
Butwal Campus Journal, Vol. 5, No. 1: 123-142, July 2022

Research Management Cell, Butwal Multiple Campus, Tribhuvan University, Nepal

DOI: <https://doi.org/10.3126/bcj.v5i1.50193>

IMPACT OF INVASIVE ALIEN PLANT SPECIES ON NATIVE VEGETATION OF CHHATRAKOT RURAL MUNICIPALITY, GULMI DISTRICT, LUMBINI PROVINCE

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Article History: Received 12 May 2022; Reviewed 07 June 2022; Revised 11 July 2022; Accepted 27 July 2022

ABSTRACT

Fieldwork was carried out in February to April 2022. The use and distribution of IAPS and their management were recorded through the application of checklists and semi-structured questionnaires. Present research shows the presence of 10 invasive alien plant species from the study area. The main invasive species include *Ageratina adenophora*, *Ageratum conyzoides*, *Ageratum houstonianum*, *Bidens pilosa*, *Chromolaena odorata*, *Parthenium hysterophorus*, *Mimosa pudica*, *Oxalis latifolia*, *Senna tora*, and *Xanthium strumarium*. *Bidens pilosa*, one of these IAPS, is the species that is most common in agricultural areas, whereas *Ageratina adenophora* is the species that is most common in grasslands and forest borders. Significant IAPS in agricultural lands include *Ageratum conyzoides*, *Ageratum houstonianum*, and *Oxalis latifolia*, which have an immediate impact on the vegetation of the rural municipality of Chhatrakot. It was discovered that *Ageratina adenophora* was introduced around 20–25 years ago when road tracts were opened, despite the fact that the past of many IAPS was unknown. Ploughing, picking, burning, and composting are some common practices used to manage these IAPS in Chhatrakot rural municipality.

Keywords: Anthropogenically, Ecosystem, Intentional and unintentional, Invasive alien plant species.

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). They alter the current ecological diversity and pose a threat to local plant species. The IAPS predators that normally maintain control over those species could not exist in a new habitat. Therefore, the population of these invasive species grows quickly. The variety and make-up of species are impacted by the ecological introduction of a new species to a region. Since invasive species play a significant role in ecosystem change and the altering of food webs, they are regarded as the second most serious threat to biological diversity after habitat fragmentation. Their beneficial effects are also taken into account; examples include the decorative value, option and existence value, and value as food sources for some species. Following the introduction, IAPS was spread out and established locally based on the resources that were available and human activity. Therefore, the majority of invasive alien plant species (IAPS) are found in anthropogenically altered landscapes such degraded forests, pastureland, and residential areas. They are less prevalent in protected forests and other locations with fewer anthropogenically altered landscapes.

There are approximately 995 invasive species worldwide, according to the IUCN Global Invasive Species Database. A number of valued and endangered species are at risk of extinction due to invasive alien species that displace native species from their natural habitats. Worldwide biological invasion, although being a natural phenomenon, poses a danger to biodiversity, native vegetation, ecosystem dynamics, resource availability, national economies, and the health of animals and plants (Ricciardi et al., 2000). The majority of invasive plant species originated in South America and was brought to the Indian subcontinent as ornamentals or fodder crops in the early 20th century (Lowe et al., 2000). There are at least 219 alien species of flowering plants (Tiwari et al 2005, Siwakoti 2012) that are naturalized in Nepal. The worst invasive species in the world include *Lantana camara*, *Mikania micrantha*, *Chromolaena odorata*, and *Eichhornia crassipes*. Compared to central and eastern Nepal, western Nepal contains less invasive alien plant species (IAPS) (Shrestha et al., 2017). An assessment of IAPS was undertaken for the first time by IUCN Nepal during 2002-2003 and reported 21 naturalized flowering plant species to be invasive in Nepal (Tiwari et al 2005). Human activities have a significant role in the introduction of invasive species, and both natural and artificial mechanisms

were involved in their dissemination. Although its effects have not been well examined, the IAPS has an impact on both manmade and natural environments in Nepal. IAPS has a detrimental impact on rural populations' livelihoods (Rai et al., 2012). *Mikania micrantha*, which prevents grass growth and tree regeneration, has a substantial negative influence on 44% of the habitat of the threatened one-horned rhinoceros in Chitwan National Park (Murphy et al., 2013). Invasive alien species were acknowledged as a threat to all levels of biodiversity in the inaugural biodiversity strategy for Nepal (MoFSC, 2002), but no management measures were provided. In the National Biodiversity Strategy and Action Plan 2014-2020, the danger presented by invasive alien species to biodiversity and ecosystem functioning of wetlands, agro-ecosystems, rangelands, etc. has been effectively taken into consideration (MoFSC, 2014a). Local people in Chitwan were able to eradicate *E. crassipes* and *Pistia* species from Tikauli Lake, which is a component of the Bishajari Lake System (WWF Nepal 2013). One of the major dangers to several protected regions, especially the Terai region of Nepal, is the introduction and spread of IAPS. The IAPS, which included *C. odorata*, *M. micrantha*, and *L. camara* was the most prevalent and troublesome species in the Terai conservation areas of Nepal (Bhujju et al., 2013).

