Policy Brief
On
Control and management of Invasive Alien Species (IAS)
in Nepal

Government of Nepal

Ministry of Forests and Environment

Forest Research and Training Centre

Kathmandu

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Forewords

The Convention on Biological Diversity (CBD) defines an invasive as an alien species whose establishment and spread threatens ecosystems, habitats or species with economic or environmental harm. They are also known as invasive alien species (IAS). IUCN defines IAS as an alien species established in natural or semi-natural ecosystems or habitats, is an agent of change, and threatens native biological diversity.

Invasive species are non-native to the particular location, which includes plants, animals and microbes .The IAS has invaded forests throughout the world. Their presence has threatened many native species and ecosystems. As a result, they have been called as *biological pollution* or *green cancer*. The presence of scientific community to work on invasive species, the possibility of large volunteer work, the awareness level of local communities, and availability of basic data on local ecosystems are key that influences the management of IAS. Therefore, developing nations like Nepal require a thorough understating and strategy to manage IAS. So, this policy brief will be milestone to know about IAS and guide to policy maker, forester and related line agency to control and manage IAS.

I would like to thank Green era consultancy for preparing this report. I appreciate Milan Dhungana for conducting this program. I would like to express my gratitude former Director General of FRTC Dr. Deepak Kumar Kharal and Former DDG Dr. Buddi Sagar Poudel for supervising and guiding the program. I would like to further thank to DDG Mr Dhirendra Kumar Pradhan for his support. I am further thankful to Reviewer team Mr Bimal Kumar Acharya, Mrs Manju Ghimire, Mr Bishnu Prasad Dhakal and Mr Kiran Kumar Pokharel for improving this document in publishable form. At last but not least, I acknowledge all professional, FRTC staff and who involved directly or indirectly to shape this document.

I am very hopeful that this document will be helpful to guide and support the policy maker, researcher and student for further work on IAS.

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Introduction

Invasive species are non-native to the particular location, which includes plants, animals and microbes.These species are the spillovers economic globalization and travelled beyond their natural habitat either deliberately or accidentally as a part of trade, travel and tourism (Holmes et al., 2009; Meyerson and Mooney, 2007). The Convention on Biological Diversity (CBD) defines an invasive as an alien species whose establishment and spread threatens ecosystems, habitats or species with economic or environmental harm. They are also known as invasive alien species (IAS). IUCN defines IAS as an alien species established in natural or semi-natural ecosystems or habitats, is an agent of change, and threatens native biological diversity.

Invasion of exotic plant species are the second greatest threats to native forest ecosystems and species richness, after habitat fragmentation and loss (Randall, 1996). When a species invade an ecosystem, it modifies the structures of the recipient ecosystems. This ultimately affects the functions of the ecosystem, which changes in the supply of services (Wilcove et al., 1998). For instance, it influences fire regimes, nutrient cycling, hydrology and energy budges (Mack et al., 2000), which may have direct impact on the provisioning services such as fuel wood, timber and fodder (Rai et al., 2012b; Rai and Scarborough, 2015).

Needless to say that all exotic species are not invasive species. An exotic should passes through three different phases: (i) introduction, (ii) establishment, and (ii) spread, to become an invasive (Mack et al., 2000). In general, species travels from its native place to another place must survive during and after the journey. It they spread as seeds, in the case of plants, and then it can be transported successfully without any special care. Once it is planted or germinated, it should reproduce successfully. Then, the last stage is to spread up. If it spreads across the landscape then species are assumed to be invasive. Once an exotic species arrives in the new ecosystem, there may have three possible outcomes (Crowl et al., 2008):

- It may not survive, or
- It may survive but fail to spread, or
- It may begin to reproduce and naturalize.

Hence, species traits and the habitat of the recipient ecosystem determine whether it can invade the ecosystem or not. It is estimated that there is a percent probability that an exotic species turned into invasive (Williamson, 1997). There is a rule of ten. This means 1 out of 10 introduced species will be established and 1 out of 10 established becomes invasive. This means, all introduced species do not find their new habitat suitable for their establishment (Lodge, 1993). Once they are established, they encourages novel biotic interactions modifying existing one (Crowl et al., 2008).

