Invasive alien species in Nepal: diversity, impacts and management options

Bharat Babu Shrestha

Central Department of Botany, Tribhuvan University

Kathmandu, Nepal

ICIMOD Webinar on

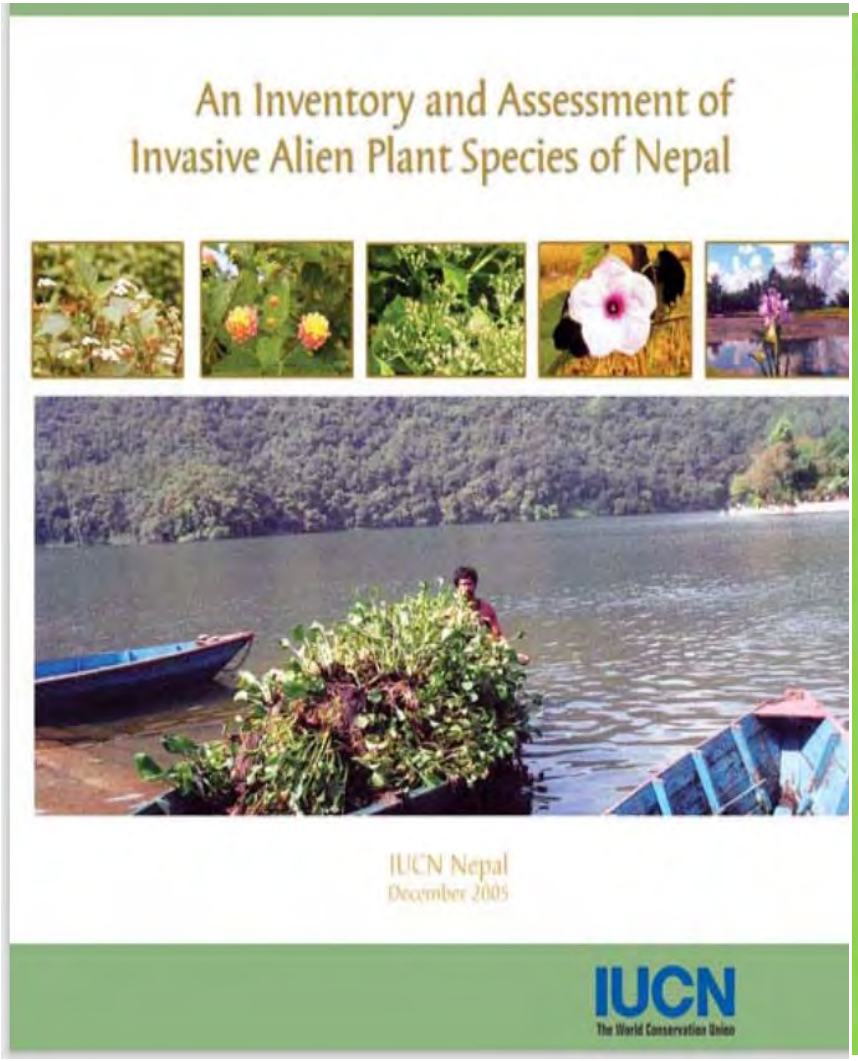
Invasive alien species in the Hindu Kush Himalaya: setting management targets for the next decade

