

Manual on Invasive Alien Plant Species in Kailash Sacred Landscape-Nepal



ICIMOD

FOR MOUNTAINS AND PEOPLE



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The International Centre for Integrated Mountain Development, ICIMOD, is a regional knowledge development and learning centre serving the eight regional member countries of the Hindu Kush Himalayas – Afghanistan, Bangladesh, Bhutan, China, India, Myanmar, Nepal, and Pakistan – and based in Kathmandu, Nepal. Globalisation and climate change have an increasing influence on the stability of fragile mountain ecosystems and the livelihoods of mountain people. ICIMOD aims to assist mountain people to understand these changes, adapt to them, and make the most of new opportunities, while addressing upstream-downstream issues. We support regional transboundary programmes through partnership with regional partner institutions, facilitate the exchange of experience, and serve as a regional knowledge hub. We strengthen networking among regional and global centres of excellence. Overall, we are working to develop an economically and environmentally sound mountain ecosystem to improve the living standards of mountain populations and to sustain vital ecosystem services for the billions of people living downstream – now, and for the future.



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Manual on

Invasive Alien Plant Species in Kailash Sacred Landscape-Nepal

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Acronyms and Abbreviations

KSL	Kailash Sacred Landscape
KSLCDI	Kailash Sacred Landscape Conservation and Development Initiative
IAPS	Invasive Alien Plant Species
VDC	Village Development Committee

About this publication

This educational material is produced to help government agencies, the academic community, and volunteers to identify invasive alien plant species in their area of work and that pose a threat in the landscape. Early detection of the species is an essential first step in the cost-effective removal or control and management of invasive species. This brochure provides specific details on invasive alien plant species found in the Kailash Sacred Landscape of Nepal, including impacts and management options.

About Kailash Sacred Landscape Conservation and Development Initiative

The Kailash Sacred Landscape Conservation and Development Initiative (KSLCDI) is a transboundary collaborative programme between China, India, and Nepal that has evolved through a participatory, iterative process among various local and national research and development institutions within these countries. The programme aims to achieve long-term conservation of ecosystems, habitats, and biodiversity while encouraging sustainable development, enhancing the resilience of communities in the landscape, and safeguarding the cultural linkages between local populations. Located within the remote southwestern portion of the Tibet Autonomous Region of China, adjacent districts in the Far-Western region of Nepal, and the northeastern flank of Uttarakhand State in northern India, the Kailash Sacred Landscape (KSL) is spread over an area of about 31,000 sq.km and represents a diverse, multi-cultural, and fragile landscape.

Objectives

- To strengthen regional, transboundary cooperation by institutionalizing the elements of the regional cooperation framework;
- To mainstream sustainable ecosystem management approaches and practices in the context of climate change adaptation in the KSL and in national policies and plans at all levels;
- To build the capacity of key institutions for long-term environmental monitoring and socioeconomic research for better planning and decision making; and
- To establish a regional knowledge sharing platform to support evidence-based decision making at regional and national levels.