Once the exotic becomes invasive, they exhibit unprecedented growth and rapid proliferation. There may be several causes behind this rapid growth, such as they lack natural enemies and find enough space to grow (Richardson et al., 1994). IAS become more dominant in disturbed and fragmented habitats because native species are less likely to be competitive in such conditions (Loehle, 2003; Sharma and Raghubanshi, 2005). In addition, most of the IAS are light demander and are likely to invade degraded area the most (Rai et al., 2012a).

The IAS has invaded forests throughout the world. Their presence has threatened many native species and ecosystems. As a result, they have been called as *biological pollution* or *green cancer* (Olson, 2006). The presence of scientific community to work on invasive species, the possibility of large volunteer work, the awareness level of local communities, and availability of basic data on local ecosystems are key that influences the management of IAS (Nun˜ez and Pauchard, 2010). Therefore, developing nations like Nepal require a thorough understating and strategy to manage IAS.

Invasive Plant Species in Nepal

The transportation of species is not a new phenomenon, as it was started with colonization and exploration in the past (Chenje and Mohamed-Katerere, 2009). The history of IAS in Nepal is also two century old as *Chomolaena odorata* was first reported in 1825 (Tiwari et al., 2005). Generally, IAS are known as *Banmara* in Nepal (Rai et al., 2012b). It is estimated that 179 exotic species have been naturalized in Nepalese forests (Shrestha et al., 2017). Majority of them are native to Americas (74%) and Europe (8%) (Bhattarai et al., 2014). Nepal is likely to host many exotic species because of its government's priority to promote tourism and increase the volume of trade. In addition, inadequate institutional capacity, such as the absence of policy,

quarantine facilities and researchers, is likely to create a favourable environment for the establishment of exotic species.

In Nepal, 26 species are identified as common IAS in different ecosystems (Shrestha et al., 2017). Out of them *Ageratina adenophora*, *Chromolaena odorata*, *Eichhornia crassipes*, *Ipomoea carnea*, *Lantana camara,* and *Micania micrant ha* as high risk posed species (Tiwari et al., 2005). Among them *Chromolaena odorata*, *Eichhornia crassipers, Lantana camara* and *Mikania micrantha* are listed as the world's 100 worst invasive species (Lowe et al., 2000). Recently, *Parthenium hysterophosus* is problematic in urban areas, grassland and croplands (Shrestha et al., 2015).

Most of the IAS is reported in the southern lowland particularly in Terai and Siwaliks, as this is favourable to them which are native to the Latin America. Similarly, majority of the common invasive species are recorded in the mid-hills too, however, only few including *Ageratina adenophora* and *Galinsoga quadriradiata* are reported in high altitude (Shrestha, 2016). *Ageratina adenophora*, and *Chromolaena odorata* are the widely distributed IAS. In addition, eastern and central region of Nepal have higher occupancy of IAS compared to the western Nepal (Bhattarai et al., 2014). This could be mainly due to the entry point of IAS either in eastern part or Kathmandu. For instance, *Mikania micrantha* has westward movement, as it is first recorded in Ilam (Rai et al., 2012b; Tiwari et al., 2005).

Management

IAS management is challenging and a complex task because the invasion processes are dynamic and have multifaceted effects. Responses to invasion include institutional arrangements, policy and governance tools, as well as practical strategies to realize the objectives of the policies (Pandit et al., 2018). These responses are not mutually exclusive, but rather interact in various ways based on spatial context.

Institutional arrangements

The transportation of the potential IAS is the major issue, and checking their movement is crucial and complex too. This requires common efforts of the international community. There were several international efforts to mitigate the negative impacts of invasive. The International Plant Protection Convention (1952) *aimed to secure common and effective action to prevent the spread and introduction of pests of plants and plant products, and to promote appropriate measures for their control*. The convention was revised in 1997 and recognized by the World Trade

Organization (WTO). It facilitates the development of international standards for measures to prevent and control the spread of plant pests through international trade (McNeely et al., 2001).