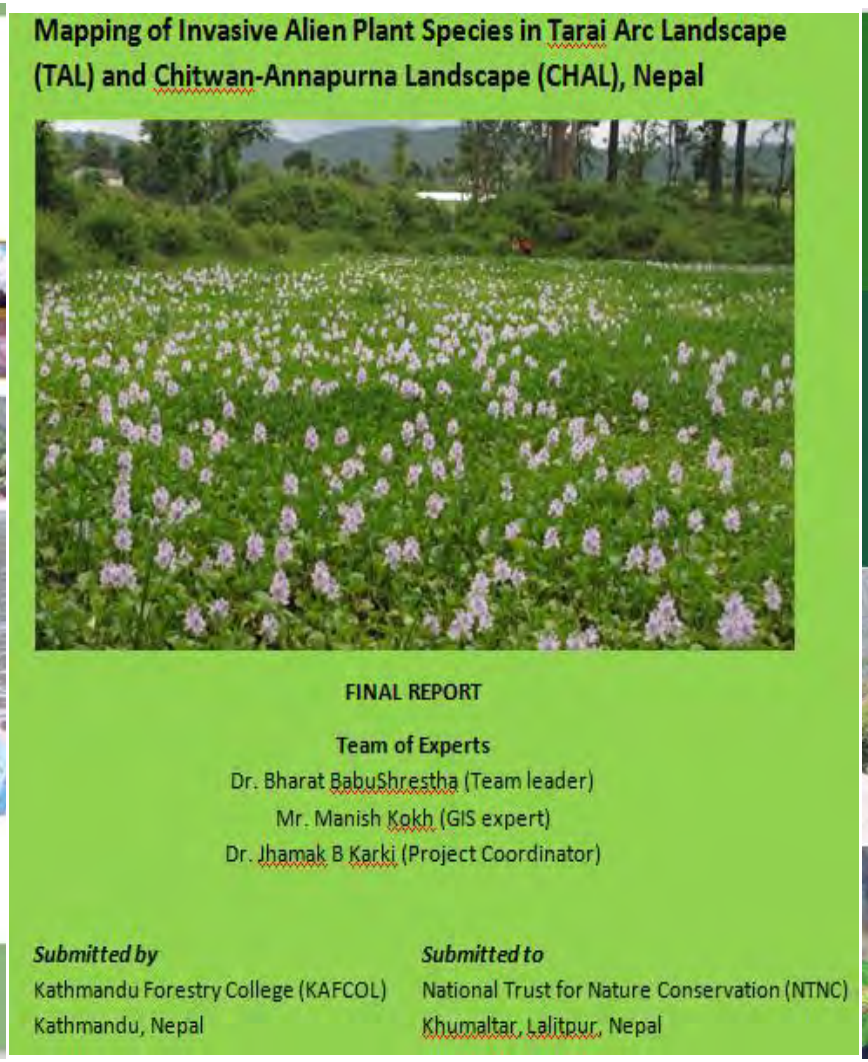
29-30 Sept 2021

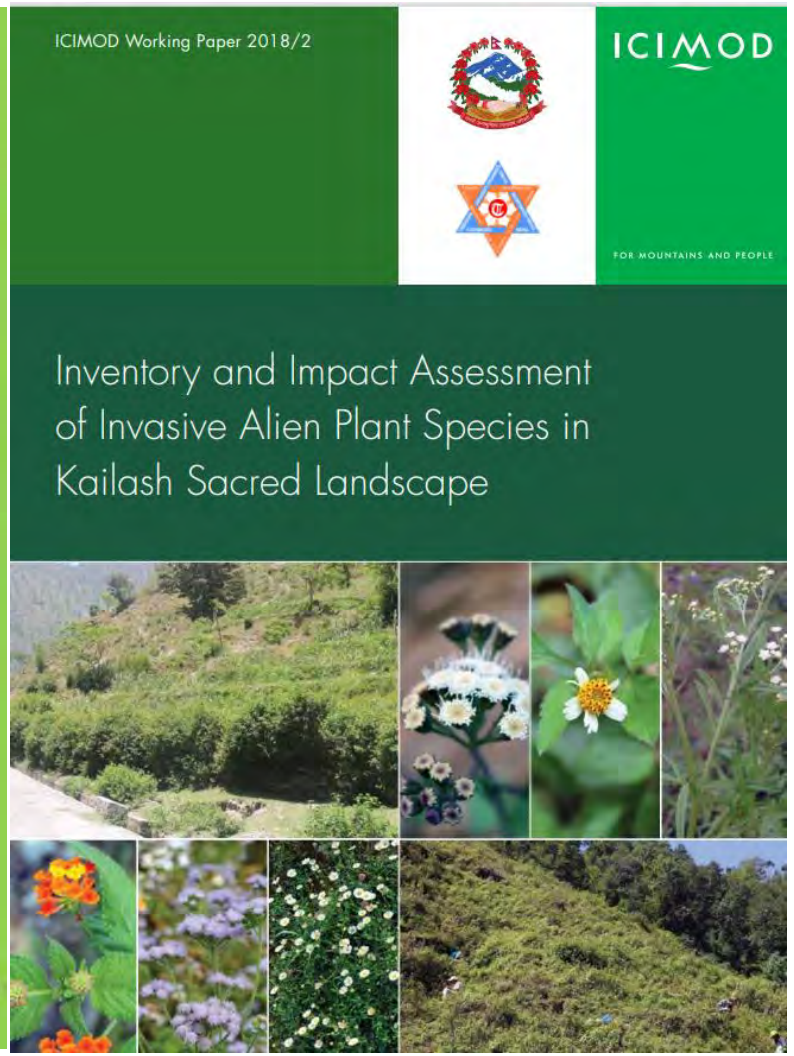
Presentation outline

- ***1. Research activities*** *related to biological invasions*
- ***2. Trends***: How many alien species are invasive? Where are they from?
- ***3. Drivers and pathways***
- ***4. Impacts***: What are the ecological and socio-economic impacts of invasive alien species?
- ***5. Management***: Which control measures are implemented to manage invasive alien species?
- ***6. Meeting the targets***: What is the progress towards meeting national and global targets in the last decade?
- ***7. Future options***: What are the options for effective management of IAS

1. *Research activities* related to biological invasions







2005 2016 2018

1. *Research activities…*

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Check for updates

BIODIVERSITY RESEARCH

Diversity and Distributions WILEY

Climate char

Uttam Babu Shres

[1]Institute for Life Sciences and Environment, University of Sou

Diversity and Ecologi

Invasive mikania in Chitwan National Park, Nepal: the threat to the greater one-horned rhinoceros *Rhinoceros*

SEAN T. MURPH

Abstract As part of a

Journal for Nature Conservation 20 (2012) 170–176

Contents lists available at SciVerse ScienceDirect

Journal for Nature Conservation

journal homepage: www.elsevier.de/jnc

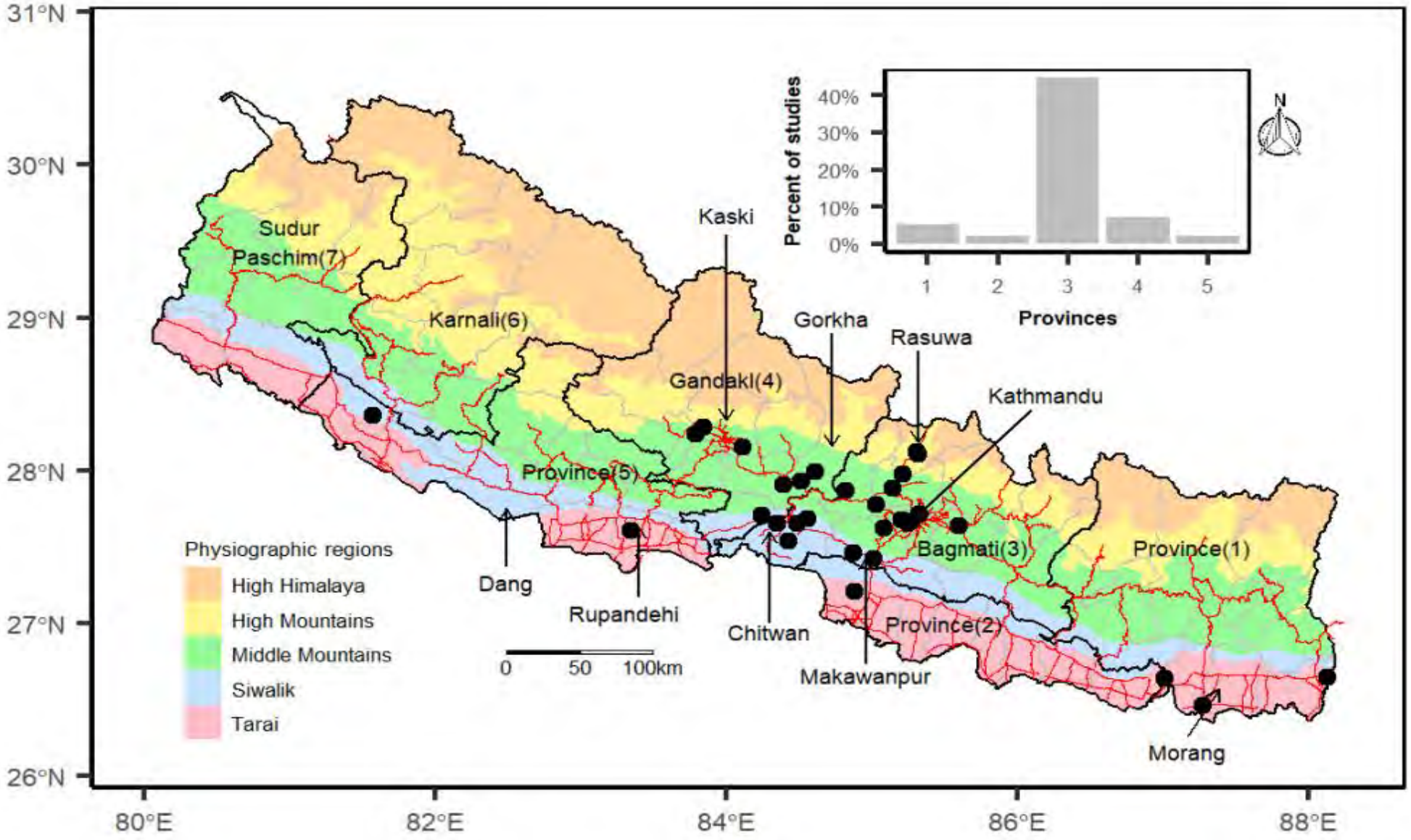
Invasive plants – Do they devastate or diversify rural livelihoods? Rural farmers' perception of three invasive plants in Nepal

Rajesh Kumar Rai[a,*], Helen Scarborough[a], Naresh Subedi[b], Baburam Lamichhane[b]

[a] *School of Accounting, Economics and Finance, Deakin University, Australia*
[b] *National Trust for Nature Conservation, Biodiversity Conservation Centre, Chitwan, Nepal*

Human adaptation

1. Research activities…



Ecological studies are mostly concentrated in central Nepal (Pandey et al 2020)

2. *Trends*: How many alien species are invasive? Where are they from?