In the case of the Chhatrakot Rural Municipality, some of the most significant invasive species in this region include *Ageratina adenophora*, *Chromolaena odorata*, *Mikania micrantha*, *Mimosa pudica*, and *Oxalis latifolia*. They are primarily found in grassland and agricultural settings. The invasion increases in both intentional and unintentional break out of invasive species outside their specific habitat. The invasive species introduced in the new region may be through agriculture, horticulture, and contamination of seeds or goods.

The unintentional movement of an organism may be through the movement of peoples or goods or through contamination with seeds, stowaway with any vehicles and equipment, or through water vessels. The seeds of any invasive species may also release through contamination in association with any organism or habitat.

Although IAPS is a threat to the world's ecosystem they are also beneficial to some extent. These IAPS can survive in more adverse conditions and spread rapidly. The degraded land can be covered rapidly. Besides this, they are also helpful to capture increased atmospheric CO₂ levels. Some of the IAPS can be used as fuel, fodder, and medicine. They also help in soil erosion control and soil reclamation. They also can be converted into renewable biofuels which reduces the net energy cost and unwanted plants

are used for a beneficial purpose. Although IAPS is a threat to native vegetation and the ecosystem.

RESEARCH METHODOLOGY

Study area

The study was conducted in Chhtrakot Rural Municipality in the Gulmi district of Lumbini province (Figure 1). It lies at a latitude of 28°3' N and a longitude of 83°21'E with total area of 87.01 sq. km. The study site lies in the tropical and sub-tropical zone of Nepal which is characterized by *Schima- Castonopsis* forest and pine forest along with others. Though the region is rich in plant diversity but due to anthropogenic disturbances some of the species are on state of extinction. The land on the research site is sloppy with clayey loam and silty clay soil types.

The average maximum temperature ranges between 28.45-40.04°C and the minimum temperature range between 11.59-15.81°C and the average precipitation of 25.32mm/1.0 in (Meteorological forecasting division Ridibazar, Gulmi 2020).

For the research work the six wards of Chhatrakot Rural Municipality were considered as the six field plots (Figure 2).

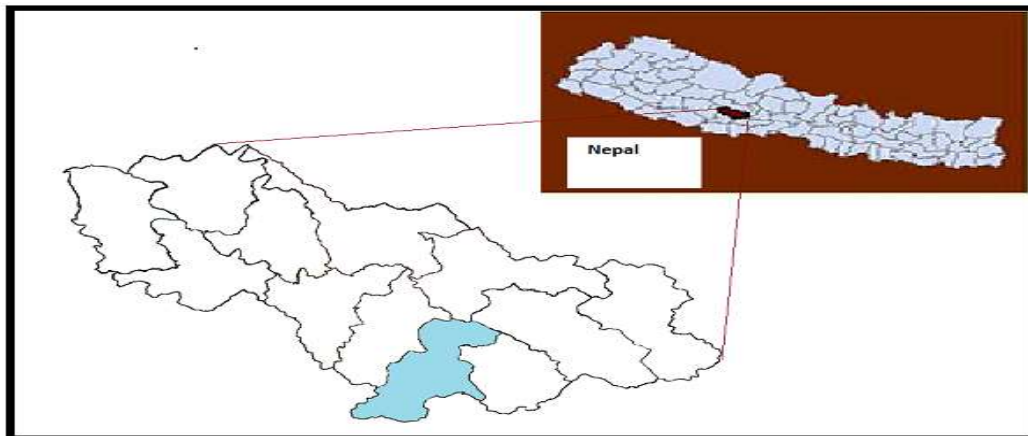
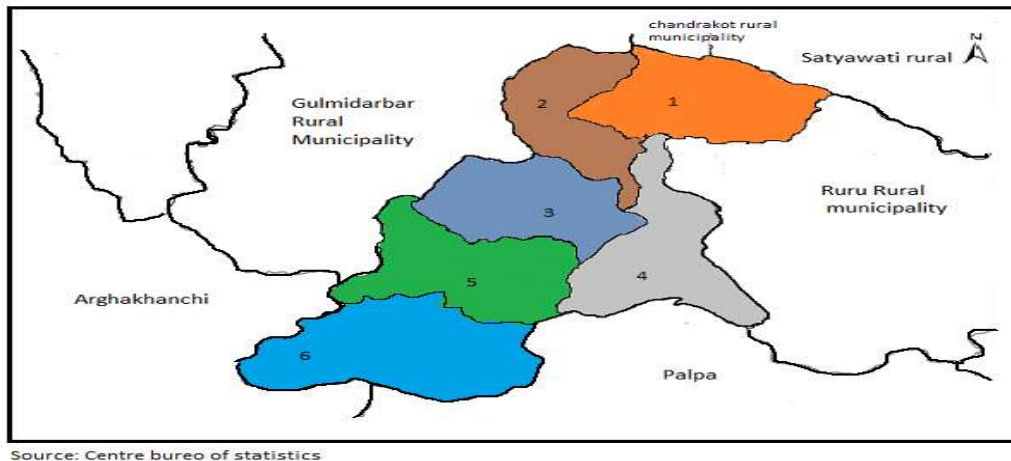


Figure 1: Gulmi district in map of Nepal.



