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Impact of Invasive Alien Plant Species in Kankali Community Forest, Khairahani-4 Chitwan

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Abstract

Fieldwork was conducted from July to August 2024 to assess the impact and management of invasive alien plant species (IAPS) in the study area. Using quadrat sampling methods, the presence of 16 invasive alien plant species was recorded. Among them, Chromolaena odorata was found to be the most dominant species in the study area. The study revealed that areas infested with these invasive species lacked native plant diversity, as IAPS inhibit the growth of other herbs, shrubs, and trees by releasing allelopathic chemicals. This leads to significant biodiversity loss, depletion of natural resources, decreased soil fertility, and a reduction in the abundance of valuable medicinal and aromatic plants. The findings underscore the urgent need for effective management strategies to control the spread of these invasive species and mitigate their detrimental effects on ecosystems and biodiversity.

Keywords: *Invasive Alien Plant Species, Biological Invasion, Ecological Disruption, Biodiversity Threat*

Introduction

An invasive alien plant species (IAPs) is one that has spread to a new location, environment, or habitat from another continent or region. Such species are referred to as invasive alien species (CBD,2002). Invasive alien species are plant, animals, pathogens and other organism that are non-native to an ecosystem and which may cause economic or environmental harm or adversely affect human health .There are at least 219 alien species of flowering plants (Tiwari et al., 2005, Siwakoti 2012, Sukhorukov,2014) that are naturalized in Nepal. There are almost 26 invasive plant species in Nepal causing serious harm to the ecology as well as economy of the country. Out of them 6 species are aquatic & almost 20 species are terrestrial invasive plant species. Aquatic invasive alien plant species found in Nepal are *Eichhornia crassipes (*Water hyacinth*), Ipomoea carnea* (Bush morning glory), *pistia stratiotes* (water lettuce) etc. (Shrestha,2016; Wagle et al.,). Some terrestrial harmful invasive plants are *Ageratum conyzoides, Ageratum houstonianum, Mikania micrantha, Parthenium hysterophorus* etc. Invasive species compete directly with native species for moisture, sunlight, nutrients and space and overall plant diversity can be decreased. Establishment and spread of invasive species can degrade wildlife habitat, degraded water quality, increased soil erosion decreased recreation opportunities.

Indeed, the number of new recordings of invasive alien species (IAS) have incessantly increase worldwide during last 200 year, but more than a third of all first introduction were recorded between 1970 and 2014 (Seebens et al 2017) over last 30 years numerous studies have demonstrated the negative effect of IAS on natural biodiversity from genetic to the ecosystem and landscape lever (Largiader 2008;

Kumschick et al., 2015). IAPs has a detrimental impact on rural populations livelihoods (Rai et al.2012). *Mikania micrantha, parthenium hysterophorus* which prevents grass growth and tree regeneration has a substantial negative influence on 44%of the threatened one-horned rhinoceros is Chitwan national park (Murphy et al.,2013). Invasive alien species were acknowledged as a threat to all levels of biodiversity in a in angular biodiversity strategy for Nepal (MoFSC,2002).

The introduction and establishment of invasive species continue to increase with world trade, and there appears to be no sign of saturation for most taxonomic groups. Invasive species have significant impacts on ecosystems, ecological processes, and both local and national economics. They can substantially alter the composition, structure, or function of native terrestrial and aquatic systems. Their impacts may occur directly or indirectly at the genetic, organism, population, community, and ecosystem levels. influences on 44%of the threatened one-horned rhinoceros is Chitwan national park (Murphy et al.,2013). Invasive alien species were acknowledged as a threat to all levels of biodiversity in an in angular biodiversity strategy for Nepal (MoFSC,2002).

Objectives of Study

- To find out the number of different invasive species present in study area.
- To find out the impact of invasive alien plant species (IAPs) on biodiversity, ecosystem.

Material and Method

Study Area

The study was conducted in kankali community forest khairahani -4 chitwan Nepal (figure below). It lies at a longitude and latitude 84.5641°E 27.6427°N and altitude 203.54 m with total area of 760.5 hector. The study side lies in the tropical and subtropical zone of Nepal which is characterized by *shorea robusta* (sal) forest, *Dalbergia sissoo* (sissoo) forest and others. Though the regions are rich in plant diversity but due to invasive species and anthropogenic disturbance some of species are on state of extinction.