Date and References	#Naturalized species	#Invasive alien species
Flowering plants		
2005 (Tiwari et al)	166	**21**
2016 (Shrestha)	-	**25** (*Ageratum houstonianum, Erigeron karvinskianus, Galinsoga quadriradiata, Spermacoce alata*)
2017 (Shrestha et al)	-	**26** (*Spergula arvensis*)
2019 (Shrestha)	179	**26**
2021 (Shrestha and Shrestha)	182	**27** (*Mimosa diplotricha*)
2021	**184**	**29** (*Sphagneticola trilobata*, *Tithonia diversifolia*)
Animals		
2015 (Budha)	64 (including captive animals)	?? (>10 species)

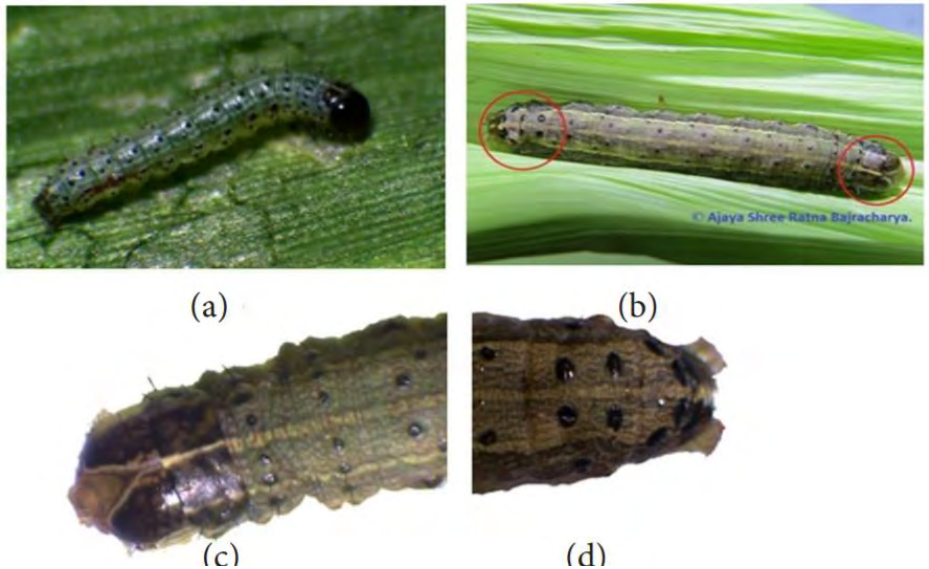
2. *Trends…*

Important IAS reported after 2015

Mimosa diplotricha (2019)

Sphagneticola trilobata (2021)

Tuta absoluta (@Bajracharya et al 2016)



Spodoptera frugiperda (@Bajracharya et al 2019)

2. *Trends…*

Among 100 of the world's worst IAS

Chromolaena odorata

Lantana camara

Mikania micrantha

Pontederia crassipes

Sphagneticola trilobata

2. *Trends…*

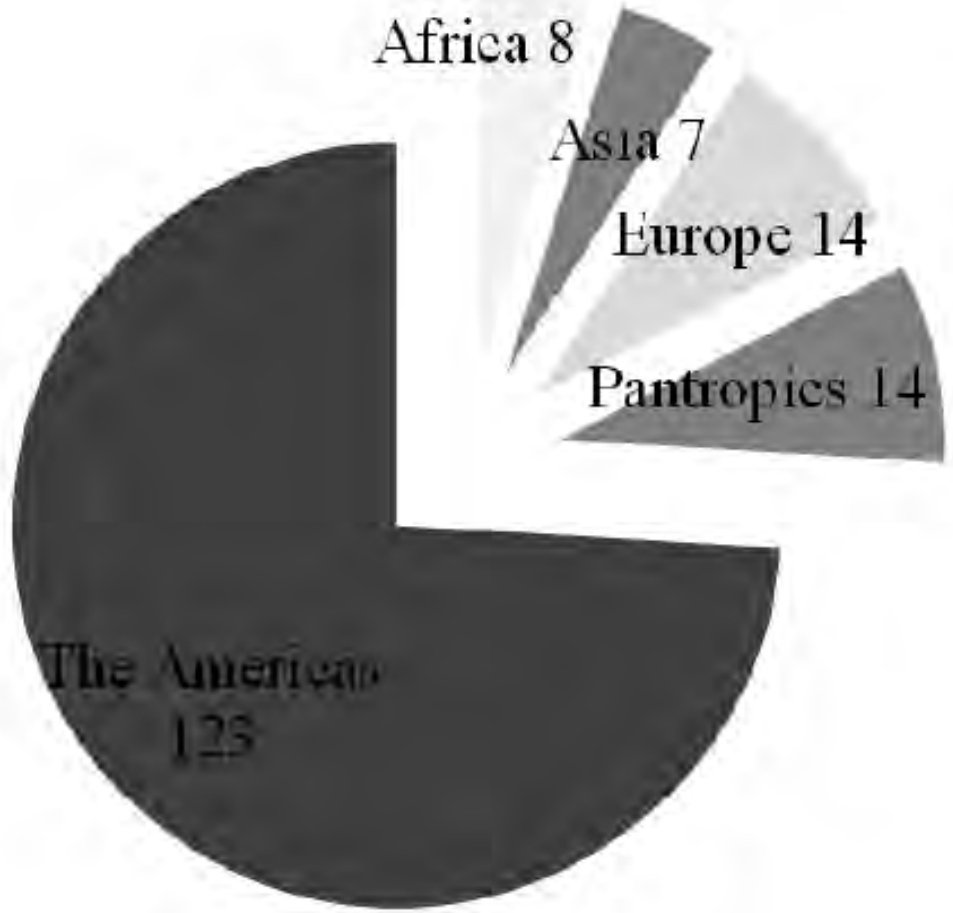
Among 100 of the world's worst IAS…

Tilapia (*Oreochromis mossambicus*)
(Begnas lake – a Ramsar site)

Giant African snail (*Achatina fulica*)

