapping was applied. A validation mechanism was used to check accuracy of identified ground objects in the map with actual ground objects. The accuracy value of *Annona glabra* identification was 85 %. The accuracy value of identification depends on the numbers of GPS points obtained for a particular species. The resolution of Google Images is 15m. Resolution also directly affects accuracy value for a given species. Based on this methodology, the total cover of *Annona glabra* in 2016 was 86.32 ha while it was 69.23ha and 62.38 ha in 2010 and 2005 respectively. Compared to the other IAS terrestrial flora species, *Annona glabra* had the highest accuracy of identification using GIS and GPS technology.

Shannon Wiener Index, Abundance Index show different invasion capacities between *Annona glabra* and other invasive plants. According to Shannon Wiener index, species richness and evenness were highest on Site one. A lower value was recorded in Site three. According to the Shannon Wiener index and relative abundance, *Annona glabra* was identified as the most aggressive invader in Bellanvila Attidiya Sanctuary.

Table 1-The area covered by Terrestrial IAS Flora and their percentages in 2016

Invasive Alien Terrestrial Floral Species	Area (m²)	Percentage (%)
<i>Annona glabra</i>	863214	23.20
<i>Chromolaena odorata</i>	1519	0.040
<i>Lantana camara</i>	1525	0.040
<i>Panicum maximum</i>	1911	0.051
<i>Tithonia diversifolia</i>	1269	0.034