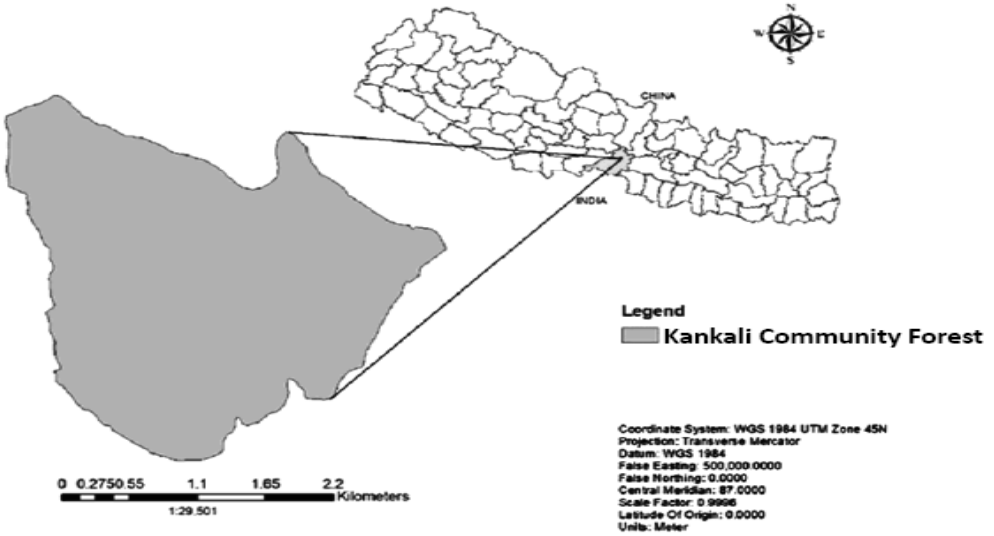

Figure 1: Map of Nepal highlighting kankali community forest (www.google.com).

Methodology

Nature and Sources of Data

The current research work was based on both primary and secondary data. Primary data were collected from the field study, interview, direct observation, informal discussion and secondary data were collected from the relevant literature, textbooks, journals, research papers, articles publications as well as from different websites.

Sampling Method and Sampling Size

For the research work,10m x 10m quadrat was taken in study area where we took 10 places. Randomly quadrat was thrown in forest and invasive species were counted in the area. Local people were interviewed about their knowledge in the native plant and invasive alien plants Species.

Different Sources for the Collection of Information

Field Visit

For these research work, different sites of kankali community forest were visited time and again for the collection of required information from July to august, 2024. Direct observation was done to collect the information from which frequency, relative frequency, density, relative density, coverage, relative coverage, IVI were studied.

Data Analysis: Both qualitative and quantitative technique were used for data analysis. Density, frequency and coverage were calculated. The analysis was interpreted in simple and understandable forms.

Frequency, Density, Coverage, and IVI:

Frequency and Relative Frequency: Frequency and relative frequency are calculated as,

$$\text{Frequency (F)} = \frac{Total\ no.of\ quadrate\ in\ which\ plant\ species\ occured}{Total\ no.of\ quadrate\ studied} \times 100\%$$

Relative Frequency (RF): It is the ratio of the number of quadrants in which a specific species is present to the total number of quadrants studied. It is expressed as a percentage.

$$\text{Relative frequency (RF)} = \frac{Frequency\ of\ individuals}{Total\ frequency\ of\ all\ species} \times 100\%$$

Density and Relative Density:

Density and relative density are determined as,

$$\text{Density(D)} = \frac{Total\ no.of species\ in\ all\ quadrants}{Total\ no.of\ quadrant\ studied}$$

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

Coverage and Relative Coverage:

Coverage and relative coverage can be calculated as;

$$\text{Coverage(C)} = \frac{Total\ area\ coverage\ of\ individual}{Species\ in\ all\ quadrant}$$

$$\text{Relative Coverage (RC)} = \frac{Total\ coverage\ of\ individual\ species\ in\ all\ quadrant}{Total\ coverage\ of\ all\ species} \times 100$$

Important Value Index (IVI)

The Important Value Index (IVI) in the quadrant method is a measure used to examine the significance of a plant species within a particular area. It is a standard tool used for vegetation analysis. The IVI can be calculated as,

$$IVI = RF + RD + RC$$

Result and Discussion

Requisite Size and Number:

To determine the appropriate size and number, the quadrat method is used. The entire set of observation was made with the necessary sized quadrat (10m10m) is thrown in order to calculate frequency, density and coverage and the result were documented (Table 1).