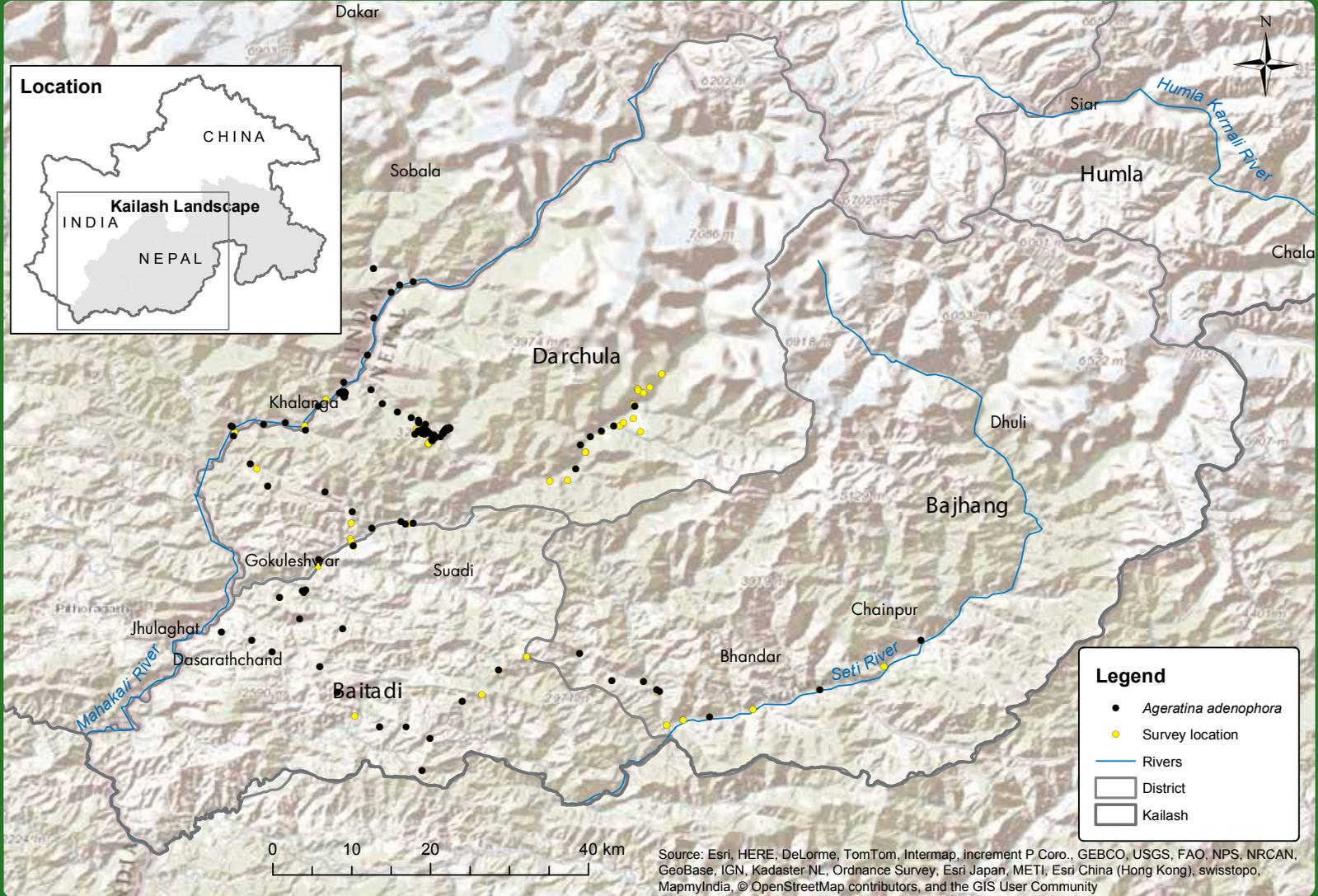
What are invasive plants?

Invasive plants are usually non-native species that have been introduced intentionally or by accident and spread from human settings into natural areas with negative effects on our economy, environment, and health. Invasive plants usually possess traits that make them effective invaders, such as a short life cycle, high growth rate, large number of seeds with good dispersal ability, and good colonizing capacity.

Why should we care?

Biological invasion has become one of the main causes of economic and environmental damage. As a result of increasing

Figure 1: Mapping of invasive alien plant species in KSL (*Ageratina adenophora*)



Map prepared by Gauri S Dangol

global trade and transport, plants are being introduced into new areas. The Convention on Biological Diversity identifies the “biological invasion of alien species as the second worst threat after habitat destruction”. Invasive species are now viewed as a significant component of global change.

The Kailash Sacred Landscape (KSL) is rich in biodiversity and offers immense opportunities for tourism (adventure, religious, heritage, cultural, and nature or wilderness tourism). However, the landscape has witnessed the spread of various non-native faunal and floral species from different parts of the world. Anthropogenic influences such as deforestation and infrastructure development have disturbed the habitat, further promoting invasion by non-native species. Farmers in the region depend on local cultivars of various crop species for their livelihoods, and native forage species for livestock farming. Some of the invasive species are of great concern to the farmers as these species reduce crop yields and ultimately result

in the decline of productivity of both crop land and pastures. It is therefore important to control invasive species in farming fields and grazing land to reduce their impacts, and prevent further spread to new areas.

Identifying invasive plants

This brochure describes some of the problematic invasive plant species in the Kailash Sacred Landscape of Nepal, their impacts, and management options.