2. *Trends…*

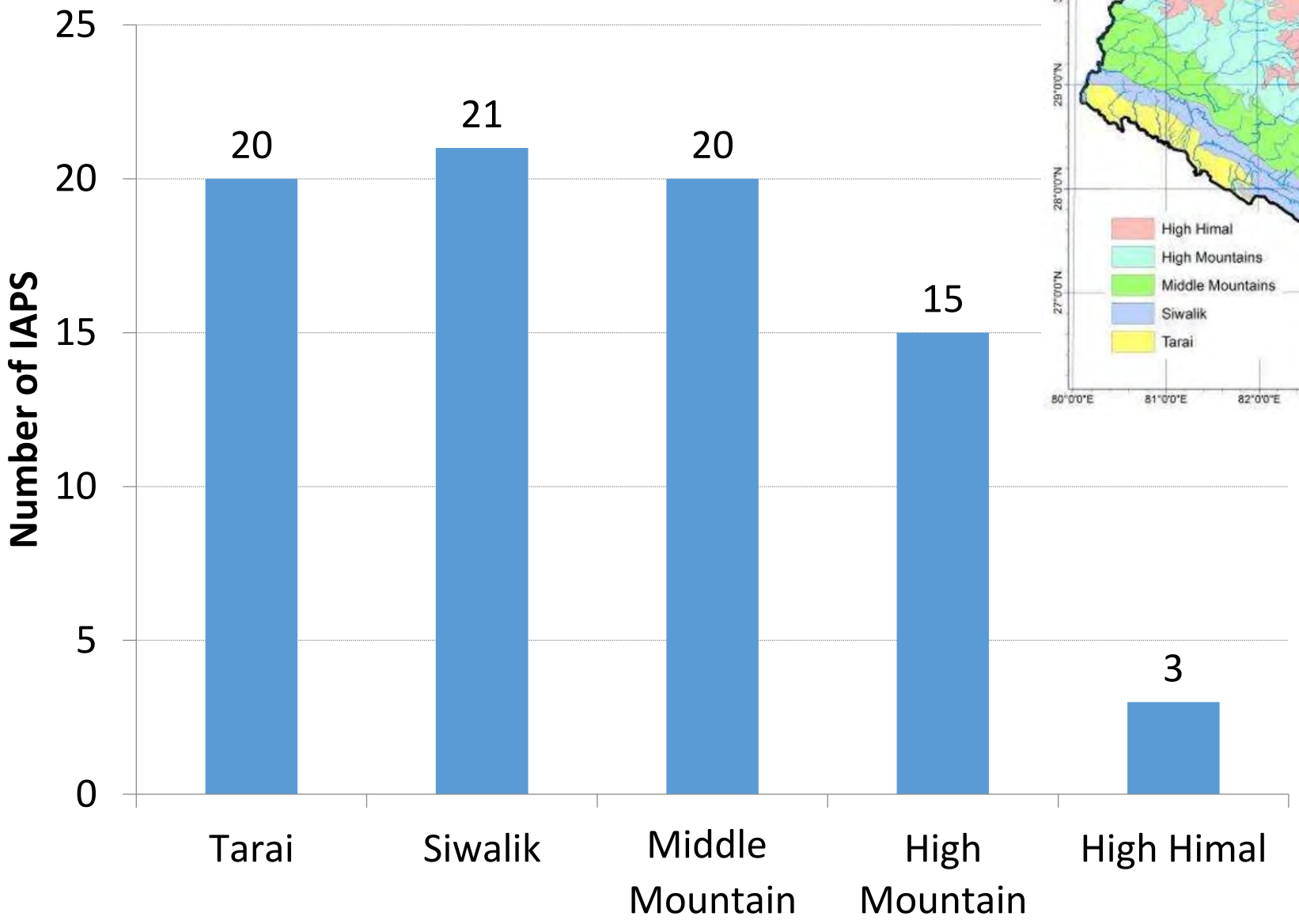
Native range of naturalized plant species

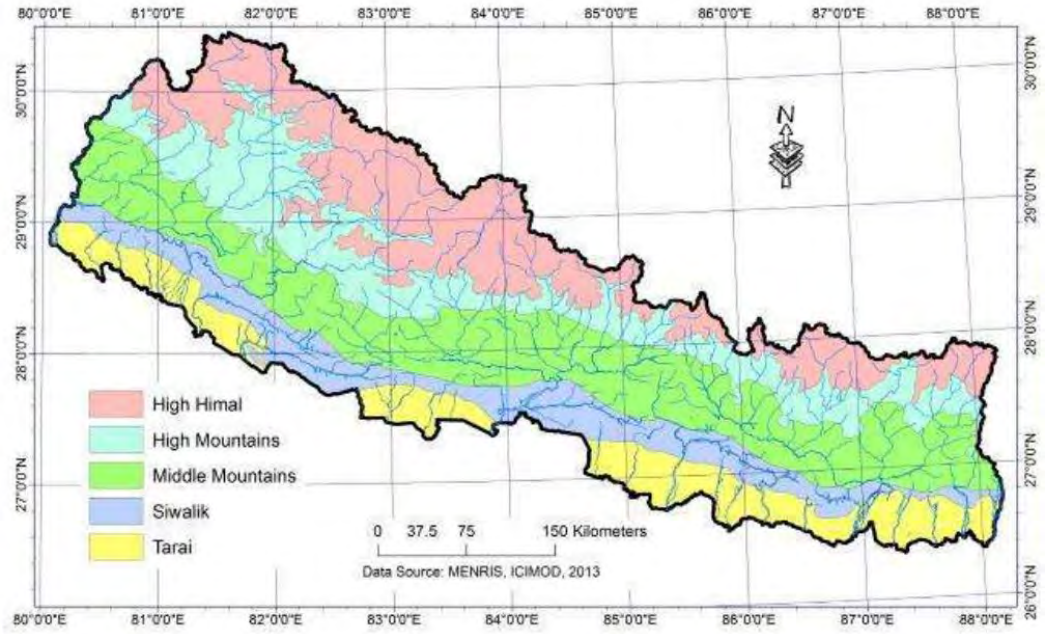


74% American native

Native range of exotic plant species naturalized in Nepal

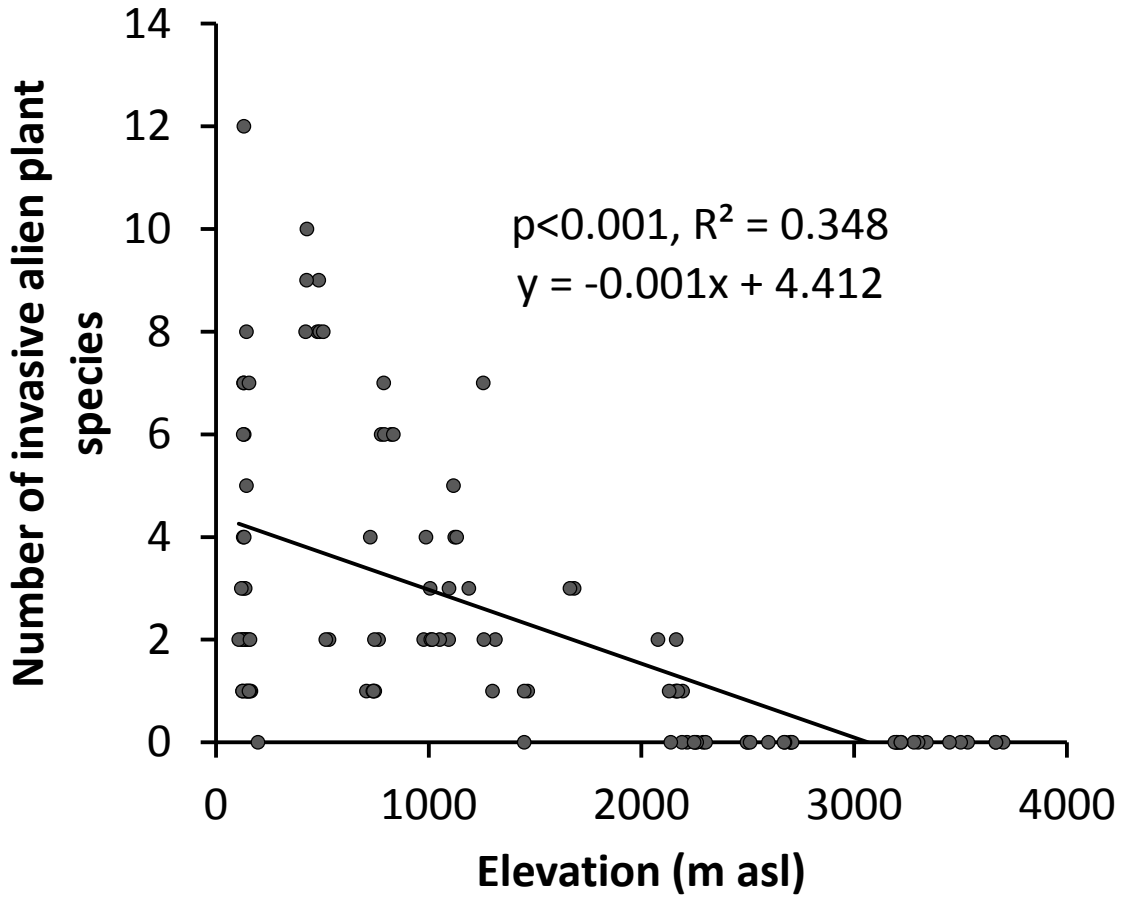
(Bhattarai *et al.* 2014)