Table 1: History of IAPS.

S.N.	Scientific name of the species	Local name	First reported in Nepal (AD)
1	*Mycania micrantha*	Laharo Banmara	1966
2	*Chromolaena odorata*	Seto Banmara	1956
3	*Ageratina Adenophora*	Kalo Banmara	1952
4	*Ageratum houstonianum*	Nilo Gandhe	2000
5	*Ageratum conizoides*	Seto Gandhe	1910
6	*Mimosa pudica*	Namaste	1910
7	*Parthenium hysterophorous*	Pati Jhar	1967
8	*Erigeron karvinskinanus*	Phoole Jhar	Unknown
9	*Leersia hexandra*	Karaute Jhar	Unknown
10	*Senna tora*	Sano Tapre	1910
11	*Xanthium hexandra*	Vedo Kuro	1952
12	*Spermacoce alate*	Aalu Pate	Unknown
13	*Euphorbia hirta*	Dudhe Jhar	Unknown
14	*Bidens Pilosa*	Kalo Kuro	Unknown
15	*Mesosphaerum suaueolen*	Ban silam	1910
16	*Oxalls articulata*	Chari Amilo	1954

Observation for Requisite Size and Requisite Number:

The study conducted in the Kankali Community Forest of Chitwan, Nepal, aimed to assess the impact of invasive alien species (IAS) on the native biodiversity using the quadrat method. Systematic sampling approach was used the required size of the quadrat is found to be 10m10m and the required number of the quadrats is found to be 10. A quadrat is constructed to findout a species area of the community to be sampled.

Frequency and Relative Frequency:

In Kankali Community Forest, *Chromoiaena odorata* has the highest average frequency and relative frequency (i.e., f = 90% and Rf = 11.54). The 2nd highest invasive species is *Mycania micrantha* with (f = 80% and Rf = 10.25). Here, *Ageratum houstonianum*, *Erigeron karvinskinanus* and *Oxalis articulata* has the medium range of frequency and relative frequency (i.e. f = 50% and Rf = 6.41) which is noted among the invasive plant species. Other species with a lower frequency and relative frequency are *Leersia hexandra* and *Euphorbia hirta* (f = 20% and Rf = 2.56).

Density and Relative Density:

The average density and relative density of *Chromoiaena odorata* is (D= 24.8 and RD = 18.66) which is the maximum density and relative density among all species and *Oxalis articulata* with (D = 15.5 and RD = 11.66) and *Mycania micrantha* with (D = 15.2 and RD = 11.43) was found to be the 2nd highest in density and relative density among all the species. Likewise, *Leersia hexandra* and *Ageratum conizoides* with (D = 3.2 and RD = 2.41) was found to be those species which has least range of density and relative density among other species.

Coverage and Relative Coverage

The average coverage and the relative coverage of *Bidens pilasa* (C = 31.66 and RC = 11.72) and *Oxalis articulata* (C=31 and RC=11.48) was maximum. It means *Bidens pilasa* and *Oxalis articulata* covers the maximum area in sampled quadrat. Other dominating species in this area are *Chromoiaena odorata (C*=27.5 and RC=10.18), *Mesosphaerum suaveolens* (C=21.5 and RC=7.96), *Erigeron karvinskinanus* (C=20.4 and RC=7.55), *Mycania micranth* (C=19 and RC=7.04). The species with the lowest coverage and relative coverage are *Ageratum houstonianum* (C=8.2 and RC=3.03) and *Ageratum adenophora* (C=8.5 and RC= 3.14).

Importance of Value Index (IVI)

Table 1: Observation for frequency, density, coverage and IVI.