You can make a difference

You can help by simply identifying invasive plants in your area, safely removing and disposing of them, and replanting with native, non-invasive plants. Your participation in this process will help restore and protect our native plants and ecosystem integrity.





Five Major Invasive
Alien Plant Species
in the Kailash
Sacred Landscape-
Nepal

Crofton weed or 'banmara', 'kalo banmara' (*Ageratina adenophora* (Spreng)).
King and H. Rob., (Asteraceae)



Reproduction and Dispersal: Reproduces by seeds; mainly dispersed through air and water as a contaminant of agriculture produce, construction material, in soil stuck to animals and vehicles, by adhering to footwear and clothing.

Identification: A perennial shrub; stem colour can be dark purple to chocolate brown; leaf is simple and oval in shape; flowers are white; fruits are small and light.

Distribution: Native of Mexico; serious weed in Asia (e.g., Nepal, India, China); found in Nepal from east to west in the Terai, Siwaliks, mid-hills, and low mountains up to around 2,800 masl. It is distributed in four districts of the KSL-Nepal



Habitat: Grasslands, rangelands, open forests, agroecosystems

Danger if it appears: Reduces productivity of fodder and carrying capacity of rangelands, increases labour input in agroecosystems, clogs irrigation channels, prevents tree regeneration, and interferes with wildlife movement; consumption fatal to horses.



What to do if it appears: Physical removal of plant, can be used in animal bedding and composting; biologically controlled by the gall fly (*Procecidochares utilis*).

Lantana or 'kirne kanda', 'ban phanda', 'sutkeri kanda', 'ban masa'
(*Lantana camara* L., Verbenaceae)



Identification: A medium-sized woody shrub with dense growth; stems have prickles; leaves are bright green, rough, with fine hair and give a pungent smell when crushed; produces 20–40 flowers in a tight cluster; colour from creamy white to yellow, pink and red; young fruit drupe and is green and turns black/purple with fleshy outer layer when ripe.



Distribution: Native of Central and South America; invasive weed in Asia found in Nepal from east to west in the Terai, Siwalik, and mid-hills up to 1,700 masl. It is widely distributed in Bajhang District of KSL-Nepal and reported from Baitadi and Darchula districts.

Reproduction and Dispersal: Reproduces mainly by seeds; dispersed naturally by birds, can also spread vegetatively.

Habitat: Degraded forests and marginal lands, plantations, roadside vegetation, shrub lands, agroecosystems

Danger if it appears: Widespread and difficult to remove, increases labour input into agricultural activities, highly successful in replacing native species, prevents regeneration in forests, reduces fodder production and carrying capacity of rangelands, negatively impacts recreational activities making it difficult to walk because it is dense and prickly.



What to do if it appears: Early detection, complete destruction by uprooting the whole plant and preventing seed production by burning or use as green manure. In recent years, it is being used for making bio-briquettes.

Parthenium or 'pati jhar', 'Madhesi pati' (*Parthenium hysterophorus* L., Asteraceae)



Identification: Annual herb; grows up to 2 m in height; highly branched; leaves resemble that of a carrot; flowers have tiny white heads, seeds are small, flat, and brown/black in colour.

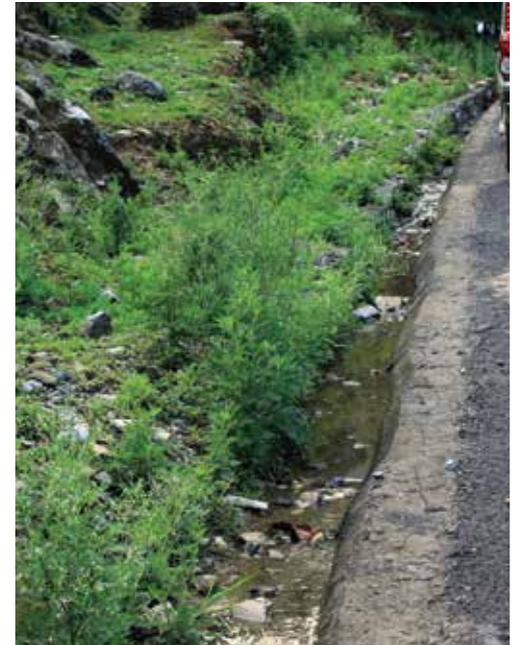
Distribution: Native of Central America (Gulf of Mexico) and invasive in Asia; found in Nepal from east to west in the Terai, Siwaliks, and mid-hills up to 1,900 masl. It is not evenly distributed but found in some patches in three districts of KSL-Nepal: Bajhang, Baitadi, and Darchula.

