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"Assessment of Invasive Alien Plant Species in Sabaiya Collaborative Forest, Parsa District, Nepal" (A Case Study from Parsagadhi Municipality, Parsa District)

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Abstract

The proliferation of invasive alien plant species (IAPS) poses a critical threat to native biodiversity, ecosystem functions, and sustainable forest management, particularly in ecologically sensitive regions. This study was conducted to assess the diversity, distribution, dominance, and ecological impacts of IAPS within the Sabaiya Collaborative Forest Management (CFM) area in Parsagadhi Municipality, Parsa District, Nepal. A total of 1,594 quadrates of 5×5 m² were surveyed using a systematic random sampling method along with sampling intensity 0.5%. The study identified 20 IAPS belonging to different families, with Asteraceae being the most dominant.

Relative Density (RD), Relative Frequency (RF), Relative Abundance (RA), and Important Value Index (IVI) were calculated to determine species dominance. Among these, Mikania micrantha emerged as the most dominant invasive species, exhibiting the highest IVI, followed by Chromolaena odorata and Parthenium hysterophorus. The results indicate a significant threat to native biodiversity, forest structure, and ecological functions due to the proliferation of these species. The diversity of IAPS in the Sabaiya Collaborative forest represents about 69% of the total IAPS in Nepal.

Based on the Findings, the study recommends urgent need for integrated management approaches, including prescribed burning, regular removal, biological control trails, legal frameworks, and community based awareness programs to control and prevent further spread. This research provides baseline data for future conservation effort and management insights that are vital for forest conservation, policy formulation, and future ecological research on IAPS in Nepal.

Keywords: *ecosystem, dominance, native biodiversity, conservation, proliferation*

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I. INTRODUCTION

1.1 Background

The plants which are capable undergoing proficient proliferation outside their native boundary are called invasive plants (Richardson et al, 2000; Daehler, 2003) which has been introduced to an environment where it is non-native, or exotic, and whose introduction causes environmental or economic damage or harm to human health (IUCN, 2012). An Alien species are non-native, exotic, foreign species, and introduced (IUCN, 2000). Some of the plant species native to one area or region after introduction into the novel area outside their normal distribution might become problematic for native diversity, ecosystem functioning, and for the livelihood of community people. Such species are termed as the invasive alien plant species (CBD, 2009). Generally, the species which show such characteristics display strong vegetative growth, grow in even adverse soil and climatic conditions, and can produce a large number of minute or long-lived seeds (Lee et al., 2018; Mathakutha et al., 2019). They also have a high seed germination rate, rapid maturation of a sexually reproductive stage, and high ability to establish over large areas (Forman and Kesseli 2003; Whitney et al., 2008). The IAPS may be herbs, shrubs, trees, and vines that can grow rapidly, form dense thickets, and negatively impact native species and natural communities (Walker and Smith, 1997; Zenni and Ziller, 2011; Barney et al., 2015).

Due to human–induced factors, whether intentional or unintentional, IAPS are expanding into new areas

that are not native to them (Karki et al., 2023). Anthropogenic disturbances, increasing human movement, global trade, and climate change have increased the intensity of biological invasion worldwide (Lin et al., 2007; Masters and Norgrove, 2010; Beauséjour et al., 2015). A wide variation of climate and geography of Nepal has favored the introduction of several alien plant species in the country. There are 26 alien plant species categorized as invasive members in Nepal (Shrestha et al., 2016). Among these, *Lantana camara*, *Mikania micrantha*, *Chromolaena odorata*, and *Eichhornia crassipes* are among the 100 of the world's worst invasive alien species (Lowe et al., 2000).

Different studies across a wide variety of taxa illustrate that the urban environment supports the quick evolution of species (Thompson et al., 2018, Cadotte et al.,2017) hinted at the higher abundances of invasive species in the urban ecosystems than in the other ecosystems, while (Padayachee et al., 2017) showed that most urban invasive species are purposely introduced. Urban ecosystems can act as surrogates for changes happening across the globe and can predict future conditions (Lahr et al., 2018). Human influence contributes to the disturbance of habitats, making them more vulnerable to invasion, facilitating many invasive plants by freeing nutrients, and by natural disruptions (Davis et al., 2000). Invasive alien species are more widespread along the road side, and anthropogenic influences (Kohli et al., 2009).

Nepal is home to at least 183 naturalized alien plant species of flowering plants, of which 29 species have been considered as invasive alien plant species (Shrestha and Shrestha, 2021; Shrestha et al., 2024; Sankaran et al., 2005) identified *Ageratina adenophora, Ageratum conyziodes, Chromolaena odorata, Eichornia crassipes, Lantana camara, Mikania micarantha, Parthenium hysterophorus* as the most problematic IAPS for Indian forests;all these species have been recorded in Nepal (Shrestha, 2016).Most of the alien plant species are found in the terai Siwalik and Mid-hills of Nepal as more than three-fourth of IAPS recorded in Nepal are native to tropical and sub-tropical regions of the world (Tiwari et al., 2005). The colonization and spread of IAPS have intensified recently due to continued economic development and global climate change (Chen et al., 2023). In this situation, activities regarding the regular monitoring of IAPS, assessing their impacts on native diversity, and control or management of IAPS are an urgent need. The main of the study is to assess some of the basic ecological parameters of IAPS found in Sabaiya Collaborative Forest of Parsa District.

1.2 Rationale/Justification

As biological diversity has grown in significance, alien plants have brought attention to be the issue of decreased biological diversity (Lee et al., 2018). Because of inadequate knowledge, weak policy and management response, invasive species are likely to have a greater impact in developing nations like Nepal (Shrestha, 2019). The distribution pattern, occurrence and colonizing habit of individual IAPS should be thoroughly considered and studied for the management of IAPS (Thapa et al., 2018).

There has been research and documentation on invasive alien plant species in Nepal, still needing more information and documentation of invasive alien plant species (IAPS) in Nepal (Shrestha et al., 2017). We have limited research about IAPS in and around forest of terai region, so this study helps to assess the status and distribution of IAPS in study areas. This study helps to provide the baseline information regarding the IAPS that helps for future conservation and management initiatives against it. Freshwater ecosystems are at high risk of invasion compared to the terrestrial ecosystems as the vulnerability of invasion varies with biotic resistance of ecosystems (Rejmánek and Richardson, 1996). Recently very limited works have been initiated by various institutions like the National Trust for Nature Conservation (NTNC), and the Nepal Academy of Science and Technology (NAST). Biological invasions have been identified as one of the emerging threats to biodiversity and ecosystem services in Nepal (Shrestha, 2019), and are one of the major causal factors of habitat degradation in Nepal (Chaudhary et al., 2016). IAPS in Nepal has grown over time (Shrestha, 2019), and is likely to escalate the majority of Nepal's IAPS climatically suitable range and shift upslope in the future under climate change scenarios (Shrestha and Shrestha, 2019). So, there is a great need to explore and research the status and impacts of invasive species in Nepal and their control measures (Tiwari et al., 2005). Furthermore, scientific data appears to be inadequate to guide management as well as to contribute to the science-policy interface.

Half of the world's wetlands have been lost, and the remaining are degraded due to large-scale water diversion, introduction of invasive species, overharvesting, industrial pollution and climate change (Carpenter et al., 2011). Sabaiya Collaborative Forest is severely colonized by invasive alien plant *Mikania micrantha* and its surrounding also invaded by a number of IAPS. In this situation, activities regarding the status distribution regular

Monitoring of IAPS and assessing their impacts on native diversity is an urgent need. This study helps to fulfill the gap of impacts of these IAPS in the forest and provide the baseline information regarding the IAPS that helps for future conservation and management initiatives against it. Provide critical insights into the extent of IAS invasion, identify hotspot of infestation, and evaluate their ecological and socio-economic impacts.

1.3 Objectives of the study

1.3.1 General objective

The general objective of this study is to assess the invasive plant species found and their impact on native plant species in Sabaiya Collaborative Foreat Management.

1.3.2 Specific objective

1. To identify the dominant invasive species in Sabaiya Collaborative Forest.
2. To find out Importance Value Index (IVI) of invasive alien plant species as a baseline study for further researches.

1.3.2 Research questions

1. What is the diversity of invasive alien plant species (IAPS) in Sabaiya Collaborative Forest?
2. Which invasive alien plant species are ecologically dominant, as indicated by their Important Value Index (IVI)?
3. How do invasive alien plant species affect native plant diversity in Sabaiya Collaborative Forest?

1.4 Limitation of the study

Some of the limitations of the research are as follows:

1. Field surveys were conducted within a limited time frame, potentially missing seasonal variations in invasive species presence.
2. The report primarily assessed plant invasions and did not evaluate impacts on fauna or soil conditions in detail.
3. Inadequate relevant literature regarding the subject matter.
4. Field survey was done only in forest areas where the water resources were available in limited amount.