Source: Centre bureo of statistics

Figure 2: Map of Chhatrakot Rural Municipality

Research design

The purposed research follows both descriptive and explanatory design. The research was carried out to find the invasive alien species and their impact in six wards namely Hunga, Palkikot, Hardineta, Digam, Kharjyang and Daungha of Chhatrakot Rural Municipality. This study also tried to explain the history and knowledge about IAPS among local.

The present research work is based on primary and secondary sources of data, where primary source of data is the first-hand fresh data taken by researcher. It is the raw form of data. In this study, observation is done for vegetation analysis by using quadrat method. An interview was conducted among local people of Chhatrakot Rural Municipality.

Data collection

Requisite size and number: For the requisite size and number quadrat method is applied. The requisite size of the quadrat is calculated by using a measuring scale thread and four nails in a random field. For requisite number, the quadrat of requisite size is thrown in a random field until steady reading.

Frequency, Density, Coverage, and IVI: From February to April 2022, the entire set of observations was made. The necessary-sized quadrat is thrown in order to calculate frequency, density, and coverage, and the results were documented. The six wards of the

Chhatrakot Rural Municipality are used as the six plots for the analysis of the vegetation. Following formulae were used to calculate frequency, density, and coverage:

Frequency and Relative Frequency: Frequency is the percentage of the total quadrat containing at least one rooted individual of a particular species as per Misra, 1968.

$$\text{Frequency (F)} = \frac{\text{Total no of quadrat in which plant speci occurred}}{\text{Total no of quadrare studied}} \times 100\%$$

Relative frequency is the frequency of one species as a percentage of total plant frequency as per Misra, 1968.

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

Frequency class (FC): Raunkiaer (1934) prepared the following frequency diagram based on the species % frequency and number of species belongs to concern frequency class. (Frequency class: A=1-20%; B=21-40%, C=41-60%, D=61-80% and E=81-100%). The normal species occurrence ratio given by Raunkiaer is A>B>C>=D<E

Density and Relative Density: Density is defined as the number of individuals of a particular species present per unit area. The study of density arises from the relative density of different plant species. Relative density is determined as the ratio of all species as per Misra, 1968.

$$\text{Density (D)} = \frac{\text{Total no of species in all quadrat}}{\text{Total no of quadrare studied}}$$

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

Coverage and Relative Coverage: Coverage can be defined as the area occupied by individual species which is expressed in %, measured in a sample of quadrat while the relative coverage is the percentage ratio of total coverage of individual species to total coverage of all species. The measure of coverage gives the extent or amount to which something is covered.

Coverage and relative coverage can be calculated as per Curtis and McIntosh (1951) and Zobel et al., (1987);

$$\text{Coverage (C)} = \frac{\text{Total area coverage of individual species in all quadrat}}{\text{Total number of quadrat studied}}$$

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

Importance value index (IVI): The importance value index (IVI) is a measure of how dominant a species is in a given area. It is a standard tool used for vegetation analysis. It shows the complete or overall ecological status of the species in a community. The structure of IVI is calculated by studying the frequency, density, and coverage of species. The IVI ranges between 0 and 300. The IVI can be calculated as;

$$\text{IVI} = \text{Relative frequency} + \text{Relative density} + \text{Relative coverage}$$

Using pre-designed questionnaires, a survey was carried out between February and April 2022 among residents of Chhatrakot Rural Municipality. 50 respondents were chosen at random to participate in the interview, and we made an effort to include people from a variety of backgrounds. The interview was conducted to ascertain local residents' awareness of the background, applications, and effects of IAPS. Books and research articles that are linked to IAPS were used to gather secondary data.

Data analysis: Both qualitative and quantitative techniques were used for data analysis. Density, frequency, and coverage were calculated. The analysis was interpreted in simple and understandable forms. The climatic characteristics of this study area were collected in terms of average temperature range and annual precipitation from hydrology and meteorological station Ridibazar, Gulmi.

STUDY RESULTS

Observation for requisite size and requisite number

For the vegetation analysis of herb species, the quadrat method of herb analysis is used. A quadrat is a frame that is laid down to mark out a specific area of the community to be sampled. Within the quadrat frame, the occurrence of plants is recorded using an appropriate measure of abundance. By using the quadrat method, the requisite size of the quadrat is found to be 35 X 35 cm² and the requisite number of the quadrat is found to be 8.