Reproduction and Dispersal: Wind, water (floods), vehicles, contaminant of agriculture and pasture produce.



Habitat: Grazing land, roadsides, agroecosystems, grasslands, degraded forests, shrub lands

Danger if it appears: Reduces fodder production; reduces productivity of agricultural crops by suppressing crop growth and increasing labour input; can cause allergic reactions in humans and livestock; taints sheep meat; makes dairy milk unpalatable due to an unpleasant odour.



What to do if it appears: Uprooting before flowering, biologically controlled with leaf feeding beetle (*Zygogramma bicolorata*); can also be controlled by competing native species.

Blue billygoat weed/floss flower or 'nilo gandhe', 'gane jhar' (*Ageratum houstonianum* Mill., Asteraceae)



It is not evenly distributed but found in some patches in three districts of KSL-Nepal: Bajhang , Baitadi and Darchula.

Reproduction and Dispersal: Reproduces mainly by seeds, seeds dispersed by wind, water, and animals

Identification: Annual, or sometimes short-lived biennial, herb reaching up to 1 m in height; stem has glandular hairs; flowers are blue to purple colour and form a cluster; fruit are brown/black.

Distribution: Native of Central America, Mexico, and the Caribbean; invasive in Asia (e.g., India, Nepal, Japan); found in Nepal from east to west in the Terai, Siwaliks, and mid-hills up to 1,500 masl.



Habitat: Agroecosystems, degraded marginal lands, roadsides

Danger if it appears: Reduces crop production by competing for resources; decreases productivity; increases labour input; toxic to livestock, causing liver lesions; replaces native forage species.



What to do if it appears: Removal by uprooting, continuous use of land without fallow period

Karwinsky's fleabane or 'phule jhar' (*Erigeron karvinskianus* DC, Asteraceae)



Identification: A mat-forming herbaceous short-lived perennial that reaches a height of 30–75 cm; stem is slender (1 mm diameter) and often woody at the base; leaf is simple and pleasant-smelling when crushed; flower is white and turns pink, purplish or lavender with age; seeds are small (up to 1.5 mm) and pale to reddish brown.

Distribution: Native of Mexico, El Salvador, Honduras, and Guatemala and invasive in North and South America, Southern and Western Europe, Eastern and Southern Africa, Asia (e.g., India, Nepal), and Oceania (e.g., Australia, New Zealand); found up to 3,500 masl in the Himalayas. It is evenly distributed in three districts of KSL-Nepal: Bajhang, Baitadi, and Darchula.



Reproduction and Dispersal: Reproduces both by seeds and vegetatively and is dispersed mainly by seeds; long-range seed dispersal by humans; local seed dispersal by wind.

Habitat: Tolerates a wide range of environmental conditions including infertile and shallow soil; common on steep hillsides, rock crevices, open forests, grasslands, agriculture land, open habitats, and water courses.

Danger if it appears: Replaces ground vegetation, reduces fodder species in hill agroecosystems.



What to do if it appears: Very difficult to control, can be eradicated only if detected very early and in an accessible location, use of weedicides is recommended if present in a small area, managed by physical removal followed by restoration by native plants.





Minor Invasive Alien Plant Species

Billygoat or 'gandhe', 'boke jhar' (*Ageratum conyzoides* L. Asteraceae)

Annual herbaceous weed with white flowers growing in agroecosystems. Seeds are dispersed by wind, water, and animals, and as a contaminant of agricultural produce. It reduces agricultural productivity and increases labour input in weeding. It can be managed by pulling out by hand for use as animal feed.



Alligator weed or 'Jalajambhu' (*Alternanthera philoxeroides* (Mart.) Griseb., Amaranthaceae)

Herbaceous perennial weed with small, white flowers that grow in clusters at the top of a stalk. It reproduces vegetatively (by stem, rhizome, or root tube fragments) and is dispersed by water. Grows in shallow water and marshes along roadsides, ditches, or drainage areas, at the edge of ponds and lakes, and also in agricultural fields. It degrades wetlands, reduces crop production, and replaces valuable forage species in pastures. The preferred method of management includes manual removal and careful destruction.