II. LITERATURE REVIEW

2.1 Invasive Alien Species

Freshwater invasions are of special concern, as freshwater ecosystems are among the most diverse and endangered ecosystems in the world harboring more than a quarter of all freshwater flora and fauna threatened or recently extinct (UNEP, 2011). Although freshwater biodiversity provides wide variety of valuable economic goods and irreplaceable ecosystem services for humanity, it is increasingly threatened by over exploitation, pollution, water flow changes, habitat degradation and invasion by alien species (Dudgeon et al., 2006). Of these threats, the spread of invasive species appears the most severe (Zedler and Kercher, 2004; Olden et al., 2006) and causes considerable damage with cascading effects on structural organization and functional integrity of freshwater ecosystems. Nepal wetlands are the Himalayan water palace, unique, biological hotspots and supermarket of biodiversity (Pokharel and Nakamura, 2010). Wetlands cover roughly five percent of Nepal land area (DOAD, 1992). Nepal has approximately 6,000 rivers and rivulets, including permanent and seasonal rivers, streams and creeks (WECS, 2002).

Human-mediated dispersal of species into new regions is known as biological invasion. Biological invasions are homogenizing the world biota (winter et al., 2010). Invasive alien species are a subset of naturalized alien species which often spread 6 widely from the point of introduction (Richardson et al., 2000; Blackburn et al., 2011) and cause negative impacts on the environment (Blackburn et al., 2014). According to (CBD, 2000) an alien species whose introduction and/or spread threatens biological diversity, are called as invasive alien species. Alien species that have established self-sustaining populations without direct human intervention are naturalized plants (Richardson et al., 2000, Pysek et al., 2004, Blackburn et al., 2011, Essl et al., 2018). Invasive alien species (IAS) pose a significant threat to biodiversity. Invasive alien species alter ecosystem processes (Raizada et al., 2008), decrease native species abundance and richness via competition, predation, hybridization and indirect effects (Gaertner et al., 2009), change community structure (Hejda et al., 2009) and alter genetic diversity (Hulme et al., 2009). Increases in the number and spread of alien species appear to be strongly associated with substantial increases in the extent and volume of trade and transport, particularly over the last 25 years (Hulme, 2009).

First assessment of Invasive Species in Nepal was done by IUCN from 2002-2003 and reported 21 IAPS (Tiwari et al., 2005). But recently, 26 species (23 dicotyledonous; 3 monocotyledonous) were recorded as invasive in Nepal (Shrestha, 2019). They belong to 14 families with the highest number of species in Asteraceae (10 spp.); followed by Fabaceae (3 Spp.) and Amaranthaceae (2 Spp.); the rest of families have one species each. (Lowe et. al., 2009) reported 100 of the world worst alien invasive species among them 4 IAPS are also reported from Nepal. They are *Eicchornia crassipes*, *Lantana camara, Mikania micrantha*, and *Chromolena odorata* (Shrestha, 2016). Despite a significant increase in the number of national and international IAPS policy

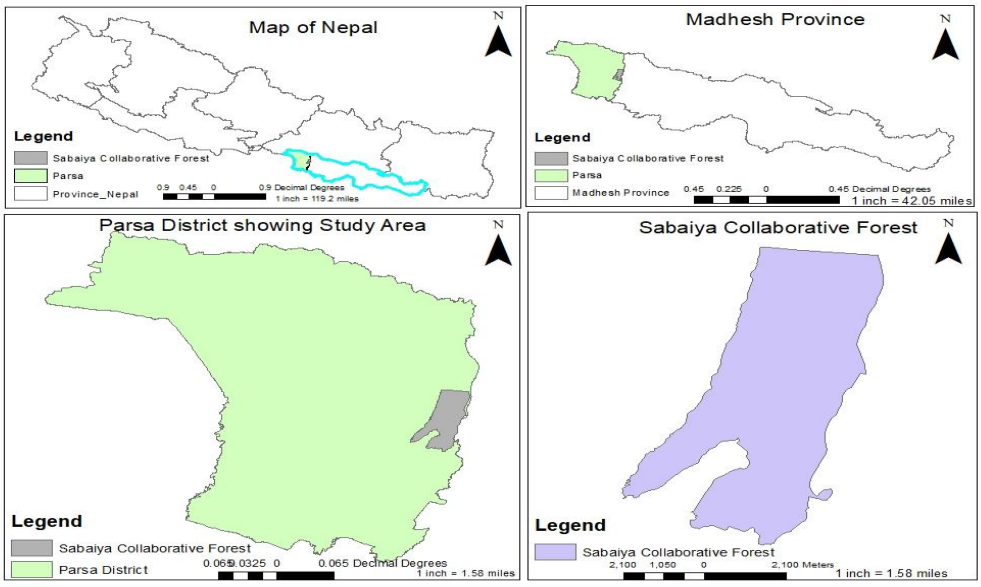
and plans (Butchart et al., 2010), spread of IAPS and mitigation of their effects have become major challenges for conservation. Wetland invasion is a global issue and considered as a major component of global environmental change.

Nutrient loading from agricultural runoff, solid wastes, 7 industrial effluents, etc. facilitates the wetland invasion (Tyler et al., 2007). Biological invasions, as a major component of global change, have caused significant ecological and economic impacts on aquatic ecosystems, together with the impacts of other factors, such as global warming, eutrophication, and flooding (Hastwell et al., 2008). Significant wetlands of Nepal are covered by IAPS. As it shows in (Shrestha, 2016) recorded six aquatic IAPS from various wetlands of Nepal; they are *Eicchornia crassipes*, *Alternanthera philoxeroides, Ipomoea carnea ssp. fistulosa, Pistia stratitoes, Myriophyllum aquaticum* and *Leersia hexandra*. *Eicchornia crassipes* belongs to 100 of the world worst invasive alien species (Lowe et al., 2009). It is the most problematic species that has invaded most wetlands of the Terai and mid-hills. This species occurs in all over Nepal extended from Kanchanpur to Jhapa districts in Terai as well as Kathmandu and Pokhara valley in mid-hills (Tiwari et al., 2005). Invasive alien plants are a significant environmental problem in wetland ecosystems (Richardson et al., 1997). IAPS increases biomass and evapotranspiration and thereby decrease both surface water runoff and groundwater recharge (Gorgens and Wilgen, 2004). Plant invasions significantly reduce biodiversity (Richardson & Wilgen, 2004). Several alien aquatic plant species are important invaders of rivers and forest in Nepal. These plants include *Eichhornia crassipes* (water hyacinth), *Mikania micrantha* (bitter vine), *Chromolaena odorata* (Siam weed), *Lantana camara* (Tick berry) and *Ipomoea carnea* (Bush Morning Glory).

III. METHODS AND METHODOLOGY

2.1 Study area

Sabaiya Collaborative Forest (SCF), a 3,138.51-hectare which is divided into Sal dominated Forest, is located in Parsagadhi Municipality of Parsa, south-central lowland Madhesh province of Nepal. Geographically positioned at 84.900°E longitude and 27.0000°N latitude, the region was characterized by an altitude ranging 100 to 300 meters above sea level. As a tropical forest, this area boasts a rich diversity of flora and fauna, marked by dense canopies, vibrant ecosystems, and variety of tree species that thrive in warm, humid conditions. The forest is likely home to wildlife, including birds, mammals, insects, contributing to its ecological significance. The collaborative management approach suggests a community-involved effort to conserve and sustainably utilize the forest's resources, promoting biodiversity while supporting local livelihoods. Overall, this forest area was a vital ecological zone with important environmental and social aspects. The Sabaiya CF has been a subject of research, focusing on aspects like species diversity, regeneration status, and the impact of CFM. It was one of the first pilot schemes designed for five-year period approved by the Ministry of Forest and Soil Conservation (MFSC) in 2004 as part of the Nepal's Collaborative Forest Management (CFM) program.