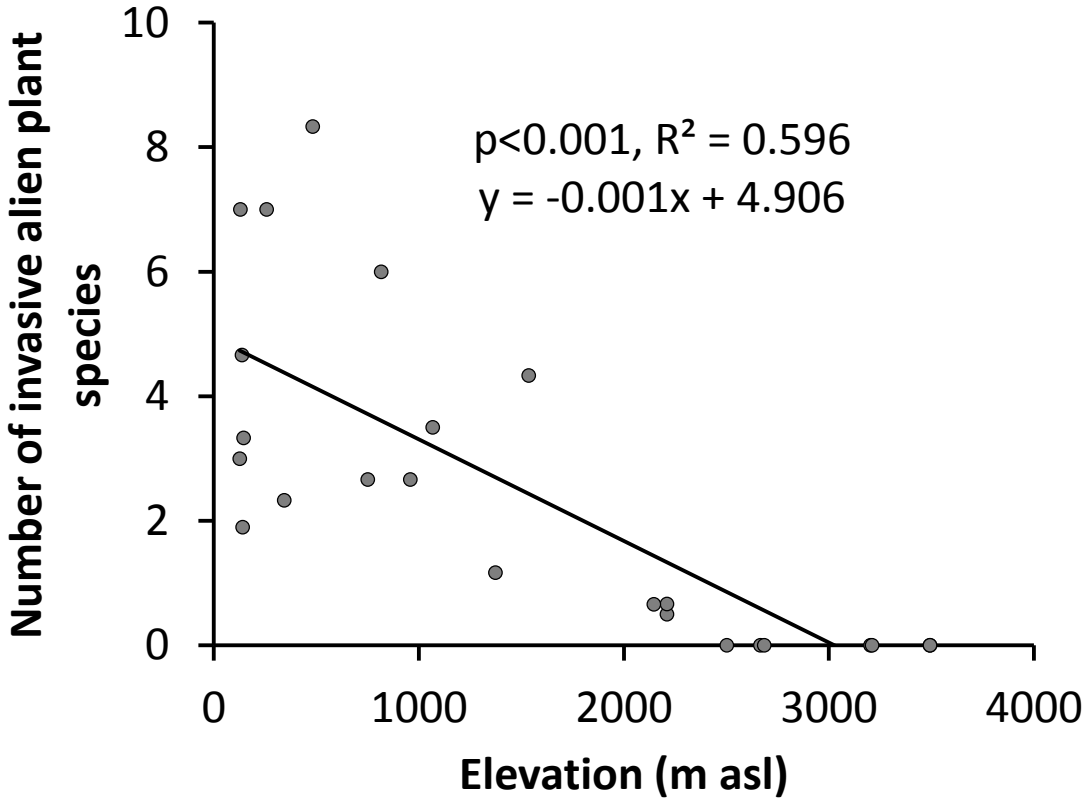


Number of IAPS across physiographic regions in ChAL (Siwakoti et al 2016)

Plot wise data (N = 110)