Spiny pigweed or 'kande lude', 'kande latte' (*Amaranthus spinosus* L., Amaranthaceae)

Herbaceous annual weed with spines, and small, greenish flowers. It reproduces by seeds, dispersed by water and as an agricultural produce contaminant. This weed grows in nutrient rich areas in settled areas and on agricultural land where it competes with crop species. Management involves uprooting the plant.



Black jack/hairy beggar-tick or 'kalo kuro' (*Bidens pilosa* L., Asteraceae)

Herbaceous annual herb reaching up to 1 m in height with yellow and black fruit. Reproduces by seeds, dispersed by animals, birds, wind, water, and contaminated soil. It is common on fallow land and agroecosystems and reduces agricultural production. It can be managed by continuous mowing and hand pulling to prevent fruiting.



Coffee senna or 'Tapre' (*Senna occidentalis* (L.) Link., Fabaceae)

Annual or biennial shrub reaching up to 2.5 m in height with yellow flowers. It is distinguished by its foetid odour. It has flattened, straight, or sickle shaped fruit and reproduces entirely by seeds dispersed by water or mud sticking to animals, humans, and vehicles. Commonly found on roadsides, grazing lands, and open woodland where it replaces plant species with forage value. Its management involves uprooting at the juvenile stage.



Sickle pod senna or 'Panwar' (*Senna tora* (L.) Roxb., Fabaceae)

A bushy, annual or short-lived perennial herb reaching up to 1 m in height with yellow flowers and linear cylinder-shaped fruits, reproduces by seeds that are yellow/brown in colour. Seeds are dispersed by water, vehicles, and livestock. It commonly grows on roadsides, forest margins, grazing land, and open woodland where it displaces native species by forming thick stands and increases the risk of forest fire. Management includes hand pulling for use as green manure and competitive displacement by native species.



Bush morning-glory or 'besaram', 'sanai phul' (*Ipomoea carnea* ssp. *fistulosa* (Mart. ex Choisy) DF Austin; Convolvulaceae)

Shrub reaching up to 3 m in height with hollow stems and simple leaves. Its flowers are large, pale pink to purple and its fruit is round. It reproduces by seeds and by vegetative methods (a cutting from the stem). Dispersal is mainly through humans, who plant it as a hedge plant and to control soil erosion along roadsides and irrigation canals. It is dominant in shallow wetlands beside springs, roadsides, and irrigation canals where it causes damage to shallow wetlands and interferes with water flow. It is managed primarily by removing and drying the plant.



Purple wood sorrel or 'chari amilo jhar' (*Oxalis latifolia* Kunth.; Oxalidaceae)

Perennial herb with a stem leading to underground bulbils. Its flowers are pink to purple and are form a small cluster at the top of a long stalk. It reproduces by seeds as well as underground bulbils, both of which are dispersed by soil movement and as a contaminant of agricultural produce. This weed causes problems in agricultural fields in subtropical regions, as it reduces crop production, increases labour input for weeding, and is poisonous to livestock. Management involves hand pulling during weeding, but pulling can leave the bulbils inside the soil.



Rough cockle-bur or 'bhende kuro', 'bhainse kuro' (*Xanthium strumarium* L.; Asteraceae)

Annual herb reaching up to 2 m in height with simple leaves, flowers that cluster around a head to give the appearance of a single flower, and fruit that are densely covered with hooked spines. It reproduces by seeds and the entire fruit is dispersed by water (floods), animals, and humans. It colonizes grazing lands, agricultural fields, and roadsides. Its management includes hand pulling and burning.





Potentially Invasive Alien Plant Species

Occurrence of the following two species is uncertain in the Kailash Sacred Landscape of Nepal, but they are already highly problematic in other parts of Nepal threatening biodiversity and livelihoods.