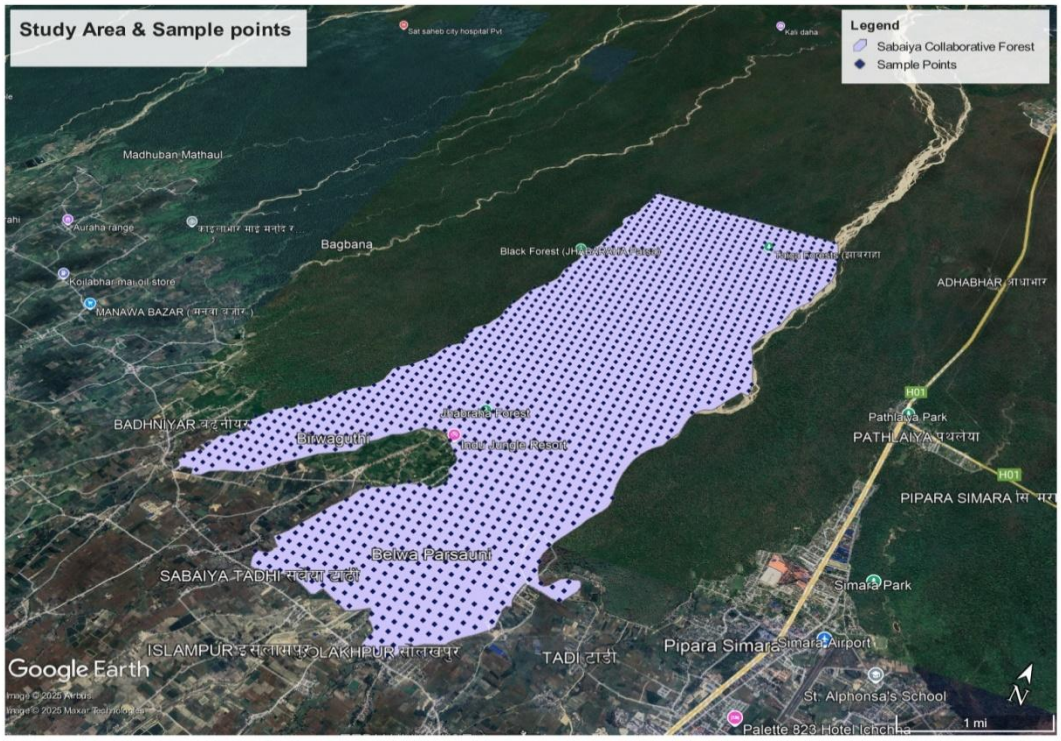


Figure 1: Map of the Study Area

2.2 Flora and Fauna diversity

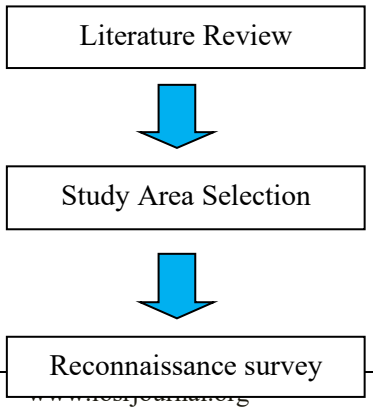
The vegetation in the Sabaiya Collaborative Forest is dominated by mainly Sal tree (*Shorea robusta), Bombax ceiba, Acacia catechu, Terminalia alata, Syzygium cumini,* and *Dalbergia sissoo.* In the forest, important plants such as Sarpagandha, Kurilo, Sugandhakokila, Vanmula, Shrikhanda, Chhativan, Satisal, Vijaysal, Arjun, Raktachandan, Neem, Harro, Amla etc. and Invasive species like *Mikania micrantha, Chromolaena odorata, Parthenium hysterophorus, and Lantana camera* was major invasive plant species and that cause negative impact to the whole forest almost destroying its natural habitat by increasing day by day.

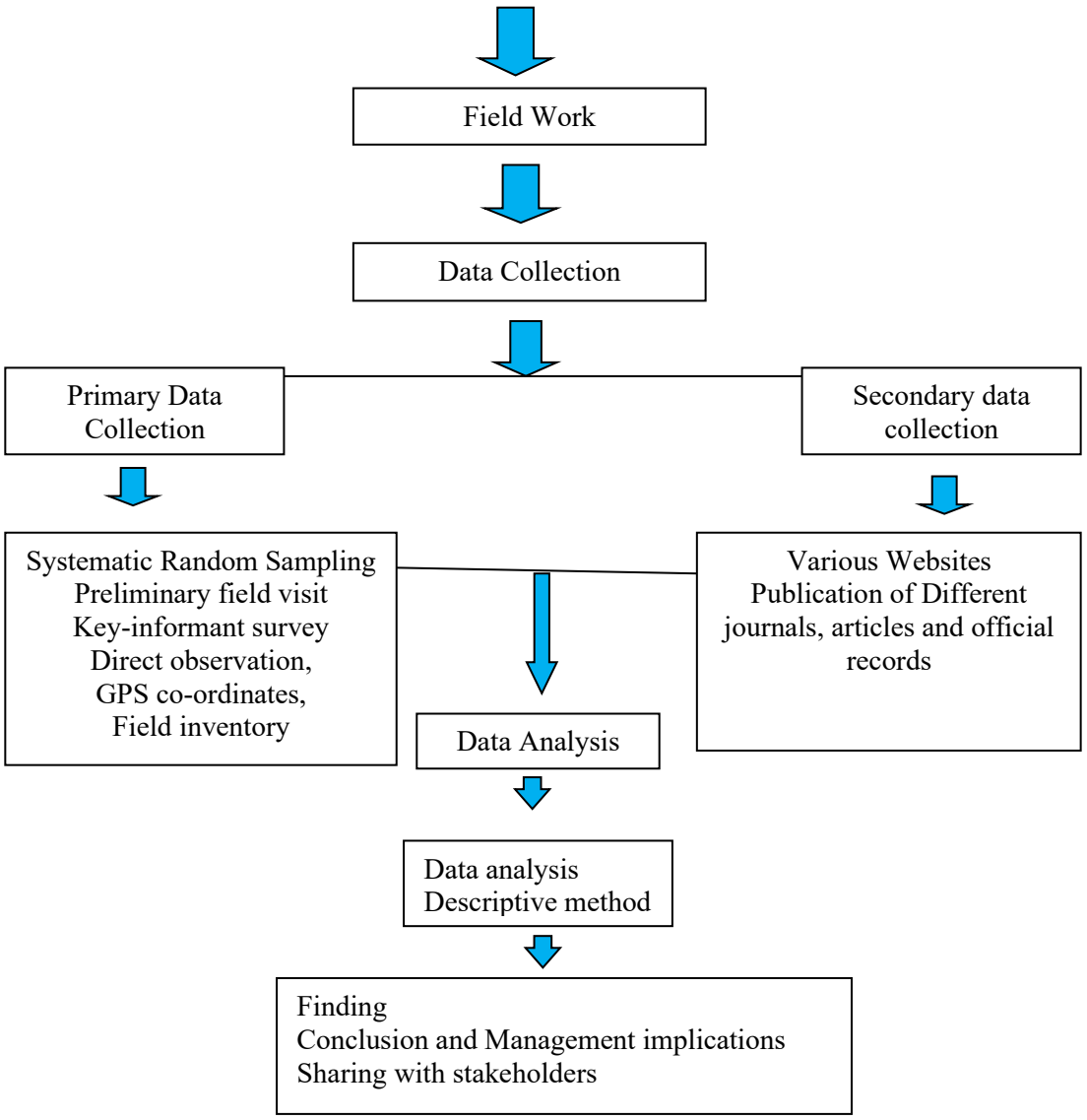
2.3 Climate

The climatic of the study site is hot in the summer season temperature can reach a maximum of 40°C (104°F) and cold in winter (7°C). The rainfall experiences the highest during the monsoon season, which typically extends from June to September. The relative humidity remains fairly throughout the year except in dry months. The surrounding of the forest was invaded by a number of IAPS.

3.3 RESEARCH DESIGN

RESEARCH DESIGN





3.4 DATA COLLECTION

3.4.1 Primary Data Collection

3.4.1.1 Field Inventory

A systematic random sampling along with 0.5% sampling intensity was followed for field data collection using quadrate, IAPS richness, density, frequency, and abundance were measured in the forest by sampling plots of size 5×5 m2 (as most of the species were herbaceous and seedling). A total of 1594 quadrates were sampled in Sabaiya Collaborative Forest Management Area. **Source: (Karki, 2005)**

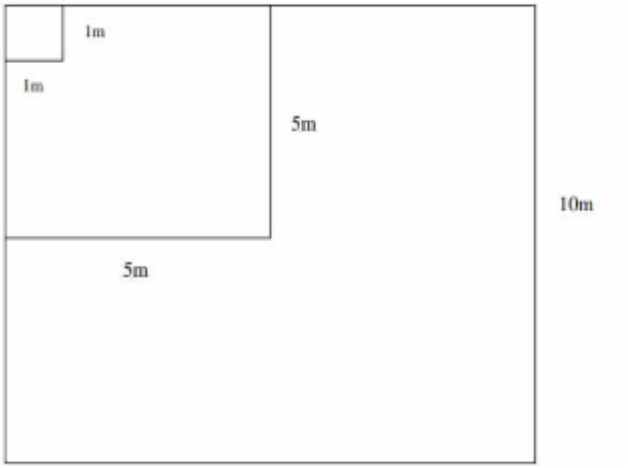


Figure 2: Plot design

3.4.1.2 Direct Observation:
The data collection was carried out to find out the current status and impacts of invasive species through systematic random sampling method. Such as the parameters: Several native species replaced, seedling recruitment of native species affected negatively, soil and water quality of the forest, as well as the flora and fauna, had changed.

3.4.2 Secondary Data Collection:
Secondary data was collected from various experts, Literature review, journal publications, published and unpublished data, and internet. The publications of NTNC, MFSC, DNPWC and IUCN were taken into considerations for the extraction of secondary data.

3.5 DATA ANALYSIS

Data collected during the field inventory were tabulated, processed and analyzed qualitatively using Microsoft Excel and SPSS.

3.5.1 Measurement of diversity (Objective 1)

For each species, data will be analyzed to assess Simpson's diversity, Shannon- Weiner index and important value index. The quantitative characteristics of the invasive alien species will be determined using the following formula:

Simpson's Index (D) = $1-\sum_{i=1}^{s}(pi)2$

Where, Pi is the proportion of individuals belonging to the i-th species.
S is the total number of species

Shannon-Weiner index (H) =$\sum_{i=1}^{s}(pi\times log2(pi))$
Where, Pi is the proportion of individuals belonging to the i-th species S is the total number of species**.**

3.5.2 Measurement of dominance (Objective 2nd)

The Mandal Josh formula (2014) was used to calculate the density, frequency, and coverage.