Table 1: Observation for frequency, density coverage and IVI

SN	Name of species	F	RF	D	RD	C	RC	IVI
1	<i>Bidens pilosa</i> L.	81.25	10.77	3.83	0.16	8.43	12.05	22.98
2	<i>Cynodon dactylon</i> (L.) Pers	56.25	7.45	2.43	0.10	5.31	7.58	15.14
3	<i>Parthenium</i> <i>hysterophorus</i> L.	33.33	4.42	0.88	0.03	7.73	7.73	12.19
4	<i>Ageratum</i> <i>haustanianum</i> Mill.	29.17	3.86	1.12	0.04	4.31	4.31	8.22
5	<i>Ageratina</i> <i>adenophora</i> (Spreng.) King & H.Rob.	50	6.62	1.60	0.06	5.95	5.95	12.64
6	<i>Artemisia vulgaris</i> L.	35.42	4.69	0.89	0.03	5.26	7.51	12.24
7	<i>Mentha spicata</i> L.	2.08	0.27	0.06	0.002	0.05	0.07	0.35
8	<i>Rumex crispus</i> L.	2.08	0.27	0.06	0.002	0.31	0.44	0.72
9	<i>Equisetum</i> <i>sps.</i>	2.08	0.27	0.04	0.001	0.05	0.07	0.35
10	<i>Eulaliopsis binata</i> (Retz.) C.E. Hubb.	2.08	0.27	0.02	0.0009	0.31	0.44	0.72
11	<i>Mimosa pudica</i> L.	12.5	1.65	0.29	0.01	0.83	1.19	2.86

Frequency and relative frequency

Frequency is the percentage of the total quadrat containing at least one rooted individual of a particular species. It gives how often a species repeat on observing several species in quadrat.

In Chhatrakot Rural Municipality, *Bidens pilosa* has the highest average frequency and relative frequency (i.e. F= 81.25% and RF= 10.77%) followed by *Cynodon dactylon* (F=56.25 and RF= 7.45) and *Ageratina adenophora* (F=50% and RF=6.62%). Other species with higher frequency among these herbs are *Axonopus compressus* (F= 10.42% and RF=1.38%, *Capillipedium* *sps.* (F=14.58% and RF=1.93%). *Rumex crispus* and *Equisetum* has lowest frequency (i.e. F=2.08% and RF= 0.27%). Other species with a lower frequency and relative frequency are *Eulaliopsis binata* (F=2.08% and RF=0.27%), *Mentha speciata* (F=2.08% and RF=0.27%), and *Tridax procumbens* (F=4.17% and RF==0.55%). In the study area, *Bidens pilosa* and *Ageratina adenophora* are the most frequent species among IAPS. *Cynodon dactylon* is most common species among non

IAPS. Other non-IAPS species with higher frequency are *Axonopus compressus*, and *Capillipedium sps.* Thapa and Maharjan (2014) found *Ageratina adenophora* as the most frequent species in the Annapurna conservation area while in Chhatrakot Rural Municipality, *Ageratina* is the second most frequent species among IAPS and the most frequent species in the non-agricultural field.

Density and relative density

Density is defined as the number of individuals of a particular species present per unit area. The study of density arises from the relative density of different plant species. Relative density is determined as the ratio of all species. The average density of *Bidens pilosa* was found to be 3.83 which is the maximum average density among all species with a relative density of 0.16. *Cynodon dactylon* (D=2.43) has the second-highest density and relative density and the highest among non-IAPS. *Imperata* also has a higher density and relative density among non-IAPS (i.e. D=2.04 and RD=0.08). In ward no 3 the density of *Cynodon dactylon* is found to be higher than that of *Bidens pilosa*. *Eulaliopsis binata* has the lowest density among all species with a density of 0.021 and a relative density of 0.0009. The other species with less density and relative density are *Digitaria sanguinalis* (D= 0.12 and RD= 0.05), *Equisetum* (D=0.04 and RD= 0.0017), *Mentha spicata*. (D=0.03 and RD=0.003). The density and relative density of *Mimosa pudica* was found to be minimum (i.e. D=0.29 and RD=0.01) among non-IAPS. *Ageratina adenophora* has the second-highest density among IAPS which is similar to that found in the Annapurna conservation area by Thapa and Maharjan (2014).

Coverage and relative coverage

Coverage can be defined as the area occupied by individual species which is expressed in %, measured in a sample of quadrat while the relative coverage is the percentage ratio of total coverage of individual species to total coverage of all species.

The average coverage of *Bidens pilosa* (8.43) was maximum. It means *Bidens pilosa* covers the maximum area in sampled quadrat. Other dominating species in this area are *Parthenium* (C=5.41; RC=7.73), *Cynodon dactylon* (C=5.31; RC=7.58), *Artemisia vulgaris* (C=5.26 and RC=7.51) and *Ageratina adenophora* (C=4.17 and RC=5.95). The species with the lowest coverage and relative coverage are *Mentha spicata* (C=0.05) and *Equisetum sps* (C=0.05). Other species with lower coverage are *Eulaliopsis binate*

(C=0.31), *Rumex crispus* (C=0.31), *Capillipedium* (C=0.36) and *Mimosa pudica* (C=0.83). *Cynodon* has the highest coverage among non-IAPS and *Mimosa pudica* has the lowest coverage among IAPS.