Siam weed or 'seto banmara' (*Chromolaena odorata* (Spreng.) King and Robinson; Asteraceae)

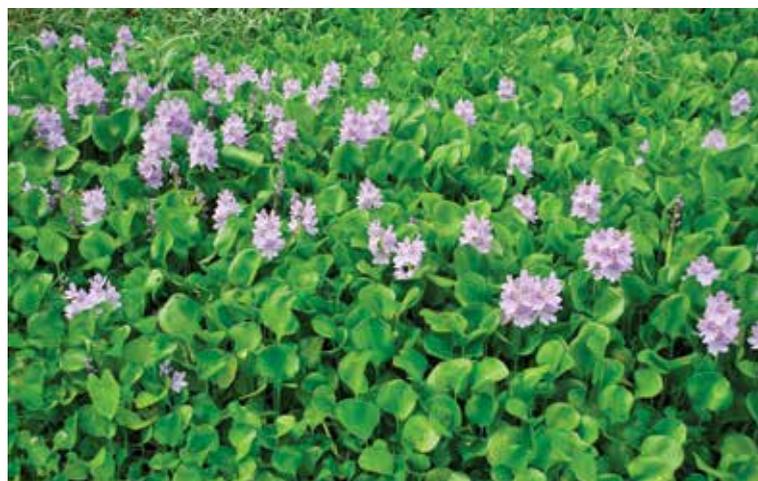
A perennial shrub reaching up to 2.5 m in height with long branches, leaves have short hair on both surfaces, flowers are pale purple to white and the fruit is long and brown/black. It reproduces primarily by seeds, but also re-sprouts from the top of the root following the death of the above ground parts. Seeds are dispersed by wind, water, animals, vehicles, and contaminated plant products. It cannot tolerate full shade and colonizes grasslands,

degraded forests, and woodlands where it forms an impenetrable bush. It replaces herbaceous and shrub species, reduces forest regeneration, and increases the risk of wild fires. The preferred management strategies include removal before flowering, use of the plant for composting and as green manure, and use of biological control agents.



Water hyacinth or 'jal kumbhi' (*Eichhornia crassipes* (Mart.) Solms., Pontederiaceae)*

Perennial floating herb that grows in wetlands. Its roots are feathery and leaves and leaf stalk are spongy. It has violet to light blue flowers and a fruit capsule that contains many seeds. It reproduces by seeds and vegetatively (by shoots). Seeds and above-ground shoots, called stolon, are dispersed by water and also by humans. This herb is extensively grown in nutrient rich wetlands and forms a floating mat, which prevents light and air from reaching plants and animals living under the water. It is controlled by physical removal and destruction.



Recommendations for the Management of Invasive Alien Plant Species

Community education

Public participation is essential for the effective management of invasive alien plant species (IAPS). Within a locality, educational materials can be published and distributed describing IAPS found within the area (with colour photographs), potential IAPS that might spread to the area, the impacts of different IAPS on the local economy and environment, and control measures that can be implemented at the local level.



Research and monitoring

Preliminary research and inventories must be conducted on a regular basis in the field to identify existing invasive species and potential threats. This provides information about the identity, location, and abundance of invasive plants within the area, which is critical for making well-informed management decisions.



Biomass utilization

Using IAPS biomass has multiple benefits: 1) It reduces the production of seeds of IAPS, and 2) Helps meet biomass demands (for organic manure, fuelwood, etc.) of local communities. Simple technologies can help make use of IAPS biomass. For example, in Khar VDC of Darchula District in Nepal, improved composting and biobriquette production techniques have maximized the use of *Ageratina adenophora* (crofton weed) biomass.



Eradication of small satellite populations

When seeds of IAPS are spread over long distances (through contamination of commercial goods, when transported on vehicles by mistake [‘hitchhiking’], or introduced intentionally by humans), a satellite population is established. When an invasive species is able to form several satellite populations at the early stage of invasion, it is more likely to establish a larger population at the landscape level. Eradication of smaller populations, like a new satellite population is much easier than for a larger, more established population. Eradication of a larger population may not be practical or possible.



Containment

Where eradication is not possible, containment is the next best option, which involves preventing the further spread of IAPS from the established population. Containment requires the use of control measures (e.g., physical, cultural and chemical methods) as well as continuous vigilance in potential dispersal sites. The use of control measures helps reduce seed production in the surrounding areas.