Frequency= $\frac{Number\ of\ sample\ plots\ in\ which\ species\ occured}{Total\ number\ of\ sample\ plots\ taken}\times 100$

RelativeFrequncy(%)= $\frac{Frequency\ of\ \ individual\ species}{Total\ frequency\ of\ all\ species}\times 100$

Desity/Ha= $\frac{\text{Total number of plant of any species}}{\text{Total number of plots taken} \times \text{area of sample plot}} \times 100$

Density(%) = $\frac{\text{Density of individual species A}}{\text{Total density of all species}} \times 100$

Relative coverage (%)= $\frac{\text{Area occupied by species A}}{\text{Area of sample plot}} \times 100$

Important value index (IVI) = RD+RF+ RC where,
RD=Relative density RF= Relative frequency RC = Relative coverage
Source: Department of Forest Research and Survey (Vol. 26, No. 1, Banko Jankari)

IV. RESULT AND DISCUSSION

3.1 Alien and invasive species found in Sabaiya Collaborative Forest

These are results for Nepal is home to at least 183 naturalized alien plant species of flowering plants , of which 29 species have been considered as invasive alien plant species (Shrestha and Shrestha, 2021; Shrestha et al, 2024).Among total plant species recorded 20 individual plants species were found with invasive character. Most of the species (9 species) were the members of the family Asteraceae. They were *Mikania micrantha, Parthenium hysterophorus, Chromolaena odorata, Ageratum conyzoies, Erigeron canadensis, Xanthium strumarium, Bidens pilosa, Ageratum houstonianum,* and *A. adenophora.* Two species *Alternanthera philoxeroides* and *Amaranthus spinosus* were the members of the family Amaranthaceae. The rest of the species represented a single-family. They were *Senna tora* (Fabaceae), *Ipomoea carnea* (Convolvulaceae), *Hptis suaveolens* (Lamiaceae), *Mimosa pudica* (Mimosaceae), *Oxalis Latifolia* (Oxalidaceae), *Argemone mexicana* (Papaveracea), *Eichhornia crassipes* (Pontederiaceae), *Lantana camara* (Verbenaceae) and *Calotropis procera* (Apocynaceae).

Table 1: List of alien invasive plant species in a Sabaiya Collaborative forest Management

S.N	Scientific Name	Common Name	Family
1	*Mikania micrantha*	Lahare Banmara	Asteraceae
2	*Parthenium hysterophorus*	Pathi jhar	Asteraceae
3	*Chromolaena odorata*	Seto Banmara, Aule Banmara	Asteraceae
4	*Ageratum conyzoides*	Gande jhar	Asteraceae
5	*Erigeron canadensis*	Kande Bhok, Harrer Pat	Asteraceae
6	*Xanthium strumarium*	Bhende kuro	Asteraceae
7	*Bidens pilosa*	Kalo kuro	Asteraceae
8	*Ageratum houstonianum*	Nilo gande	Asteraceae
9	*A. adenophora*	Kalo Banmara	Asteraceae
10	*Alternanthera philoxeroides*	Jaljamboo	Amranthaceae
11	*Amaranthus spinosus*	Kande lundo	Amranthaceae
12	*Senna tora*	Tapre	Fabaceae
13	*Ipomoea carnea*	Besheram	Convolvulaceae
14	*Hyptis suaveolens*	Thoolo mirre	Lamiaceae
15	*Mimosa pudica*	Lajawati ,(touch me not plant)	Mimosaceae
16	*Oxalis latifolia*	Chari amilo	Oxalidaceae

17	*Argemone mexicana*	Thaakal	Papaveracea
18	*Eichhornia crassipes*	Jalakumbhi	Pontederiaceae
19	*Lantana camara*	Kirne kanda	Verbenaceae
20	*Calotropis procera*	Aank, Seto Aank	Apocynaceae

3.2 Alien and invasive species found in Sabaiya Collaborative Forest

Among the 20 IAPS reported from Sabaiya Collaborative Forest Management Area, the most dominant two species were *Mikania micrantha* and *Chromolaena odorata*. Relative density (RD), relative frequency (RF), and relative abundance (RA) of *Mikania micrantha* were 45.12, 15.45, and 45.12, respectively followed by *Chromolaena odorata* (RD = 14.05, RF = 14.54 and RA = 14.05). RD and RA values were the same because the area was the same for all plots. The highest IVI was calculated in *Mikania micrantha* i.e. 105.7 followed by 42.64 in *Chromolaena odorata*. *Alternanthera philoxeroides* had the lowest RD (0.57) and IVI (1.44). The lowest Relative frequency was found in *Alternanthera philoxeroides* (0.3) and *Eichhornia crassipes* (0.6).

Table 2: Table 3: RD, RF, RA, and IVI of all the 20 species

S.N	Scientific Name	Relative Density	Relative Frequency	Relative Abundance	Important Value Index
1	*Mikania micrantha*	45.12	15.45	45.12	105.7
2	*Parthenium hysterophorus*	5.52	7.27	5.52	18.31
3	*Chromolaena odorata*	14.05	14.54	14.05	42.64
4	*Ageratum conyzoides*	3.79	3.63	3.79	11.21
5	*canadensis Erigeron*	1.91	4.23	1.91	8.05
6	*Xanthium strumarium*	1.08	2.4	1.08	4.56
7	*Bidens pilosa*	2.09	3.6	2.09	7.78
8	*Ageratum houstonianum*	2.49	2.11	2.49	7.09
9	*A. adenophora*	2.56	4.54	2.56	9.66
10	*Alternanthera philoxeroides*	0.57	0.3	0.57	1.44
11	*Amaranthus spinosus*	1.55	1.51	1.55	4.61
12	*Senna tora*	2.78	3.63	2.78	9.19
13	*Ipomoea carnea*	2.23	3	2.23	7.46
14	*Hyptis suaveolens*	0.57	1.81	0.57	2.95
15	*Mimosa pudica*	3.57	10.3	3.57	17.44
16	*Oxalis latifolia*	2.6	7.27	2.6	12.47
17	*Argemone mexicana*	1.51	1.2	1.51	4.22
18	*Eichhornia crassipes*	0.97	0.6	0.97	2.54
19	*Lantana camara*	3.54	9.39	3.54	16.47
20	*Calotropis procera*	1.4	3	1.4	5.8