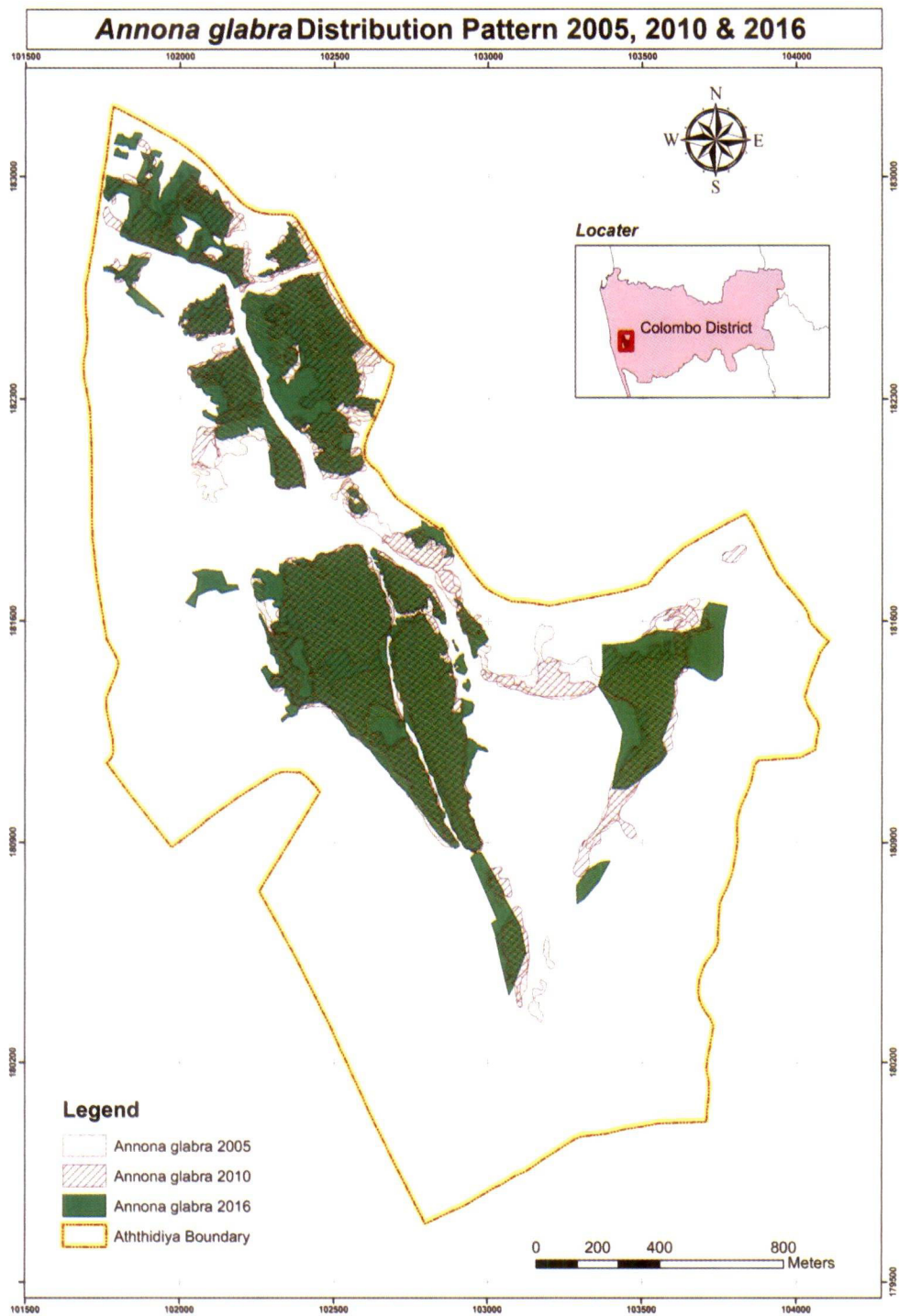


Figure No - 2 *Annona glabra* distribution pattern from 2005, 2010 & 2016

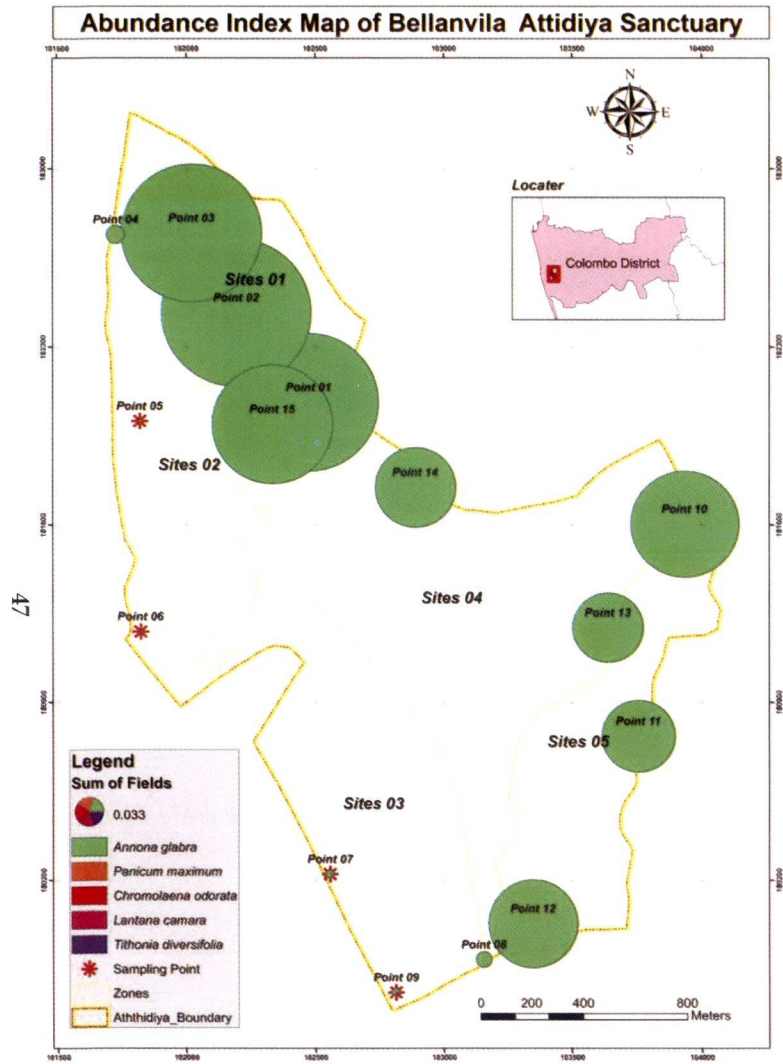


Figure No.3- Abundance Index Map

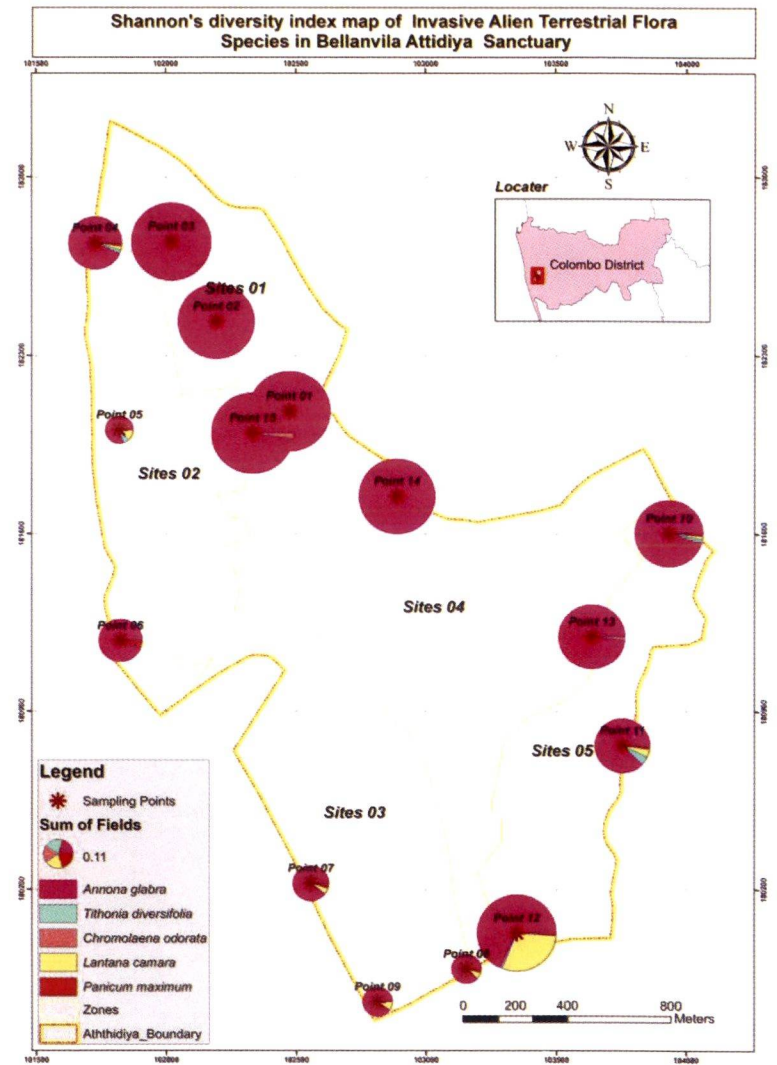


Figure No - 04. Shannon's Diversity Index map

Table 2-Analysis of Invasive Alien Terrestrial Flora Species - 2016

Scientific Names, English Names (E) and Sinhala Names (S) of Invasive Alien Plants	Sites (S1, S2, S3, S4, S5) Presence of Species (✓)				
	S1	S2	S3	S4	S5
<i>Annona glabra</i> Pond Apple (E) Wel Aththa (S) (Annonaceae)	✓	✓	✓	✓	✓
<i>Tithonia diversifolia</i> Mexican sunflower (E) Kuda Sooriya kantha (S) (Asteraceae)				✓	
<i>Lantana camara</i> Prickly Lantana (E) Higuru/Gandapana (S) (Verbenaceae)		✓	✓		✓
<i>Chromolaena odorata</i> Siam weed (E) Podisinchomaran (S) (Asteraceae)		✓	✓		✓
<i>Panicum maximum</i> Guinea grass (E), Gini Thana (S) (Poaceae)	✓	✓		✓	✓

CONCLUSIONS AND RECOMMENDATIONS

According to data from Google Images, the growth rate of *Annona glabra* is 5% annually. The vulnerability of the *Annona glabra* is minimising the biodiversity of the wetland and it has rapidly increased during last decade. The growth rates the other four IAS are very low when compared to that of *Annona glabra*. Our results show that immediate conservation measures are required to protect the Bellanvila Attidiya Sanctuary. The main management measures are to remove IAS from existing sites and replace it using native plants. Examples: *Terminalia arjuna*, *Madhuca longifolia* and *Syzygium caryophyllatum*. Sites Three should have the highest priority, because the current density of *Annona glabra* is lower