Importance value index (IVI)

The importance value index (IVI) is a measure of how dominant a species is in a given area. It is a standard tool used for vegetation analysis. It shows the complete or overall ecological status of the species in a community. The structure of IVI is calculated by studying the frequency, density, and coverage of species. The IVI ranges between 0 and 300.

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 22.98(*Bidens pilosa*) to 0.35 (*Mentha spicata*). 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 22.98 whereas *Mentha spicata* is the least dominating species with an IVI value of 0.35. *Cynodon dactylon* is the second most dominant species in the field and the most dominant among non-IAPS species with an IVI value of 15.14. The other dominating species are *Ageratina adenophora* (12.64), *Parthenium hysterophorus* L. (12.19) *Imperata* (11.57) and *Cyperus* (10.05). *Bidens pilosa* is the most dominating species in the field among all while *Cynodon dactylon* is the most dominant species among non-IAPS species. *Mimosa pudica* is the least spread species among IAPS species (IVI=2.86) while the *Mentha spicata* is found to be the least dominant species in this season.

Overall 71% area is covered by non-IAPS species and 29% of the area is occupied by IAPS species (fig.4.1). The average IVI of IAPS is found to be 11.78 and that of non-IAPS is 5.07. this data shows that the average IVI of IAPS is higher than that of non-IAPS species. This may be due to only five species of IAPS occupying the 29% area whereas the remaining 71% area contains 28 non-IAPS species.

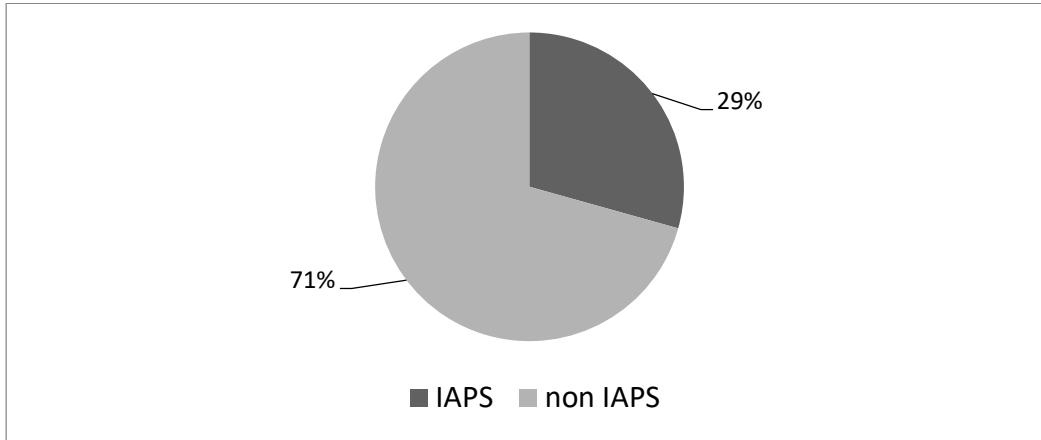


Figure 3: Distribution of IAPS and non IAPS species

Diversity of IAPS

The IAPS is the most threat to native vegetation. Impacts of *Ageratina adenophora* were well observed throughout the study area. Edges of forests, agricultural lands, wetlands, and roads were invaded by the species. The abandoned agricultural lands and adjoining forests served as a good refuge for *Ageratina adenophora*.

Among the IAPS *Bidens Pilosa* is the most spreading species in Chhatrakot which is becoming problematic in both agricultural as well as Non- agricultural fields. *Bidens* occupy about 39% distribution among IAPS only. Other most spreaded species are *Ageratina adenophora* and *Parthenium* with 21% IVI among IAPS. *Mimosa pudica* is the least spreaded species among IAPS with a 5% distribution (Figure 4).

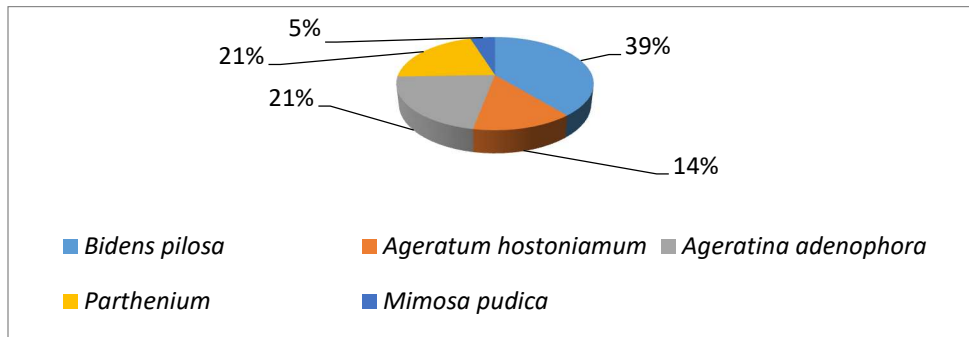


Figure 4: Distribution of IAPS in Chhatrakot

Table 2: History of IAPS.