4.2 Graphical representation of various parameter of Alien invasive species

4.2.1 Relative Density

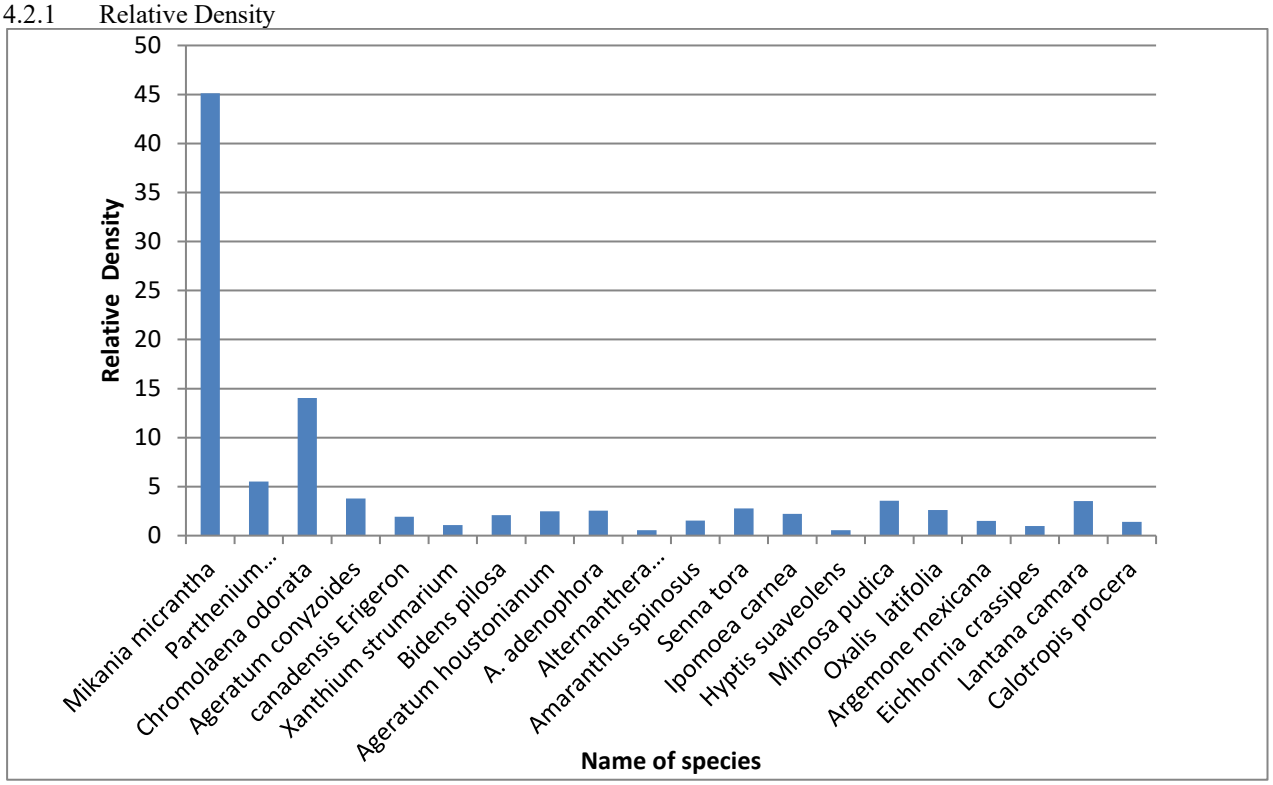


Figure 3: Relative Density

4.2.2 Relative frequency

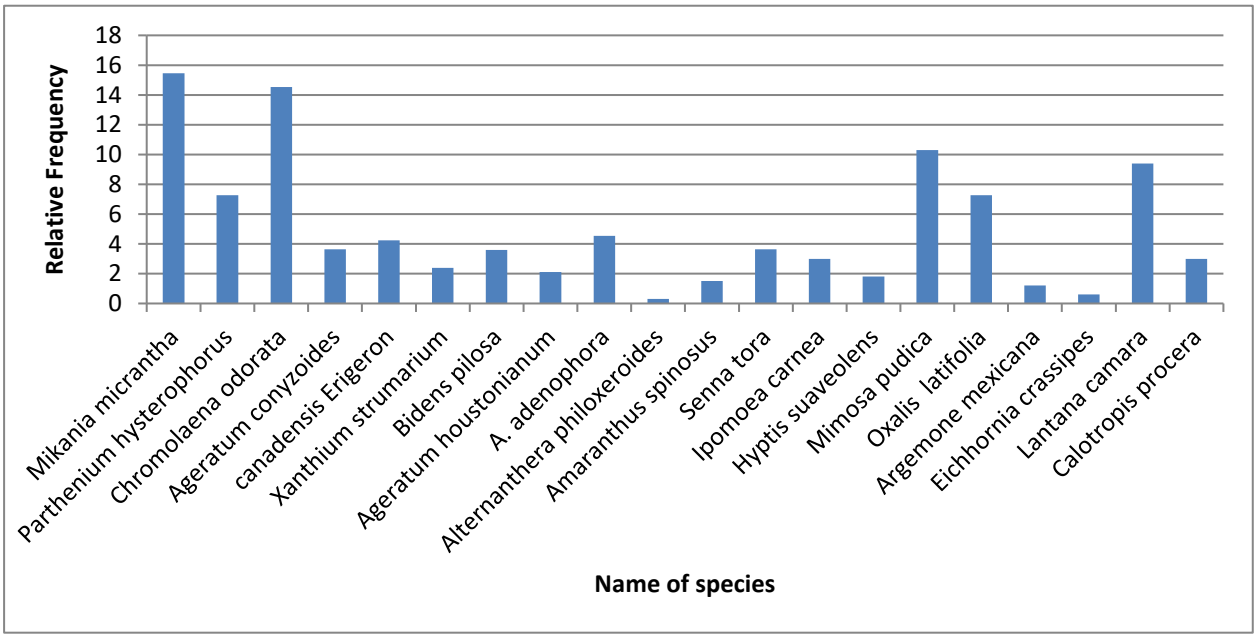


Figure 4: Relative frequency

4.2.3 Relative Abundance

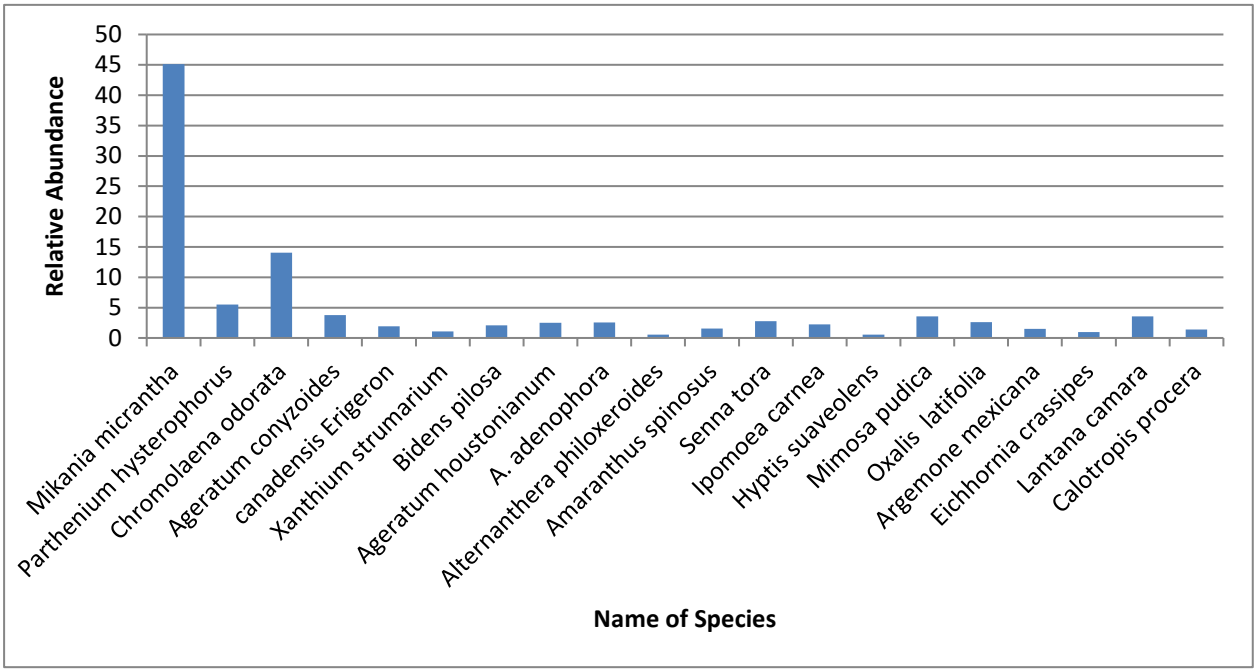


Figure 5: Relative Abundance

4.2.4 Important Value Index (IVI)

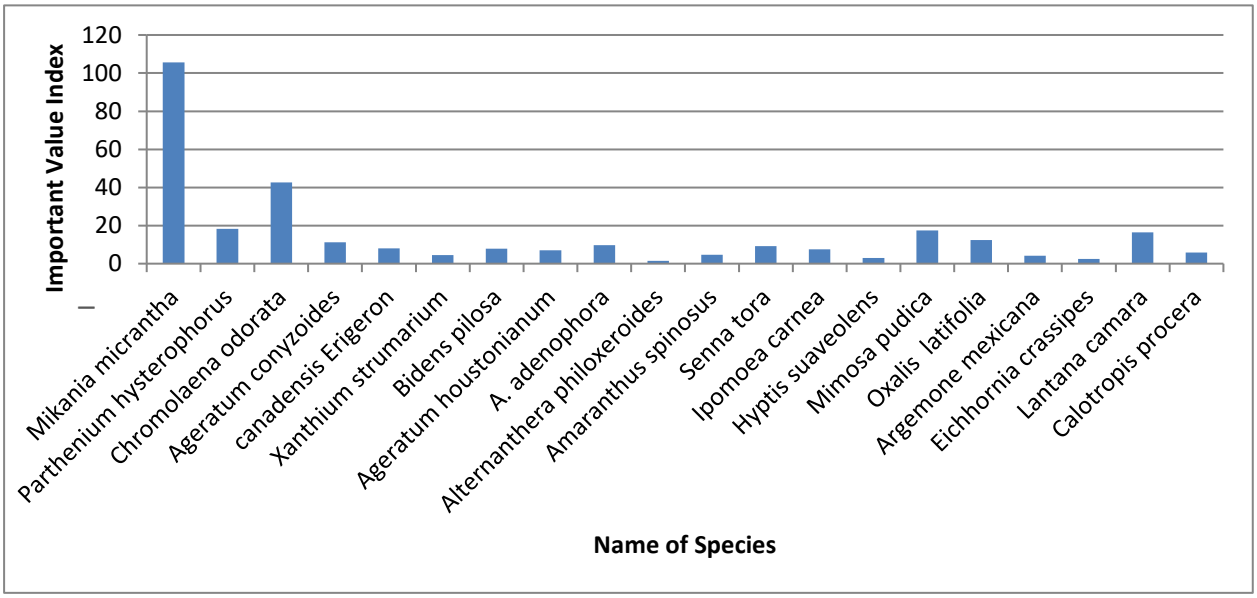


Figure 6: Important Value Index (IVI)

4.3 To assess the effect of Invasive Species in of Sabaiya Collaborative Forest

The presence of invasive species in Sabaiya Collaborative Forest is being detrimental to the available floras, faunas and the whole ecosystem of the area. The beauty and the vigor of the area are arrested by the active proliferation of the invasive floras over there.

Some of the known ecological effects of invasive plants are summarized below, and include:

- Reduction of biodiversity
- Loss of and encroachment upon endangered and threatened species and their habitat
- Loss of habitat for native insects, birds and other wildlife
- Loss of food sources for wildlife

- Changes to natural ecological processes such as plant community succession
- Alterations to the frequency and intensity of natural fires
- Disruption of native plant-animal associations such as pollination, seed dispersal and host plants relationships

4.3.1 Invasive Alien Plants:

- Compete with and replace rare and endangered species
- Encroach upon limited habitat of rare and endangered species
- Destroy or displace specialized native plant communities like spring ephemerals.
- Interrupt insect-plant relationships vital for native seed dispersal.
- Interfere with native plant-pollinator interactions.
- Remove host plants essential for native insects and wildlife.
- Hybridize with native plant species, altering their genetic makeup
- Hybridize with native plant species, altering their genetic makeup
- Cause death of trees and shrubs along gridlines.
- Raise plant disease and stress levels in forested areas
- Prevent seedling establishment of native trees and shrubs
- Reduce vigor of mature trees through shading
- Limit space, water, sunlight, and nutrients available to native species.
- Alter the soil's structure and chemical composition.