when compared to that of other sites and it is much easier to remove and control than the other sites. According to the result Site Two should give second priority because these are the moderate IAS density sites and easier control and remove than the high density sites.

Sites number One, Four and Five earliness consist with native biodiversity and currently waste water highly comprise in these area because of these reason high growth of IAS can be identifying.

Lack of information about IAS spreading patterns is directly affecting IAS management activities. Low spatial resolution of satellite images available for this study is one of main limitations of this study. If possible, use of a drone to obtain data for this type of research would be more suitable as it gives greater resolution than satellite images.

This marsh harbours several species of endemic fish, including *Esomus thermoicos*, *Clarias brachysoma*, *Aplocheilichthys dayi* and *Channa orientalis*. Among the amphibians, endemics include *Bufo atukoralei*, *Polypedates cruciger*, *Rana gracilis* while the site also harbours *Rana aurentiaca*. Aquatic reptiles include freshwater turtles (*Melanochelis trijuga*, *Lissemys punctata*) serpents (i.e. *Xenocrophis asperrimus*) and the crocodile (*Crocodylus palustris*). Water birds include uncommon species such as *Pelecanus philippensis*, *Rallus striatus*, *Porzana fusca*, *Gallinix cinerea* and *Rostratula benghalensis*. Rare mammals such as a *Prionailurus viverrinus* and *Lutra lutra* also inhabit this marsh. The endemic mammals *Paradoxurus zeylonensis* has also been recorded.

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