S. N	Name of species	F	RF	D	RD	C	RC	IVI
1.	*Mycania micrantha*	80	10.25	15.2	11.43	19	7.04	28.71
2.	*Chromolaena odorata*	90	11.54	24.8	18.66	27.5	10.18	40.38
3.	*Ageratina adenophora*	40	5.13	3.4	2.58	8.5	3.14	10.83
4.	*Ageratum houstonianum*	50	6.41	4.1	3.08	8.2	3.03	12.53
5.	*Ageratum conizoides*	30	3.84	3.2	2.41	10.66	3.94	10.19

6.	*Mimosa pudica*	60	7.86	5.9	4.44	9.83	3.64	15.76
7.	*Parthenium hysterophorus*	60	7.69	9.3	7.07	15.5	5.74	20.43
8.	*Erigeron karvinskinanus*	50	6.41	10.2	7.67	20.4	7.55	21.63
9.	*Leersia hexandra*	20	2.56	3.2	2.41	16	5.92	10.89
10.	*Senna tora*	60	7.69	6.0	4.51	10	3.70	15.9
11.	*Xanthium strumarium*	70	8.97	6.8	5.11	9.71	3.59	17.67
12.	*Spermacoce alate*	30	3.84	3.5	2.63	11.66	4.31	10.79
13.	*Euphorbia hirta*	20	2.56	3.7	2.78	18.5	6.85	12.19
14.	*Bidens pilosa*	30	3.84	9.5	7.14	31.66	11.72	42.65
15.	*Mesosphaerum suaveolens*	40	5.12	8.6	6.47	21.5	7.96	19.55
16.	*Oxalis articulata*	50	6.41	15.5	11.67	31	11.48	29.55

The observed data shows the relative frequency, relative density, relative coverage, and importance value index (IVI) of different species in the field (Table no 1). This observation shows that the IAPs occupy less area than those of non-IAPs species (Figure 3).

During vegetation analysis by the quadrat method (table no. 1), the IVI ranges from 42.646(*Bidens pilosa*) to 10.193 (*Ageratum conizoides*). During vegetation analysis, the IVI shows relative dominance. From the above table *Bidens pilosa* is the most dominant species among all 32 herb species having an IVI of 42.646 whereas *Ageratum conizoides* is the least dominating species with an IVI value of 10.193. *Chromolaena odorata* is the second most dominant species in the field. The other dominating species are *Oxalls articulata* (29.55), *Mycania micrantha* (28.717) and *Erigeron karvinskinanus* (21.63). *Bidens pilosa* is the most dominating species in the field among all. *Ageratum conizoides* is the least spread species among IAPs species.

Overall, 71% of the area is covered by non-IAPs species out of which 16% area is covered by tree species and 29% of the area is covered by IAPs (Fig. 4.1). The average IVI of IAPs is found to be 42.646. This indicates that the average IVI of IAPs is higher than that of non-IAPs species. This disparity could be attributed to 16 IAPs species occupying 29% of the area, while the remaining 71%n of the area contains 7 non-IAPs species, with an additional 16% being occupied by tree species that contribute to the overall composition of the area.

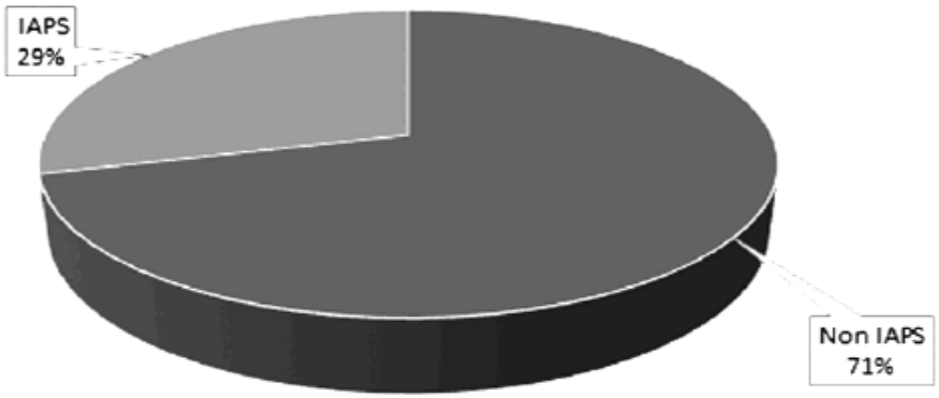

Figure 2: Distribution of Vegetation in Kankali community forest

Impacts of IAPS

The interview was conducted with people from the Kankali Community Forest located in Parsa, Chitwan. Twenty respondents were selected by random sampling method from different section of the community. Out of twenty respondents, all respondents (i.e., 100% of the people) mainly focused on the reduction in biodiversity and the degradation of forest quality.