V. CONCLUSION AND RECOMMENDATION

5.1 CONCLUSION

A total of 20 species of IAPS have invaded in Sabaiya Collaborative Forest of Parsa District. Most of the IAPS were the members of the family Asteraceae.

- The diversity of IAPS in the forest represents about 69% of the total IAPS in Nepal.
- In the Sabaiya Collaborative Forest Management Area, *Mikania micrantha, Chromolaena odorata* and *Parthenium hysterophorus* were major IAPS.
- The natural beauty of the Forest has been corrupted by these IAPS. A detailed study on the assessment of these IAPS in the Sabaiya Collaborative Forest is still lacking.
- Hence, it is recommended that the IAPS in the Sabaiya Collaborative Forest should be controlled to conserve the native biodiversity and the natural beauty of the Forest.

5.2 RECOMMENDATION

- Prescribed fire should be done to control invasive species.
- Regular removal should be done for aquatic invasive species.
- Effective legal framework is necessary to regulate, manage and control the introduction of invasive alien plant species.
- Extension education related to the invasive alien species and their behaviors should be provided to the local peoples and visitors.
- Season wise study of invasive alien species should be done.

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Annex: Photographs

Table 4: Photo Plates

Photographs 1: Quadrate Sampling

Photographs 2: During Field Survey Data

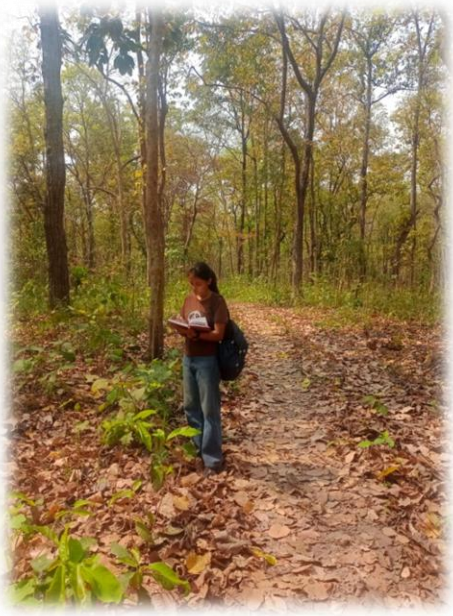
Photographs 3: Ipomoea carnea Invasive Species Plant

Photographs 4: Lantana camara Invasive alien Plant

Photographs 5: Invasive Alien Plant Species Quadrant Sampling Data

Photographs 6: Mikania micrantha in Sabaiya Collaborative Forest Management Area

Photographs 7: Chromolaena odorata At the Study Area



Photographs 8: During The Field data Collection at Sabaiya Collaborative Forest

Annex: List of Invasive Species

Table 5: Lists of Invasive Species

	Local name :Jalakumbhi
	Scientific Name :Eichhornia crassipes
	Common /English Name :Water hyacinth
	Native: Amazon Basin
	Family: Pontederiaceae
Description	Perennial, stoloniferous herb, floating or rooting in mud; roots feathery. Leaves in basal rosette; petiole long, spongy, lower part becoming inflated; leaf blade rhombic to widely elliptic, 3.6-8.4*2.4-4.9 cm, base cuneate, apex sub-acute. Inflorescence a terminal spike. Peduncle largely hidden by 2 sheathing membranous spathes; lower spathe bearing small leaf like blade. Tepals pale mauve or pale violet to light blue, occasionally white, upper most with yellow spot near base surrounded by darker mauve ring. Capsule 3 locular: many seeded.
Ecological Character	It grows most prolifically in nutrient-enriched water and forms small colonies, floating islands or extensive mats completely covering water surface that excludes most light and air for submerged organisms, thus depriving them of essential for survival. It prevents people's access to water bodies for collecting water and fishes and provides habitat to disease vectors and vermin. It also increases evapotranspiration causing significant loss of water.
Biological character	In their native range these flowers are pollinated by long tongued bees and they can reproduce both sexually and clonally. The invasiveness of the hyacinth is related to its ability to clone itself and large patches are likely to all be part of the same genetic form. There are three morphs of water hyacinth, long medium and short. However, the short morph is restricted to the native range due to founder events during its distribution.
Management information	The three commonly used control methods against water hyacinth infestations are physical, chemical, and biological controls. No one control method is

	Local Name: Besharam
	Scientific Name: *Ipomoea carnea*
	Common/English Name: Shrubby morning glory
	Native: South America
	Family: Convolvulaceae

Description	Erect or straggling shrub up to 3 m high. Stem hollow, woody at base.
Ecological Character	Plant grows well in moist habitats usually in lowlands. It shows an exception ecological tolerance. A piece of steam could stabilize and grow as a fully developed plant. The plants often form tangling cover over ground vegetation or wetland sites.
Biological character	Plant reproduces sexually by seeds as well as the plants spread vegetative through rooting of steam pieces. Due to it fast growing habit, people planted it along irrigation canal to check erosion or fenced around their cultivated lands. Once established it spread quickly through vegetative propagation.

Management information	Uprooting or cutting but it is difficult once established. It can be controlled by the chemical but have not practiced in Nepal.
Other Region/Country Invaded	Nepal, India, China, Bangladesh
Uses	Fencing, green manure, construction material for the poor people's house.

	Scientific Name: *Ageratina adenophora*
	Common/English Name: Crofton weed or sticky snakeroot
	Native: Native to Mexico and possibly Central America.
	Family: Asteraceae
Description	*Perennial herb* to 1(-2.5) m. *Stems reddish-brown and markedly glandular-pubescent, especially above*. Leaves opposite: petiole up to 4 cm; lamina up to 10 × 6 cm, ovate or rhombic, dark green above, paler beneath; base cuneate; apex acute to acuminate; margin crenate. Capitula c. 5 × 5 mm, crowded in corymbs. Phyllaries 2-seriate, lanceolate, glandular-pubescent. Flowers white, often appearing in the winter. Achenes c. 2 mm, ± cylindric, smoothly 5-angled. Pappus of numerous scab rid bristles.
Habitat	This species is a weed of roadsides, railways, pastures, fence- lines, disturbed sites, waste areas and riparian zones (banks of watercourses) in subtropical and warmer temperate regions. It is also commonly found in urban open spaces, open woodlands, forest margins and rainforest clearings.
Reproduction and Dispersal	*Ageratina adenophora* reproduces by seeds which are easily dispersed by wind and float on water. They may also be spread in by animals and vehicles and can

	Contaminate agricultural produce.
Management information	The precise management measures adopted for any plant invasion will depend upon factors such as the terrain, the cost and availability of labour, the severity of the infestation and the presence of other invasive species. Some components of an integrated management approach are introduced below. The best form of invasive species management is prevention. If prevention is no longer possible, it is best to treat the weed infestations when they are small to prevent them from establishing. Controlling the weed before it seeds will reduce future problems. Control is generally best applied to the least infested areas before dense infestations are tackled. Consistent follow-up work is required for sustainable management.

	Local Name: Bhatmash Jhar
	Scientific Name: *Senna Tora*
	Common/English Name: Sickle pod, Chinese Senna
	Native: Southern and Eastern USA, Mexico and tropical America.
	Family: Fabaceae (Legminosae)
Description	*Senna tora* is a short-lived (annual or biennial) shrub growing up to 2 m. tall, but usually less than 2 m in height. The lower stems often sprawl along the ground in open areas. Plants produce numerous, branched, sprawling stems that are 1.5-2 m long. These stem are usually softly hairy when young but become mostly hairless with age. The foliage has a slightly rank odor.

Habitat	*Senna tora* is a weed of disturbed sites, waste areas, roadsides, riparian zones, floodplains, drainage channels, open woodlands, fallow land, crops and pastures in wetter tropical and subtropical environments. It usually grows as a pasture weed but is sometimes fond along roads and disturbed areas in rain forests.
Reproduction and Dispersal	This species reproduces by seed only. This plant spreads by reseeding itself. Seeds are dispersed by water and animals that eat the fruit. They may also be spread as a contaminant of agricultural produce or in mud sticking too animals, footwear, machinery and vehicles.
Economic and other uses	*Senna tora* can be used as a medicinal plant, a green manure for poles, hedges and for fuel wood.
Other region/country invaded	Majority country of Asia, Africa, North America, Central America and Caribbean, South America, Oceania, in Europe Norway and Spain only.