S.No.	Scientific of the species	Local name	First reported in Nepal (AD)	First time reported in study area (AD)
1.	<i>Bidens pilosa</i>	Kalo kuro	1910	Not known
2.	<i>Parthenium hysterophorus</i>	Pati jhar	1967	2012
3.	<i>Ageratina adenophora</i>	Kalo banmara	1952	1995
4.	<i>Ageratum conyzoides</i>	Gandhe jhar	1910	Not know
5.	<i>Ageratum houstonianum</i>	Nilo gandhe	1929	2000
6.	<i>Chromolaena odorata</i>	Seto banmara	1956	1995
7.	<i>Mimosa pudica</i>	Lajjawati jhar	1910	Not known
8.	<i>Oxalis latifolia</i>	Chariamilo	1954	1970
9.	<i>Senna tora</i>	Chakmake	1910	Not known
10.	<i>Xanthium strumarium</i>	Bhede kuro	1952	Not known

Source: Adhikari et al. 2022.

In Chhatrakot Rural Municipality, IAPS were introduced in different ways. Maximum people are unaware of the introduction of many IAPS and their introduction purposes. Only a few people know about the introduction of some IAPS. The actual history of *Ageratum conyzoides*, *Bidens pilosa*, *Senna tora*, and *Xanthium strumarium* is unknown in this area (Table 2). Many people confirm the introduction of *Ageratina adenophora* and *Chromolaena odorata* after the opening of road tracts near road and forest edges with an excavator and spreaded naturally. The pathway of the introduction of *Oxalis latifolia* is different in different wards. In ward no-1 (Huga) someone brings it for consumption as a pickle (intentional release) from Dharampani and spreaded as contamination with seeds and agricultural tools. In ward no 2 and 3 (Pallikot and Dharampani) it was introduced with seeds. It was first observe in Ward number 4 as contamination from Thorga-imported Ginger seeds. The consensus in Ward number 5 was that the introduction was caused by seed contamination. *Ageratum houstonianum* was imported with contaminated wheat seeds from the Terai and Palpa districts, according to respondents from several wards.

Impacts of IAPS

The interview was conducted with people of Chhatrakot Rural Municipality. Fifty respondents were selected by random sampling method from six wards of Chhatrakot Rural Municipality. Out of fifty respondents, all respondents (i.e. 100% people) mainly focused on the reduction of yield after the introduction of IAPS. With the introduction of such IAPS, the loss has appeared in all products and they increase the external effort on production. The loss may be due to the uncontrolled spread of IAPS in agricultural land.

Besides reduction in yield, about 16% of respondent's replies on increase in the chance of disease introduction and IAPS as an alternative shelter for disease causing agents and some crop feeding insects (Figure 5).

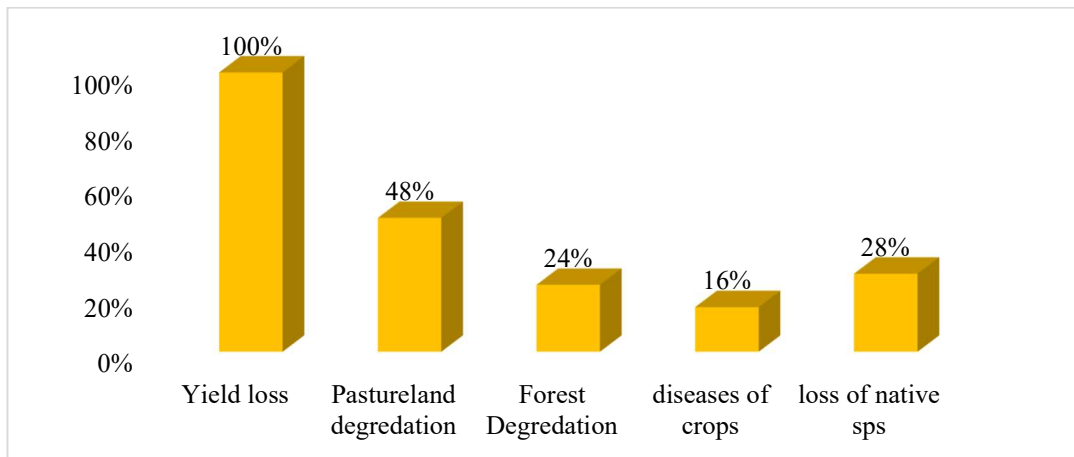


Figure 5: Effects of IAPS

Those IAPS also have impacts outside agricultural land. Outside agricultural land, the IAPS destroys the forest and pasture land, and there may be the destruction of native species. Out of fifty respondents, 48% of people are affected by pastureland degradation. They depend on pastureland for cattle farming and goat keeping. Similarly, 24% of people affected by forest degradation, and 28% of people replied about the loss of native vegetation loss. Due to the introduction of these IAPS findings of some medicinal plants, it became more difficult. 12 people out of 50 people respond to forest degradation. Forest degradation reduces the availability of some timber, fodder, medicinal plants, and many more. Some people depend on the forest for fodder, firewood, and medicinal plants. The young plants are mostly affected by these IAPS.