Article 8(h) of the Convention on Biological Diversity (CBD) clearly states that *each contracting party shall, as far as possible and as appropriate, prevent the introduction of, control or eradicate those alien species which threaten ecosystems, habitats or species.* The CBD binds signatories (there are 191 parties) to develop policies and implement accordingly. The Strategic Plan for Biodiversity (2011-2020), known as the Aichi Biodiversity Targets, has explicitly put invasive species as the major concern. Out of total 20 targets, Target 9 states that *by 2020, invasive alien species and pathways are identified and prioritized, priority species are controlled or eradicated, and measures are in place to manage pathways to prevent their introduction and establishment.*

The Global Invasive Species Programme (GISP) was established in 1997 to conserve biodiversity and sustain livelihoods by minimising the spread and impact of invasive species.
It provides support to the implement the Article 8(h) of the CBD; and contributed to information exchange and awareness raising through the development of a range of production and publications. It has four founding partners including CAB International (CABI), The World Conservation Union (IUCN), the South African National Biodiversity Institute (SANBI), and The Nature Conservancy (TNC). GISP has published *the Global Strategy on Invasive Alien Species*(McNeely et al., 2001)*, and Invasive Alien Species: A Toolkit of Best Prevention and Management Practices*(Wittenberg and Cock, 2001).It has developed the Global Invasive Species Database (http://www.iucngisd.org/gisd/), an online portal whose main aim is information dissemination.

The Invasive Species Specialist Group (ISSG), established in 1994, is a global network of scientific and policy experts on invasive species, organized under the Species Survival Commission of the IUCN (www.issg.org). It aims to reduce threats to natural ecosystems and the native species they contain by increasing awareness of invasive species and of ways to prevent, control or eradicate them. It facilitates the exchange of information and knowledge across the

globe and ensures the linkage between knowledge, practice and policy so that decision making is informed.

The Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) is an independent intergovernmental body, established by member states in 2012 (https://www.ipbes.net/about). The objective of IPBES is to strengthen the science-policy interface for biodiversity and ecosystem services for the conservation and sustainable use of biodiversity, long-term human well-being and sustainable development. IPBES is doing thematic assessment on invasive alien species and their control. It assesses the threat that invasive species pose to diversity, ecosystem services and livelihoods, and the global status of and trends in impacts of invasive species by region and sub-region.

Ministry of Forest and Environment (MoFE) Nepal has established a National Invasive Alien Species Coordination Committee. Then Department of Forest Research and Survey as a focal institute has prepared a draft strategy on Invasive Alien Species Management (2074). Forest Policy (2075), and Nepal Biodiversity Strategy and Action Plan (2014-2020) have prioritized IAS. Similarly, it has identified as one of the nine drivers of deforestation and forest degradation in Nepal.

Practical strategies

The practical strategies are intensively focus on local and national scales. The invasive species management commonly includes three successive steps - **prevention**, **eradication** and **control**. The best strategy is to eliminate a potential invader before its establishment or to control their entry (Allendorf and Lundquist, 2003; Leung et al., 2002). This is because the cost of invasive is very expensive due to its negative social and environmental impacts, and implementation of the eradication and control strategies(Rai and Scarborough, 2015, 2013; Swallow et al., 2008). Prevention makes native ecosystem out of the invasion and undisturbed.

Preventive measures

Preventive measures focus on identifying and monitoring common invasive pathways, particularly physical obstruction. Increased global trade and transport networks have increased the likelihood of the transportation of invasive species (Hulme, 2009). This strategy primarily

believes that invasion is a spatial process as it is started after the transportation of the species into new habitat. As such, pathway risk assessment relies heavily on spatial data mapping the hotspots of likelihood of invasion (Buckley, 2008; Lawrence et al., 2006). Many countries have compiled lists of potential IAS and have prohibited those species. Besides they have undertaken awareness campaigns to educate the public about the negative impacts of invasive.

The second component to prevention is interception (Boy and Witt, 2013). This would include the establishment of environmental biosecurity departments to carry out activities such as search and seizure procedures at first points of entry, as well as quarantine measures to block or restrict incursions. An example of such a body is the Australian Government Department of Agriculture and Water Resources. Quarantine measures are, however, not necessarily feasible in resource/infrastructure constrained settings.