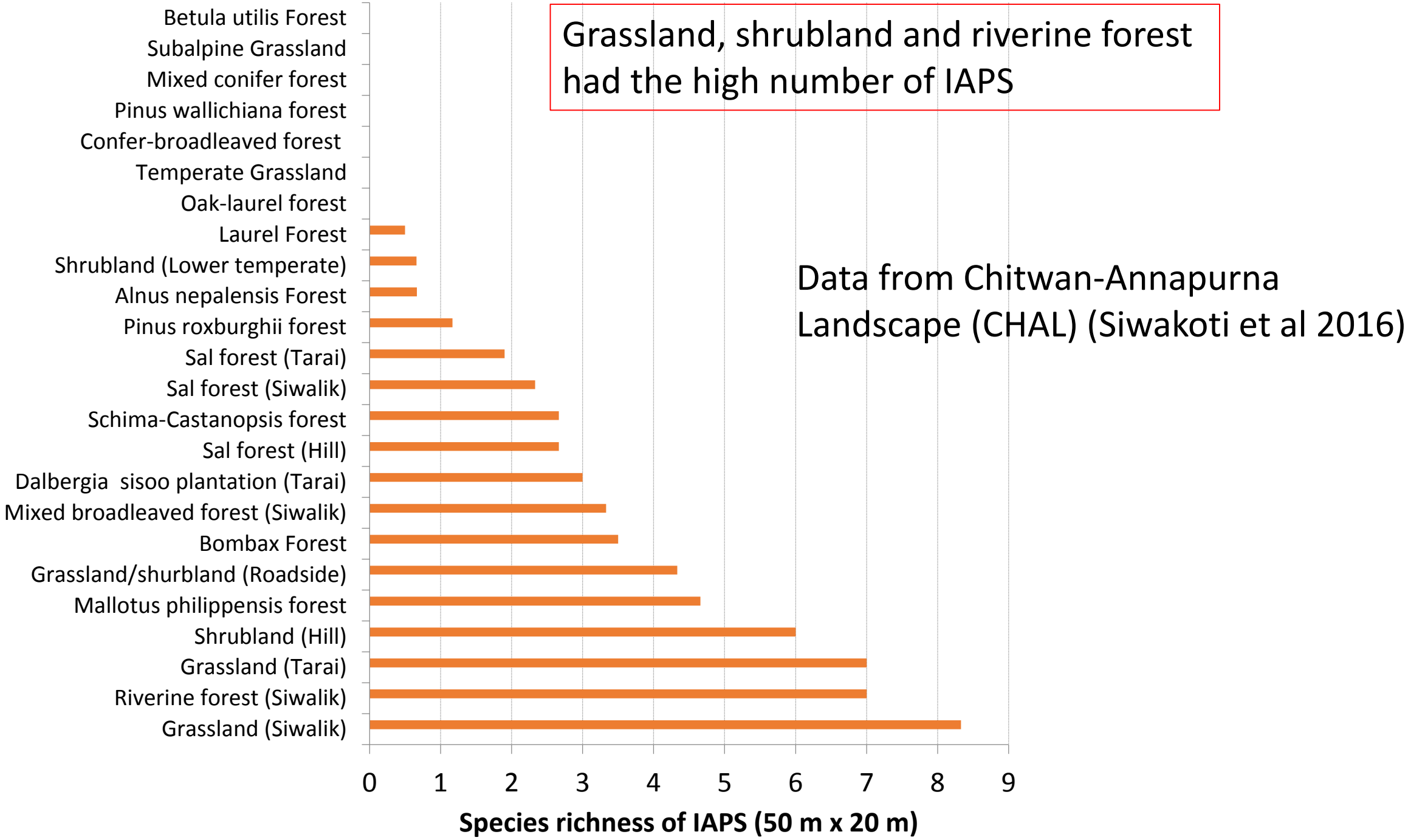


Vegetation wise data (N = 24)



Number of invasive alien plant species declined with increasing elevation

(Siwakoti et al 2016)


Grassland, shrubland and riverine forest had the high number of IAPS
Data from Chitwan-Annapurna Landscape (CHAL) (Siwakoti et al 2016)
Betula utilis Forest
Subalpine Grassland
Mixed conifer forest
Pinus wallichiana forest
Confer-broadleaved forest
Temperate Grassland
Oak-laurel forest
Laurel Forest
Shrubland (Lower temperate)
Alnus nepalensis Forest
Pinus roxburghii forest
Sal forest (Tarai)
Sal forest (Siwalik)
Schima-Castanopsis forest
Sal forest (Hill)
Dalbergia sisoo plantation (Tarai)
Mixed broadleaved forest (Siwalik)
Bombax Forest
Grassland/shurbland (Roadside)
Mallotus philippensis forest
Shrubland (Hill)
Grassland (Tarai)
Riverine forest (Siwalik)
Grassland (Siwalik)
0
1
2
3
4
5
6
7
8
9
Species richness of IAPS (50 m x 20 m)

3. Drivers and pathways

Drivers of invasions

- **Global drivers**: Climate change, Global trade (Nepal being **3rd most threatened** among 124 countries, Paini *et al.* 2016)

Future climate scenario: RCP 4.5 (Shrestha et al 2018)

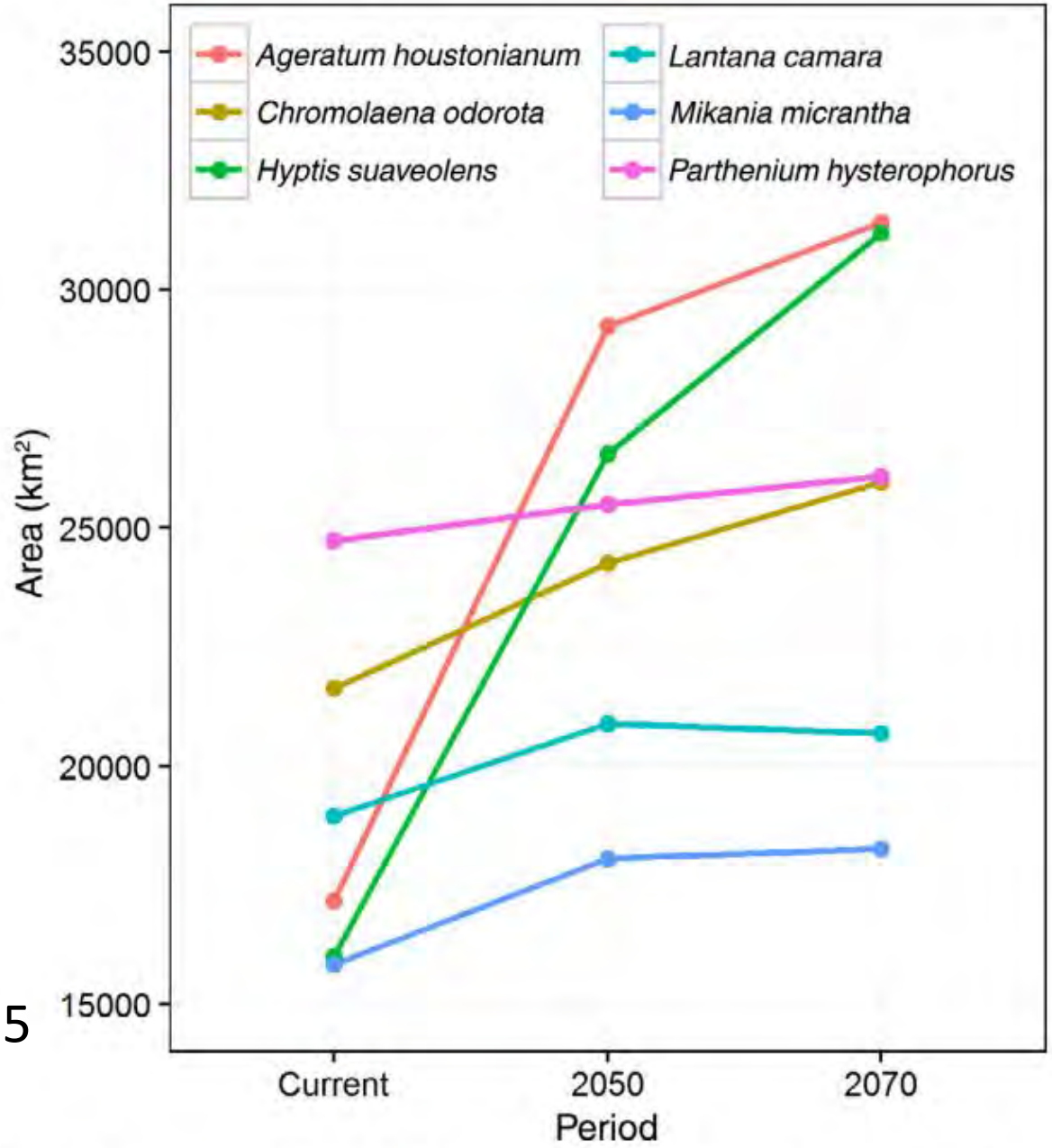


Fig. 3. Changes in the suitable habitats of six invasive alien plants in Nepal under future climate.