After the introduction of Invasive Alien Plant Species (IAPs). The introduction of IAPs has led to a decline in the quality and availability of native vegetation, causing severe ecological imbalance. The uncontrolled spread of IAPs in the forest has resulted in the loss of medicinal plants and other economically important species, increasing the difficulty of resource collection. Additionally, 20% of people of respondents noted an increase in the presence of disease-causing agents and crop-feeding insects, possibly due to IAPs acting as alternative shelters of these pestsThese IAPs has also significantly impacted areas outside of the forest. For instance, 46% of respondents reported pastureland degradation, which negatively affects cattle farming and goat-keeping, essential livelihoods in the community. Similarly, 26% of people were affected by forest degradation, and 28% reported the loss of native vegetation. The presence of these IAPs has particularly reduced the availability of young plants, which are essential for the regeneration of the forest ecosystem.

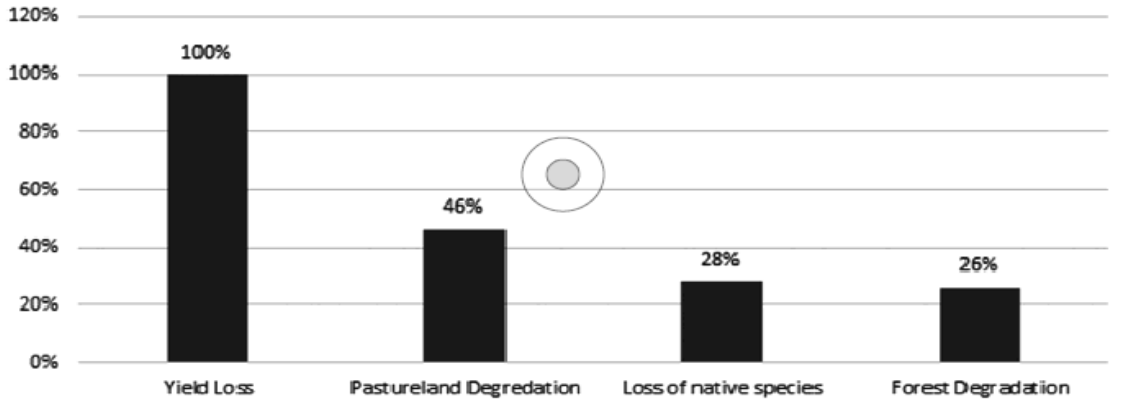

Figure 3: Impact of IAPS

In conclusion, the spread of IAPs in the Kankali Community Forest has resulted in ecological degradation, economic loss, and health risks to the local community, making the management of these species a critical issue for the sustainability of the forest and the livelihoods dependent on it.

Conclusion and Recommendation

Conclusion

The study conducted on the impacts of Invasive Alien Plant Species (IAPS) in the Kankali Community Forest, Chitwan, led to the following conclusions:

Diversity of IAPs: There were 16 species of IAPs identified in the Kankali Community Forest.

Introduction and Spread: The origin of these IAPs was largely unknown, but they were likely introduced through contaminated seeds, agricultural tools, and the movement of goods. Their uncontrolled spread has been a significant issue in the forest.

Dominance of Species: Among these species, *Chromolaena odorata and Ageratina adenophora* were found to be the most dominant, outcompeting native vegetation and causing significant ecological changes in the forest ecosystem.

Coverage: The IAPs have spread extensively, covering approximately 35% of the forest area, leading to a significant reduction in the presence of native species.

Negative Impacts: The primary negative impacts of IAPs in the Kankali Community Forest included the degradation of pastureland, loss of native species, forest degradation, and the introduction of diseases that affect crops. These impacts have had a detrimental effect on both the environment and the livelihoods of local communities.

In summary, while the presence of IAPs in the Kankali Community Forest poses significant challenges, the community has developed various strategies to manage and even utilize these species for beneficial purposes, although the ecological impact remains a concern.

Recommendations

The following recommendations are suggested to control the introduction and spread of Invasive Alien Plant Species (IAPs) in the Kankali Community Forest, Chitwan:

Awareness Programs: Local communities in the Kankali Community Forest area need to be educated about the dangers of IAPs.

Assessment and Control Measures: A detailed study should be conducted to assess the actual ecological and economic losses caused by IAPs. Based on this data, appropriate control measures should be developed and implemented to mitigate these losses.

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