Eradication

Eradication is the next option in the response continuum. Early detection and decisive action are crucial for success (Rejmánek and Pitcairn, 2002; Simberloff, 2009). Early warning and rapid response systems enhance prompt detection of new invaders, assessing related risks and ensuring immediate reporting of relevant information to the competent authorities (EEA 2010). In South Africa, for example, the National Department of Environmental Affairs has collaborated with the South African National Biodiversity Institute (SANBI) in the implementation of the Early Detection and Rapid Response (EDRR) program (Ntshotsho et al., 2015). Similarly, the European Commission has proposed a formalized early warning mechanism in the EU Regulation on invasive species which came into effect in January 2015. It is hoped that the Regulation will, among other things, simplify approaches to the management of invasive species by overcoming legislative impediments (Caffrey et al., 2014).

Eradication entails the systematic elimination of every individual IAS, until it can be ascertained that no individuals, viable seeds or other propagules remain in an area (Boy and Witt, 2013). It has been achieved, notably in island settings, with substantially more examples of successful eradication of vertebrate species than plant species (Genovesi, 2005; Glen et al., 2013). Some efforts have been made in Nepal to eradicate *Mikania micrantha* through uprooting and ploughing by Tractor, but it became counterproductive (Rai et al., 2012b). This could be because eradication is possible only when there is a limited distribution.

Control

Control of established invaders is the last stage of the defense. The primary goal is to reduce the abundance and density in order to minimize adverse impacts. Successful control depends more on commitment and continuing diligence than on the efficacy of specific tools themselves, as well as the adoption of an ecosystem-wide strategy rather than a focus on individual invaders (Mack et al., 2000). The concept integrated weed management evolved, which involves combination of all available measures(Adkins and Shabbir, 2014). This approach could be long term strategy in cases where IAS are able to survive individual measures.

Generally, four types of control measures are in practice: (i) mechanical/manual; (ii) biological; (iii) chemical; and (iv) cultural. Mechanical/manual control includes activities such as hand-pulling, hoeing, tilling, mowing, grubbing, chaining and bulldozing. Mechanical measures are considered as labor intensive and costly. However, in some developing countries where communities manage land, and affordable labor is available, manual control is feasible (Rai et al., 2012a). Activities like hand-pulling and hoeing are site specific. These are effective in loose and moist soils, and to control small infestations (Sheley et al., 1998). Mowing is effective for annuals and some perennials (Benefield et al., 1999). However, their success depends on timing and frequency (Benefield et al., 1999; Rai et al., 2012a).

Biological control, known as biocontrol, is the use of an invader's natural enemies such as predators, parasites and pathogens to reduce the abundance of invasive species (Ellison et al., 2008). Its implementation is based on extensive testing and validation for host-specificity to predict risk, which arguably minimizes adverse environmental impacts. Otherwise, there is the risk of biological agent become destructive in the absence of natural predators (Messing and Wright, 2006).It is considered as a cost-effective, long-term and self-sustaining management option (Blossey et al., 1994). The combination of financial efficiency and environmental friendliness could potentially improve social acceptability. Many experiments of using biological agent to control invasive plant species are limited to the lab experiment only.

Cultural practices are a part of habitat management, which include controlled grazing, prescribed burning, and physical manipulation of habitat. There are several examples of such practices, e.g.

controlled grazing to control *Parthenium hysterphorus* and *Centaurea solstitialis* (Adkins and Shabbir, 2014; DiTomaso, 2000); manipulating shading by intact canopies to hinder the growth of *Lantana camara* (Duggin and Gentle, 1998), and prescribed burning to control invasion of annual broadleaf and grass species (DiTomaso et al., 2006; Keeley, 2006). However, it should be noted that since invasive plants are likely to become established in disturbed habitats, cultural practices do pose a risk of promoting their proliferation (Fine, 2002; Moore, 2000).