Management of IAPS

Many people ignore the impact of IAPS and use these for beneficial purposes. Many management practices (mechanical, chemical, and biological) exist for controlling the spread of IAPS. However in the study area, people are found practicing hand pulling, and ploughing to check the spread of IAPS in farmland (Figure 6). One important approach of biological method of IAPS management is the use of biological control agents. In Nepal, biological control agents are present only for two IAPS: leaf-feeding

beetle *Zygogramma bicolorata* Pallister and winter rust *Puccinia abrupta* var. *partheniicola*, Parmelee for *Parthenium hysterophorus* (Shrestha et al. 2015), and stem galling fly *Procecidochares utilis* Stone and leaf spot fungus *Passalora ageratinae* Crous and A.R Wood for *Ageratina adenophora* (Winston et al. 2014). However, these biological control agents were not introduced officially after quarantine screening but spread naturally into Nepal from India and other Asian countries. Recently, Nepal Agriculture Research Council (NARC) has imported two weevils *Neochetina eichhorniae* Warner and *N. bruchi* Hustache from the USA (Florida) as an effort to biological control *Eichhornia crassipes* and both these weevils are under laboratory trial 279 (Anonymous 2015a and b).

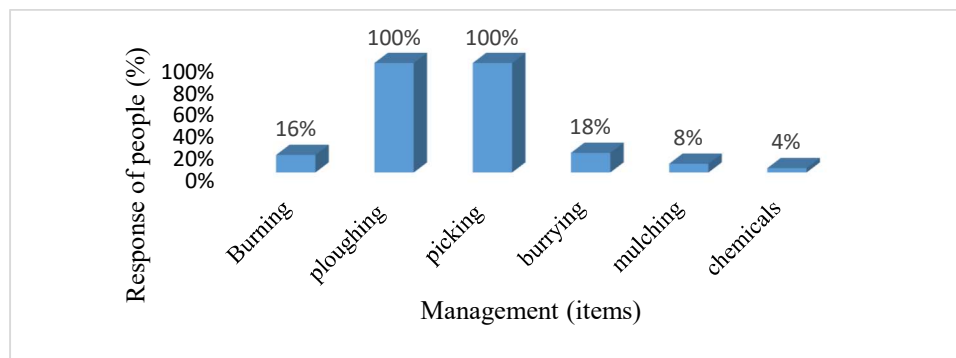


Figure 6: Management practices for IAPS in agricultural field

The management of IAPS was essential at this period of time. Among people of Chhatrakot Rural Municipality ploughing and picking is the most common practice for controlling IAPS as well as other weeds. All participants (i.e. 100% people) agree with ploughing and picking practice of weed control. After picking and the ploughing 18% of people prefer burying and 16% are burning the gathered weeds to control further spreading process. Besides these very few people use mulching practices and chemical control for Weed management. only about 8% of people use mulching paper for weed control and only 4% of people tried chemical control in the agricultural field.

Thapa and Maharjan (2014) found that traditional hand pulling and composting methods to check the IAPS in the Annapurna conservation area. In Chhatrakot, people use burning and composting along with hand picking and ploughing.

Uses of IAPS

By ignoring the effect of IAPS, they can utilize it for some beneficial purposes. IAPS can be used as fodder, medicine, fuel, and many more. People of this area use these IAPS for some purposes (Figure 7)

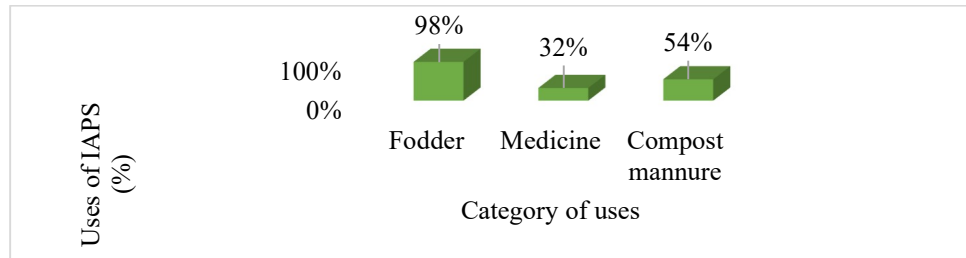


Figure 7: Uses of IAPS among peoples of Chhatrakot.