3. Drivers and pathways…

Drivers of invasions…

- **Local drivers**: Deforestation, Agriculture land abandonment…

Lantana camara in degraded forests (Jajarkot district)

Parthenium hysterophorus in abandoned agriculture land (Kathmandu valley)

3. Drivers and pathways…

Drivers of invasions…

- **Local drivers**:… Infrastructure development (e.g. road), wetland eutrophication

Roads are dispersal corridors for species like *Parthenium* (Pyuthan district)

Lake eutrophication allows establishment and rapid spread of species like *Pontederia crassipes* (Kailali district)

3. Drivers and pathways…

Introduction pathways: not known for many species

- **Accidental introduction**: *Mikania micrantha, Tuta absoluta*
- **Intentional introduction**: e.g. *Mimosa diplotricha* (for soil bioengineering), *Lantana camara* (for ornamental), Tilapia (for fish farming)

Lantan camara grown in a private garden in Kathmandu
(Photo: Yamuna Ghale, 2021)

4. Impacts: What are the ecological and socio-economic impacts of invasive alien species?

Ecological impacts

- Habitat degradation of endangered wildlife (e.g. one-horned rhinoceros) by *Mikania micrantha* (Murphy *et al*. 2013)

(Photo: Baburam Lamichhane, NTNC/BCC)

4. Impacts: What are the ecological and socio-economic impacts of invasive alien species?

Ecological impacts…

- Altered species composition and soil chemistry of grasslands by *Parthenium hysterophorus* (Timsina *et al*. 2011)
- Reduced species richness due to *Lantana camara* in Bardian NP (Bhatt et al 2020)

Plot types and statistical variables	Species richness (±SD)		Species diversity	
	Total species	Native species	Shannon diversity index (H')	Simpson diversity index (1 – D)
Non-invaded	16.3 ± 4.6	14.1 ± 3.5	3.6	0.9
Invaded	7.0 ± 2.0	6.4 ± 1.9	3.4	0.2
t-value	15.9	16.7		
p-value	0.0001	0.001		

4. *Impacts*:...

Socio-economic impacts

- Negative effects on the livelihood of wetland dependent and rural communities (Rai *et al*. 2012; Personal observations)
- Reduced provisional ecosystem services of forests and rangelands; reduced agriculture production (Shrestha *et al.* 2010)
- Health hazard to human and livestock b
(Shrestha *et al.* 2015)

A livestock owner at Mahdendranagar, Kailali, affected seriously by parthenium allergy

4. *Impacts*:...

Socio-economic impacts…

- **Damage to agriculture crops**: Tomato leaf miner (*Tuta absoluta*) on tomato, fall armyworm (*Spodoptera frugiperda*) on maize, giant African snail (*Achatina fulica*) on vegetables

Tomato leaf miner (@Bajracharya et al 2016)

Fall armyworm damage on maize

https://risingnepaldaily.com/detour/fall-armyworm-a-menace-for-nepali-farmers

4. *Impacts*:...

Socio-economic impacts

- **Rising economic burden**: management/control cost

A machine removing water hyacinth from Fewa Lake in Pokhara, Kaski, on Wednesday, January 31, 2018.
Photo: THT

https://thehimalayantimes.com/multimedia/photo-gallery/cleansing-fewa-lake/

Pokhara Lekhnath metropolitan city bought a machine in January 2018 to remove water hyacinth (*Pontederia crassipes*) investing Rs. 2.5 millions (ca. US $ 23,000)

4. Impacts:...

Socio-economic impacts

- Rising economic burden:...

A Community Forest Users' Group of Jhapa spent Rs. **1.4 millions (ca. US $ 13,000) in last 4 years** to remove *Mimosa diplotricha* (Renuka Upreti, Interviewed, 2020)

4. *Impacts*:...

Cultural impacts

- Use of *Parthenium* instead of native *Anaphalis busuwa* during festivals in Kathmandu valley

Native *Anaphalis busuwa*

Parthenium for sale instead of native *A. busuwa*

(Photo: Nirmala Joshi)

4. Impacts:...

Gaps in impact related knowledge

- Ecological impacts of many IAS yet to be studied
- Impacts on ecological and evolutionary processes have not been studied
- Economic impacts have not been estimated

5. Management: Which control measures are implemented to manage invasive alien species?

- **Physical removal** has been most frequently implemented

Removal of *Pontederia crassipes* and *Leersia hexandra* from Beeshajari lake, Chitwan (2012)

Removal of *Parthenium hysterophorus* (Kathmandu, 2014)


Lantana cleared in a community forest in Bardia, western Nepal

Removal of *Mikania* in Jhapa, eastern Nepal

5. *Management*:...

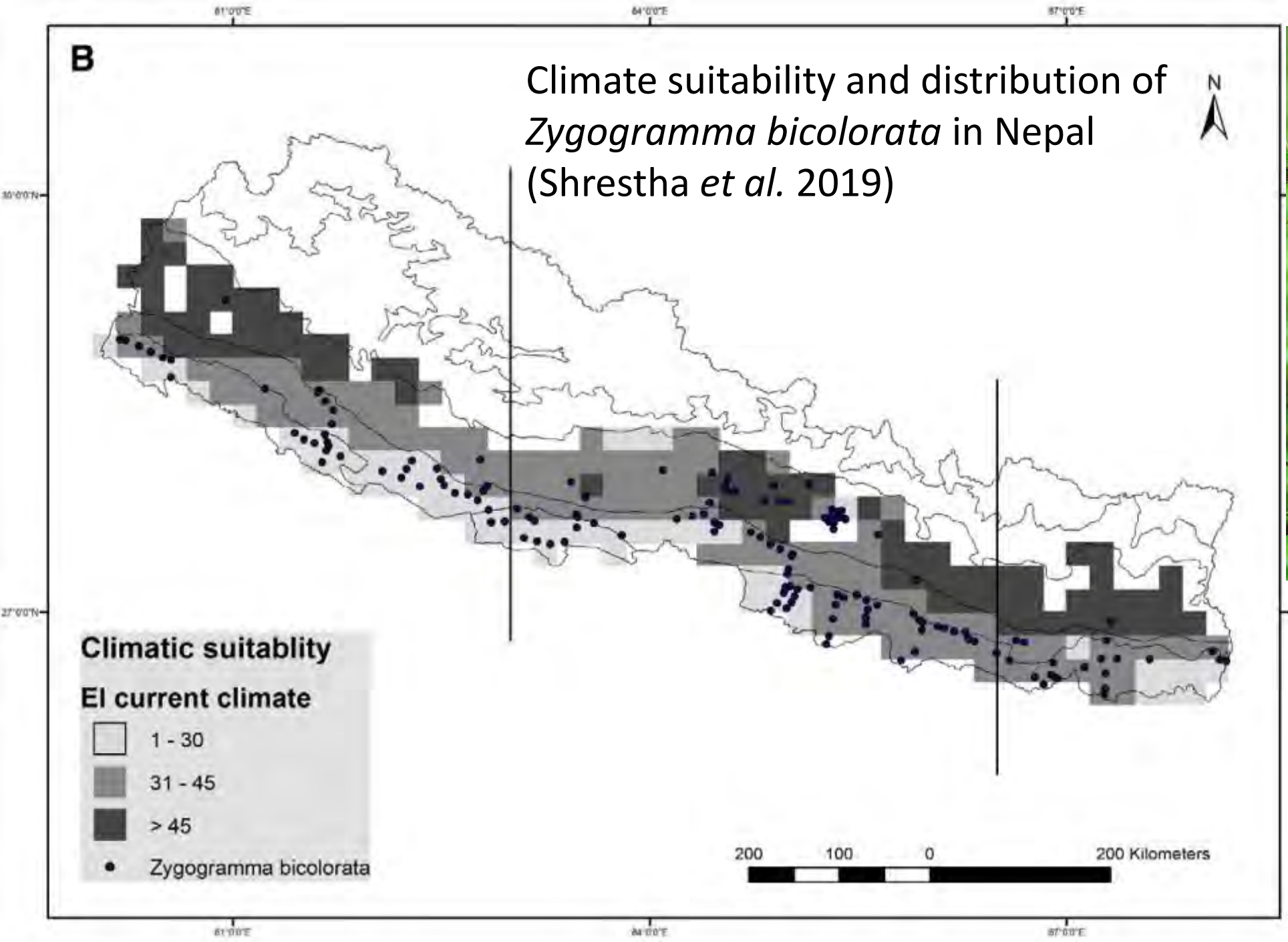
- **Biological control**: formally not initiated yet, but some biological control agents have spread from the neighboring countries and established with some impacts.