	*Local Name: Gandhe (seto)*

	Scientific Name: Ageratum conzoides
	Common/English Name: Billy goat-weed
	Native: South America
	Family: Asteraceae
Description	*Annual herb, 10-60 cm. Leaves: base usually blunt or rounded, rarely cordate. Florets blue or white. Phyllaries 3-4 mm, oblong, abruptly acuminate, sparingly if at all hairy on the back, erase and ciliate. Style arms exerted 1 mm from corolla tube.*
Ecology	*A. conzoides* occurs as a major to intermediate weed of frequently disturbed areas, such as vegetables and other cultivated crops, pastures (especially when overgrazed), plantations, orchards and roadsides. It thrives best in rich, moist, mineral soils with high air humidity's, and tolerates shade. It grows particularly well where soil fertility is high, with dense populations developing when fertilizer is used (Marnotte, 1984). The drier and less fertile conditions typical of Pacific atolls do not suit the plant so well (PIER, 2004). In Fiji, it is an abundant naturalized weed at altitudes from near sea level to about 950 m in clearings, cultivated areas, grassland and forest, often along trails and roads (PIER, 2004).
Reproductive Biology	*A. conzoides* has no photoperiodic requirement and is self- pollinated, producing up to 40,000 seeds per plant. Seeds are dispersed by wind and water (Baker, 1965). *A. conzoides does* not marked dormancy (Sauer born, 1985) but requires light for germination (Sauer born et al., 1988) and is therefore unable to germinate when buried below the soil surface. Optimum germination has been noted at 20°C but will occur in the range of 15 to 30°C. The lower limit allows it to thrive at higher altitudes. Seed viability is often lost.

	Local Name: Banmara
	Scientific Name: *Lantana camera*
	Common/English Name: Siam weed
	Native: South America
	Family: Asteraceae
Description	Scrambling or climbing shrub, to 4 m (or more when supported). Leaves ovate to triangular, 3-veined from the base, gland-dotted below*, smelling strongly of turpentine or paraffin when crushed.* Capitula c. 10 × 3 mm, cylindric. Achenes c.5 mm, straw-colored.
	Genetic variation in invasive populations has been noted. In Australia, two genotypes have been found (Waterhouse and Zeimer, 2002). Von Senger et al. (2000) found that the form *lantana camera occurring* in South Africa is morphologically distinct from other investigated material and that more than one genotype exists. Kriticos et al. (2005) also found that the distribution of *lantana amera in* South Africa extends further south than predicted by their model, based on Asian and American distribution records, which supports the view the South African variety has different climatic requirements.

Ecology	Zachariades et al. (2004) confirmed that South African populations have a northern Caribbean origin, identical to material from Cuba, Jamaica and Puerto Rico.

Reproductive Biology	Sexual reproduction can occur at the end of the first growth season (Gautier, 1993). Flowering is seasonal and generally occurs in the dry season. Flowers are visited by various unspecialized insects, but reproduction is often apodictic. Seventy-five days after the first appearance of the flower buds, fruits are ready to be dispersed. Fruit production of 1 ha of *Lantana camera* thicket can reach 1 billion. Most of the seeds enter the soil and build up a seed bank (Epp, 1987) and seeds may survive in the soil for up to 6 years (Waterhouse and Zeimer, 2002) but usually less than a year unless sheltered microsites exist (Witkowski,

	Local Name: Floss flower
	Scientific Name: *A.houtonianum*
	Common/English Name: Bitter Vine
	Native: Central and South America
	Family: Asteraceae
Description	A branched, slender-stemmed perennial vine. The leaves are arranged in opposite pairs along the stems and are heart-shaped or triangular with an acute tip and a broad base. Leaves may be 4-13 cm long. The flowers, each 3-5 mm long, are arranged in dense terminal or axillary corymbos, individual florists are white to greenish white. The seed is black, linear oblong, five-angled and about 2 mm long. Each seed has a terminal popups of white bristles that facilitates dispersal by wind or on the hair of animals. It occurs in agricultural areas, coastland, natural forests, planted forests riparian zones, ruderal/disturbed areas, scrub/shrub lands, urban areas and wetlands.

Ecological Character	*A. hautonianum is* a perennial creeping climber known for its vigorous and rampant growth. It grows best where fertility, organic matter, soil moisture and humidity are all high. It damages or kills other plants by cutting out the light and smothering them. A native of Central and South America. *M. micrantha* was introduced in India after the Second World War to camouflage air- fields and is now a major weed. It is also one of the most widespread and problematic weeds in the pacific region, its seeds are dispersed by the wind and also on clothing or hair.

	Local Name: Kaalo Kuro

	
	Scientific Name: Bidens Pilosa
	Common/English Name: Hairy beggar ticks
	Native: Central and South America
	Family: Asteraceae
Description	Bides pilosa is typically an herbaceous or semi-woody plant that grows to a height of around 0.5 to 2 meters. The plant has erect, often branched stems that are green or reddish in color. These stems are typically covered in short hairs. The leaves are alternate, with a simple, oblong to lanceolate shape. The edges may be serrated or slightly lobed. The surface is often covered in fine hairs, giving the leaves a rough texture. The leaf size ranges from 5 to 12 cm in length and 2 to 5 cm in width. The plant produces small, composite flowers, characteristic of The Asteraceae family. These flowers are grouped in clusters known as inflorescences. The flowers typically have a yellow
	Central disc surrounded by white or pinkish ray florets. The individual florets are often quite small but dense, forming large flower heads.The fruit is a small achene (a type of dry, indehiscent fruit), which is typically equipped with a pappus (a tuft of hair-like structures) that aids in wind dispersal.
Ecological Character	Bides Pilosa plays a role in its ecosystem as a pioneer species, helping to stabilize soil in disturbed areas. It is also a source of food and habitat for various insects, including pollinators like bees and butterflies. As an opportunistic plant, it grows quickly in areas where other vegetation may struggle, especially in disturbed habitats. Its rapid growth and prolific seed production allow it to dominate areas where soil conditions are not ideal for other plants.

	Local Name:
	Scientific Name: *Parthenium hysterophorus*
	Common/English Name: Whitetop weed
	Native: Australia ,Africa
	Family: Asteraceae

Description	Parthenium hysterophorus is a perennial or sometimes annual herb that can grow up to 1 to 2 meters (3 to 6 feet) tall. It has an erect, branching stem and can form dense thickets, outcompeting native vegetation. The plant has deeply lobed, pinnate (feather-like) leaves that are typically green in color, with a rough, hairy texture on both surfaces. The leaves are arranged alternately along the stem, and they can range from 5 to 10 cm long. The margins are often

	Jagged or toothed. The plant produces small, white to pale purple flowers in dense clusters known as capitol. Each flower head contains numerous individual disk florets (with no ray florets), which are typical of the Asteraceae family Parthenium flowers from late summer to autumn (in tropical climates, it can bloom year-round). The flower heads appear in loose clusters or panicles at the top of the plant. The blooming period is marked by the release of large amounts of pollen, contributing to its allergenic properties. The flowers are followed by small, light brown or black seeds that are easily dispersed by wind, water, and human activities. Seeds are a significant factor in the plant's rapid spread and ability to invade new area. Parthenium has a fibrous root system. It also tends to be fairly drought-tolerant once established, and its roots can compete for resources with nearby plants. The weed's roots have been known to allelopathically suppress the growth of neighboring plants by releasing chemicals that inhibit seed germination and growth.
Ecology	Genetic variation in invasive populations has been noted. In Australia, two genotypes have been found (Waterhouse and Zeimer, 2002). Von Senger et al. (2000) found that the form of C. odorata occurring in South Africa is morphologically distinct from other investigated material and that more than one genotype exists. Kriticos et al. (2005) also found that the distribution of C. odorata in South Africa extends further south than predicted by their model, based on Asian and American distribution records, which supports the view the South African variety has different climatic requirements. Zachariades et al. (2004) confirmed that South African populations have a northern Caribbean origin, identical to material from Cuba, Jamaica and Puerto

	Rico.
Reproductive Biology	Sexual reproduction can occur at the end of the first growth season (Gautier, 1993). Flowering is seasonal and generally occurs in the dry season. Flowers are visited by various unspecialized insects, but reproduction is often apodictic. Seventy-five days after the first appearance of the flower buds, fruits are ready to be dispersed. Fruit production of 1 ha of *hysterophorus thicket* can reach 1 billion. Most of the seeds enter the soil and build up a seed bank (Epp, 1987) and seeds may survive in the soil for up to 6 years (Waterhouse and Zeimer, 2002) but usually less than a year unless sheltered microsites exist (Witkowski,

	Scientific Name: Mikania micrantha
	Common/English Name: Lahare Banmara
	Native: Central and South America

	Family: Asteraceae
Description	*Mikania micrantha* is a vigorous, fast-growing, perennial, creeping or twining plant, with numerous cordate leaves and numerous large, loose heads of white or cream-coloured flowers that produce many seeds. This plant can climb and smother other vegetation such as plantation trees e.g. coconuts, or *Hevea brasiliensis* (rubber) trees as tall as 25 m. Mikania micrantha is a much-branched, scrambling, slender-stemmed vine; stems herbaceous to semi-woody, branched, sparsely pubescentor glabrous; leaves simple opposite, glabrous, thin, broadly ovate, shallowly or coarsely toothed, triangular or ovate, tip acuminate, blade 4-13 cm long, 2-9 cm wide, 3-7 nerved; at the junction of the petioles with the nodes, unusual nodal appendages, membranous, up to 5 mm long; petioles tendriliform, 2-9 cm long; inflorescence a corymbose panicle with subcymose branches, 3-6 cm long by 3-10 cm wide; flowers small, white or cream-coloured, actinomorphic, 4.5-6 mm long, in leaf axils or on terminal shoots; florets white or greenish, fragrant; corolla mostly white, tubular, 2.5-4 mm long; involucral bracts 4, oblong to obovate, 2-4 mm long, acute, green, with one additional smaller bract 1-2 mm long; pappus (calyx) of 32-38 barbellate, capillary bristles, 2-3 mm long; stamens attached by their anthers, these exserted, with a triangular-ovate apical appendage as long as broad or longer and rounded or rarely emarginate or subsagittate at base; ovary inferior, the style base glabrous; fruit an achene that is somewhat flattened, elliptic, 4-ribbed with short, white hairs along the ribs, with a tuft of white pappus at the summit, glandular, 1.2-1.8 mm long, dark grey to black (Parham, 1958; 1962; Adams and Proctor, 1972; Nair, 1988; Holm et al., 1991).
Ecology	*Mikania micrantha*, commonly known as bitter vine or devil's weed, is a highly invasive plant with a strong impact on ecosystems. It's characterized by rapid growth, prolific seed production, and the ability to smother other vegetation, making it a serious threat to biodiversity and agricultural productivity in many regions.