The IAPS has some beneficial uses too. Among the people, the survey shows that about 98% of people use some IAPS as fodder. About 32% of people use it as a medicine and 54% of people answered as compost manure. The use of these IAPS as a fuel was not practiced in Chhatrakot Rural Municipality. *Ageratum conyzoides*, *Bidens pilosa*, and *Mimosa pudica* were major fodder plants. *Ageratum houstonianum* was also used as fodder. *Ageratum* is used in fresh as well as in dried form. *Ageratina adenophora* was used as a medicinal plant for the treatment of wound healing. It facilitates the faster coating of blood. Some IAPS found in the agricultural field are used for compost manure.

Thapa and Maharjan (2014) found that the majority of people (72.1%) in the Annapurna conservation area, do not use any IAPS for any purposes. Besides this, they also found that 17.1% of people use *Ageratina* in composting. In Chhatrakot Rural Municipality, the majority of people (98%) use IAPS as fodder, 32% of people use *Ageratina adenophora* as a medicine for healing wounds, and of 54% people use some IAPS for composting.

DISCUSSION

In Nepal, biological invasion is becoming a major environmental issue that directly affects ecosystem services, economic growth, and biodiversity preservation. In recent decades, the number of invasive species and their abundance in Nepal has been expanding fast. This may be ascribed to local level causes like land use change, infrastructure

development, and greater human migration, as well as regional and global level forces like globalization of commerce and transit. Despite the fact that most of Nepal's national level legal documents do not adequately address the issue of biological invasion (Siwakoti and Shrestha 2014), the recently developed National Biodiversity Strategy and Action Plan (MoFSC 2014a) has acknowledged the issue of invasive alien species and included a number of management strategies. An essential initial step in the control of invasive species will be the efficient implementation of these measures within the allotted period. The assessment of the invasive species' effects on the environment and the economy might be the second crucial stage.

The majority of the invasive species' "impacts" are anecdotal. The government will be hesitant to provide funds to managing invasive species unless empirical and quantitative statistics on their impact are produced. This also relates to climate change, as biological invasion is projected to intensify as a result of human climate change (Simberloff, 2000). The development of a national plan for the control of invasive species is the third phase. The fact that "eradication" of invasive species is practically unattainable and that "management" necessitates the integration of many techniques at various levels of both temporal and geographical dimensions is an important lesson learnt thus far in the management of invasive species. Only the national policy for the management of invasive species makes this type of unification of management strategies and the limited resources available practicable. The scaling up of the national plan to the regional level is the fourth phase. It goes without saying that biological invasion is a trans-boundary issue, and efficient control of invasive species involves coordination of the strategies used by the nations with shared borders.

CONCLUSION AND RECOMMENDATION

Conclusion

Following conclusions were drawn from the study carried out on the impacts of IAPS in Chhatrakot Rural Municipality.

- There were mainly 10 species of IAPS found in Chhatrakot Rural Municipality. They are *Bidens pilosa*, *Ageratum conyzoides*, *Ageratum houstonianum*, *Ageratina adenophora*, *Mimosa pudica*, *Parthenium hysterophorus* L., *Senna tora*, *Xanthium strumarium*, *Oxalis latifolia*, and *Chromolaena odorata*.

- The history of IAPS was mainly unknown. They were mainly introduced with contamination with seeds and agricultural tools.
- Among these IAPS *Bidens pilosa* was the most dominant species in Chhatrakot Rural Municipality with IVI 22.9833.
- *Cynodon dactylon* was the second most spreader species and most dominant among non-IAPS. Whereas *Equisetum* and *Mentha spicata* has the lowest IVI (i.e. 0.352331).
- Overall 71% area was covered by non-IAPS species and whereas 29% of the area was covered by IAPS species.
- The main negative effect of IAPS faced by people of Chhatrakot Rural Municipality was yield loss followed by pastureland degradation, loss of native species, forest degradation, and diseases in crops.
- Ploughing and picking (by 100% people) was the main practice applied by the people of Chhatrakot Rural Municipality. The other practices were burying (by 18% of people), burning (by 16% of people) mulching (By 8% of people), and chemical control (by 4% of people).
- About 98% of people, use some IAPS as fodder, 54% of people used it to make compost manure, and about 32% of people use some IAPS as medicine.

Recommendation

Following recommendations were suggested to check the introduction and spread of IAPS in Chhatrakot Rural Municipality.

- In Chhatrakot Rural Municipality, peoples are unaware of IAPS. So, there should be conducted about an awareness program for local people.
- The actual loss should be calculated and the control measure should be applied to control loss.
- The spread of IAPS should be controlled by conducting a campaign.
- The awareness program should be conducted for local people on the negative impacts of IAPS on pastureland, forest, and native vegetation.
- Social institutions at the local level like mother's groups and youth clubs should be involved in cleaning campaigns.
- The other use (like making briquette or extraction of essential oil) of IAPS rather than traditional use should be initiated.

- Further research should be conducted to find the more economic use of IAPS.
- An awareness campaign should also be conducted about the importance of the conservation of native species.

ACKNOWLEDGEMENTS

Authors are thankful to the respondents of study area for keen support during field survey and data collection. Authors are also grateful to all the members of Botany department of Butwal Multiple Campus for support during data compilation and analysis.

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