Reduction of anthropogenic disturbance

Anthropogenic disturbances are among the leading causes of vegetation loss in terrestrial ecosystems. Vegetation loss creates suitable habitats for the establishment of IAPS. In forest ecosystems, canopy opening (due to deforestation) and the removal of ground vegetation of native species increases the abundance of IAPS. In rangelands, overgrazing reduces the competitive ability of palatable native species, creating favorable conditions for colonization by non-palatable IAPS. In Khar VDC, the practice of removing vegetation cover from the terraced surface of farmlands exposes soil surface. This has created a very suitable environment for the establishment of *Erigeron karvinskianus* (Spanish daisy), the most problematic IAPS in the agro-ecosystem of Khar VDC. Because of this, it is recommended that farmers minimize the practice of slicing bunds and terraces during the preparation of farmland for cropping.

Restoration with native species

The restoration with native species, preferably having some use values (e.g., fodder, timber, medicinal, etc.), is an important method of IAPS management. The selection of species for restoration should be done based on the natural history of the region, habitat suitability of the species, and in consultation with local communities. In Khar VDC, the habitat of locally important species of non-timber forest products like *Gerardinia diversifolia* (allo) is being colonized by *Ageratina adenophora* (crofton weed). The removal and composting of *A. adenophora* biomass can be coupled with the restoration of *G. diversifolia*.

Transboundary vigilance

Because Nepal is a landlocked country, with relatively free movement of vehicles and people across the border with India, IAPS management in the country is a transboundary issue. The porous border creates possibilities for exotic species to easily enter Nepal. Therefore regular vigilance by local stakeholders and communities across international borders is essential to control the spread of IAPS in the landscape. Government bodies and conservation partners should establish a mechanism through which communities in the border region will be able to inform authorities about the arrival of new IAPS so that they can be eradicated before a large population is established.



Glossary

Abundance: The total number of individuals of a species in an area, population, or community

Agroecosystem: Biological and natural resource system managed by humans for the primary purpose of producing food

Annual: A plant that germinates, flowers, sets seed and dies in one year

Anthropogenic: Influence by human activity

Biobriquette: A compressed block of coal dust or other combustible biomass material

Biological control agent: A natural enemy, antagonist or competitor, and other self-replicating biotic entities

Biennial: A plant that lives only two years; flowering, producing seed and dying in the second year

Biomass: Any plant derived organic matter

Bulbils: A small new bulb that grows around a parent bulb or a bulb like structure that grows in the leaf axil

Capsule: A dry, splitting fruit that grows from more than one carpel, usually with several or many seeds

Carrying capacity of an ecosystem: Maximum population of a particular species that a given habitat can support over a given period of time.

Colonizing capacity: Rate of spread of any species

Deforestation: The direct human-induced conversion of forested land to non-forested land

Forage: Plant material/fodder consumed by grazing animals

Eradicate: Completely remove a species from an area of interest

Fallow: Land left unseeded for a season or more

Forests: A natural community that is dominated by trees

Grasslands: Ecosystems or areas dominated by grasses

Green manure: Annual crops that are grown for nutrient enrichment of the soil

Glandular: Bearing glands

Hedge: A barrier or boundary formed by closely growing shrubs or tree species.

Invasive/alien species: A species spreading naturally without the direct assistance of people in an area outside of its historically known natural range as a result of intentional or accidental dispersal by human activities

Juvenile: Young

Landscape: A mosaic of interacting ecosystems (at any scale)

Leaflet: One of the sub units that make up a compound leaf.

Native species: Plants, animals, fungi, and microorganisms that occur naturally in a given area or region

Non-native: see Invasive/alien species

Pasture: Area used for grazing by livestock

Perennial: A plant that lives more than two years

Pinnate: Arranged in two rows along an axis, like barbs on a feather

Rachis: The central stalk to which leaflets of a compound leaf are attached

Rangeland: Land on which the vegetation is predominantly grasses, grass-like plants, forbs, or shrubs and is managed as a natural ecosystem.

Regeneration: Process of renewal or restoration of any species

Restoration: The act or process of returning something to its original condition by repairing it

Rhomboidal: Shaped like a rhombus diamond-shaped.

Shrub: A medium or small sized woody plant.

Thicket: A thick or dense group of shrubs or trees

Unpalatable: Distasteful or unpleasant to eat

Uprooting: Removal from ground keeping the roots intact

Weedicides: Any chemical which will kill weeds

Wetlands: Unique, nutrient-rich ecosystems where terrestrial and aquatic habitats meet.

Woody: With lignified cell walls; wood-like

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