Reproductive Biology	*Mikania micrantha* undergoes both sexual (through seeds) and asexual reproduction (through runners, suckers, and old rootstocks) [1,15]. *Mikania micrantha* vines produce 93,000–154,000 flowers/0.25 m^2 [53]. From this prolific flower production, seed production ranging from 90,000 to 210,000 seeds/m^2 may be achieved by *M*, asexually. It exhibits a prolific flower production and seed production, contributing to its invasive nature. Seed germination is influenced by temperature and light, with optimal conditions around 25-30°C and light exposure.

	Local Name: Lajalu, Touch- me- not plant
	Scientific Name: *Mimosa pudica*
	Common/English Name: Sensitive plant, Malu
	Native: South America
	Family: Fabaceae
Description	*Mimosa pudica* is a perennial herbaceous plant belonging to the legume family (Fabaceae) that is widely recognized for its sensitive movements. Commonly known as the "sensitive plant" or "touch- me-not," *Mimosa pudica* exhibits rapid leaf movement in response to physical stimuli, such as touch, vibration, or heat, a phenomenon known as seismonastic movement. The plant's leaves fold inward when disturbed, which serves as a defense mechanism to deter herbivores (Muthusamy et al., 2020). The plant typically grows to about 0.5 to 1 meter in height and produces small, pink, spherical flowers. It thrives in tropical and

	subtropical climates, especially in regions with well-drained, fertile soils. *Mimosa pudica* is often found in disturbed habitats, such as roadsides, gardens, and agricultural fields, but it can also grow in the wild (Rao et al., 2019). The compound leaves of *Mimosa pudica* are bipinnate, with leaflets arranged in pairs along the leaf rachis. The plant's notable thorns are present along the stems, which may also contribute to its defense against grazing animals. In addition to its rapid movement, the plant's ability to regenerate from cuttings and its widespread distribution make it an intriguing subject for studies on plant behavior, ecological adaptation, and potential medicinal properties (Kumar & Rani, 2018).
Ecology	Mimosa pudica, commonly known as the sensitive plant, is a member of the legume family, Fabaceae, and exhibits a variety of reproductive strategies and characteristics that facilitate its growth and survival in diverse environments. This plant is primarily reproduced through sexual reproduction, though vegetative reproduction via root sprouting can occur under certain conditions (Smith & Jones, 2020). The reproductive process involves the production of flowers, pollination, and the formation of seeds.

Reproductive Biology	The flower of Mimosa pudica is characterized by its small, pink to purple globular inflorescence, which consists of numerous stamens (Glover et al., 2018). These flowers are hermaphroditic, meaning they contain both male (stamens) and female (pistil) reproductive organs, allowing for self-pollination. However, the plant is also capable of cross-pollination through the assistance of various pollinators, including bees and butterflies (Nguyen & Thompson, 2021). The anther dehiscence occurs as the flower's stamens are triggered by external stimuli, releasing pollen to be transferred to the pistil or neighboring flowers.
	*Local Name: Amrit sag*
	Scientific Name: Oxalis latifolia
	Common/English Name: Garden pink –sorrel ,Broadleaf wood- sorrel, Brazilian sorrel
	Native: North America
	Family: Oxalidaceae
Description	
Ecological Character	*leaves of Oxalis species are perhaps the most recognizable feature. Typically, they are compound, consisting of three (trifoliate) or five leaflets. The leaflets are often heart-shaped or kidney-shaped, and they are known for their ability to fold and unfold in response to light, a phenomenon known as nyctinasty (Cheng et al., 2020). The leaves can be green, purple, or variegated, depending on the species.*

	Oxalis flowers are usually small, with five petals that are often brightly colored in shades of white, pink, yellow, or purple. The flowers have a characteristic funnel-shaped or trumpet-like appearance, with an arrangement that often exhibits bilateral symmetry. The sepals are typically small, while the petals are elongated and sometimes marked with darker veins. The fruit of Oxalis species is typically a capsule that splits open when mature to release seeds. The seeds are small and may be dispersed by wind or animals, facilitating the plant's spread across diverse habitats. Some species of Oxalis produce tubers, while others grow from rhizomes or stolons (Schiemenz et al., 2013). Some species of Oxalis, such as Oxalis tuberosa (oca), develop edible tubers. These tubers are often rich in starch and have been cultivated as a food crop in the Andes for centuries (Aguirre et al., 2020). Other species rely on fibrous or rhizomatous roots, with the root system often helping in

	vegetative reproduction.
Biological character	Plant reproduces sexually by seeds as well as the plants spread vegetative through rooting of steam pieces. Due to it fast growing habit, people planted it along irrigation canal to check erosion or fenced around their cultivated lands. Once established it spread quickly through vegetative propagation.
Management Information	Uprooting or cutting but it is difficult once established. It can be controlled by the chemical but have not practiced in Nepal.
Other Region/Country Invaded	Nepal, India, China, Bangladesh
Uses	Certain species of Oxalis are used in traditional medicine. For example, Oxalis corniculata has been used in folk medicine for its anti-inflammatory, antimicrobial, and analgesic properties
	(Yadav et al., 2019). However, due to the oxalic acid content, these plants need to be consumed in moderation to avoid Potential toxicity.

	Local Name: Jogera
	Scientific Name: *Xanthium strumarium*
	Common/English Name: cocklebur
	Native: southern Europe ,Asia
	Family: Asteraceae
Description	**Common Cocklebur** is a species of flowering plant in the Asteraceae family. It is native to North and South America but has become widely distributed across the world, particularly in temperate regions. This herbaceous plant grows as an annual or biennial, reaching up to 2 meters in height, and is characterized by its rough, alternate, ovate leaves with serrated edges. Xanthium strumarium produces small, unisexual flowers that form in clusters, and its distinctive fruit is a spiny, burs that easily adhere to animals or human clothing, facilitating its dispersal. The plant has a deep taproot system and thrives in disturbed areas such as roadsides, agricultural fields, and waste grounds. It is considered both a weed and a medicinal plant, with certain compounds showing potential for therapeutic uses, though its seeds contain toxic substances, such as carboxyatractyloside, which can be harmful if ingested in large amounts (Chaudhary et al., 2012). Additionally, Xanthium strumarium has shown promise in traditional medicine for treating a variety of ailments, including respiratory issues, but its use is typically subject to caution due to its toxicity (Sharma et al., 2005).

	Local Name: Gandhe (seto)
	Scientific Name: *Ageratum conyzoides*
	Common/English Name: Billy goat-weed
	Native: South America
	Family: Asteraceae
Description	Annual herb, 10-60 cm. Leaves: base usually blunt or rounded, rarely cordate. Florets blue or white. Phyllaries 3-4 mm, oblong, abruptly acuminate, sparingly if at all hairy on the back, erase and ciliate. Style arms exerted 1 mm from corolla tube.

Ecology	*A. conyzoides* occurs as a major to intermediate weed of frequently disturbed areas, such as vegetables and other cultivated crops, pastures (especially when overgrazed), plantations, orchards and roadsides. It thrives best in rich, moist, mineral soils with high air humidity's, and tolerates shade. It grows particularly well where soil fertility is high, with dense populations developing when fertilizer is used (Marnotte, 1984). The drier and less fertile conditions typical of Pacific atoll's do not suit the plant so well (PIER, 2004). In Fiji, it is an abundant naturalized weed at altitudes from near sea level to about 950 m in clearings, cultivated areas, grassland and forest, often along trails and roads (PIER, 2004).
Reproductive Biology	*A. conyzoides* has no photoperiodic requirement and is self- pollinated, producing up to 40,000 seeds per plant. Seeds are dispersed by wind and water (Baker, 1965). *A. conyzoides* does not possess any marked dormancy (Sauer born, 1985) but requires light for germination (Sauer born et al., 1988) and is therefore unable to germinate when buried below the soil surface. Optimum germination has been noted at 20°C but will occur in the range of
	15 to 30°C. *The lower limit allows it to thrive at higher altitudes. Seed viability is often lost*