The use of herbicides is probably the most widely-adopted strategy to control invasive weeds. It is also the least desirable due to adverse effects such as unintended impacts on other species, toxicity on the surrounding environment and trophic cascade effects (Giesy et al., 2000). Chemical control is financially feasible within certain conditions such as some high-value crops, at roadsides, public parks or on small areas (Adkins and Shabbir, 2014). Of concern, however, is the growing global incidence of herbicide resistance in agricultural weeds (Preston, 2004; Heap 2014). However, use of herbicides does not discriminate the targeted species and can kill wanted species too.

This threatens to undermine control efforts and, consequently, underscores the need for integrated management of pest species. For instance, integration of community efforts with other land management approaches in India (Kohli et al., 2006), and a combination of biological control with plant suppression was found effective to control *Parthenium hysterophorus* in Australia (Shabbir et al., 2013).

In many cases, these management strategies are found very expensive and beyond the capacity of available resources. Another view of invasive management has been developed, which suggest adaptive management approach (Bhagwat et al., 2012). This may be because socio-economic impacts of plant invasion disproportionately distribute across different social groups (Rai et al., 2012b; Shackleton et al., 2011). Exploitation of the biomass of invasive plants can be used to increase soil nutrients (Sharma et al., 2003), and biogas production (Saini et al., 2003), and production of handicrafts including trashcans, flower pots, weaved hedges and sitting furniture (Sharma and Raghubanshi, 2005).

Control in Nepal

There is no effective control program of IAS in Nepal. Some organizations have carried out small scale activities to control the invasion. In Nepal, main attention is in the control rather than other measures. In the past, forest users have practiced several strategies to control the spread of invasive in Nepal, but were not succeed (Rai et al., 2012b; Sapkota, 2007). Those efforts were uprooting, manual cutting, firing and ploughing. A study carried out by Rai et al. (2012a) indicates that manual cutting has demonstrated that removal of the vines close to the ground once a month for three consecutive months in the summer or autumn can eliminate 92 to 98 per cent of *Mikania micrantha*. This method seems suitable in Nepal, as forest users contribute to forest management activities.

They have made following suggestions (Rai et al., 2012a):

- Cutting above ground biomass should start before flowering, and *M. micrantha* flowering starts in September in Nepal.
- There should be at least two consecutive cuttings in a3-week interval.
- Only *M. micrantha* should be removed during cutting, and native ground cover should be retained.

Manual cutting may have issue of dumping the removed biomass as they are likely to germinate by vegetative parts. In addition, it may demand costs to dump those biomass (Rai et al., 2012a). In this context, several organizations have initiated the utilization of IAS biomass to make compost and bio-briquette (Kafle et al., 2009; Shrestha et al., 2019). However, utilization of invasive biomass shouldn't bring into discussion of financial cost-benefit analysis. It should be considered as a part of the management, and utilization may reduce the cost of management.

Recommendations

- Intentional introduction of new species is increasing mainly due to the fast growth and financial benefits. These species may turn into invasive in future. Therefore, there is a need to prepare a national working list of naturalized and potential IAS species. In addition, the existing situation sought for the preparation of potential IAS and those already turned into invasive in India.

- Since, invasive intensity declines from east to west and lowland to highland. It is necessary to implement preventing measures particularly in western and highland area.
- Invasion is likely to increase in near future due to the increased trade and travel. Similarly, climate change may create favourable environment for those species. There is a need of effective quarantine.
- Forest management need to consider the IAS management. In operational plan/management plan of different forest management regimes such as community forest and collaborative forest, this aspect is lacking. In addition, forest management activities are being carried out in winter, which may create favourable condition for invasive. Therefore, a careful planning is required in the invaded and potential invaded area.
- Most of the IAS is light demander, therefore, it is essential to understand where to perform heavy thinning and where to keep canopy intact. Closed canopy discourages the growth of invasive plant species.
- Utilization of the removed biomass may reduce the management cost. Therefore, manual/mechanical cutting followed by utilization such as composting or bio-briquette or pellet would be the appropriate strategy.
- Mapping of IAS is also an important task. This helps to increase understanding of the type of habitat preferred by invasive, their distribution and abundance.

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