Stem galling insect (*Procecidochares utilis*) against *Ageratina adenophora*

Leaf feeding beetle (*Zygogramma bicolorata*) against *Parthenium*

Winter rust (*Puccinia abrupta* var. *partheniicola*) against *Parthenium*

Climate suitability and distribution of *Zygogramma bicolorata* in Nepal (Shrestha *et al.* 2019)



6. Meeting the targets: What is the progress towards meeting national and global targets in the last decade?

Targets	National document	Progress
Management plan of three IAS (*Mikania, Parthenium* and *Pontederia/Eichhornia*) **prepared and implemented by 2010**	4th National Report to CBD (2009)	No progress
Nation-wide survey and **research** on at least five most problematic invasive alien plant species by 2020.	National Biodiversity Strategy and Action Plan (2014)	Mostly achieved
Development of an **Invasive Plant Atlas** for identification, early detection, prevention and management of invasive plants.	National Biodiversity Strategy and Action Plan (2014)	Will be achieved soon!

Invasive Alien Plants of Nepal

A field guide to the 27 problematic species

To be published in 2021

Ageratina adenophora — कालो बनमारा Kalo banmara

Banmasa, Banmara

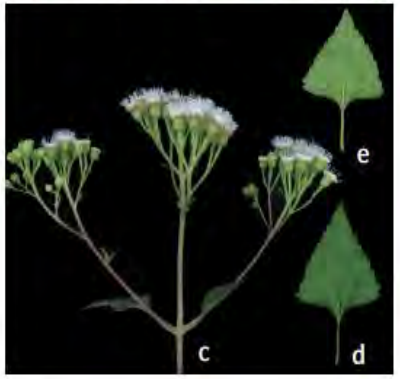
Family: Asteraceae

- Herb to 2 m high, stem purplish brown, glandular pubescent
- Leaves 5–8 × 3.5–7 cm
- Flower head 0.5–1 cm in dense axillary and terminal corymbs, florets 40–50, white
- Achenes 1–1.5 mm, black-brown, 5-angled

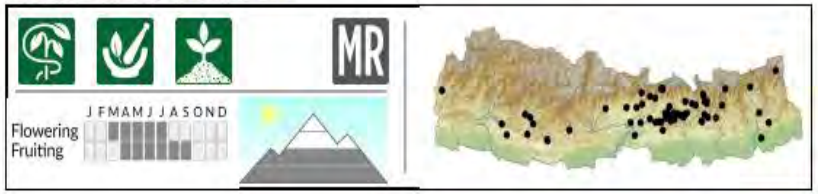
Ageratina adenophora is native to Mexico, but is now known to occur in more than 40 countries across six continents. It probably entered eastern Nepal from India. It forms a dense stand that suppresses the growth of other species through competition and allelopathic (chemical) effects. It is toxic to livestock. A single plant can produce several thousand seeds which are easily dispersed in the wind. Local people use the leaf juice to stop bleeding from minor cuts. It is used to make compost, green manure, and is also used in biogas plants. The char produced from its stem is used to make pellets, briquettes and biochar. People remove plants manually from forests and agricultural lands. A biological control programme using the stem gall fly *Procecidochare utilis* has not been successful in Nepal.

Open areas, degraded forest, forest margins, streams, fallow lands.

Nepal (200–3200 m, first report 1952), native to C America, accidentally introduced to tropical and subtropical areas of the world.



a, *A. adenophora* in degraded forest; b, c, flowering plant; d, leaf (upper surface); e leaf (lower surface).



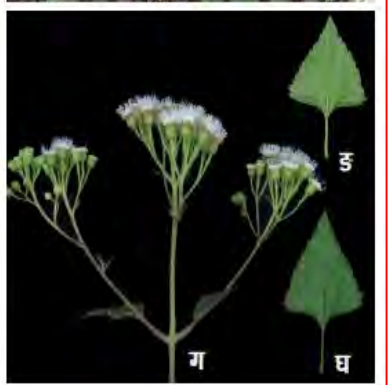
कालो बनमारा — एजेरेटिना एडेनोफोरा Ageratina adenophora

बनमासा, बनमारा

- २ मिटर सम्म अग्लो हुने झार, काण्ड बैजनी खैरो रंगको
- पात ५–८×३.५–७ से.मी.
- फूल सेतो २–४ से.मी. व्यास भएको र ४०–५० वटा स-साना फूलहरु मीली बनेको
- बीउ कालो खैरो रंगको, १-१.५ मी.मी., पाँचवटा धार भएको

कालो बनमाराको उत्पति मध्य अमेरिकामा (मेक्सिको) भएको हो र अहिले यो प्रजाति संसारका ६ महादेशका ४० भन्दा बढी देशमा फैलिएको छ । यो बिरुवा भारत हुदै नेपालको पुर्वी क्षेत्रबाट प्रवेश गरेको अनुमान गरिन्छ । एउटा बिरुवाबाट हजारौको संख्यामा बीउहरु उत्पादन हुन्छन र यी बीउहरु हावाको मध्यमबाट सजिलै एक ठाउँबाट अर्को ठाउँ सम्म पुग्दछन् । यो बिरुवा घना झाडीको रुपमा फैलिन्छ र यसमा अरु नजिकका बिरुवाहरूलाई बढन नदिने क्षमता हुन्छ । स्थानीयहरु काटेको ठाउँमा रगत बगेको रोक्न यसको पातको रस प्रयोग गर्छन् । यो बिरुवालाई प्रांगारिक र हरितमलको रुपमा पनि प्रयोग गर्ने गरिन्छ । यसको अंगारबाट ब्रिकेट बनाई बैकल्पिक इन्धनको रुपमा पनि प्रयोग गर्न सकिन्छ । यो मिचाहा बिरुवा नियन्त्रण गर्न बन उपभोक्ता समिति र स्थानीय व्यक्तिहरुले यसलाई उखेलेर फाल्ने गर्दछन् । यसको नियन्त्रण गर्न केहि किराहरुको पनि प्रयोग गरिएको थियो तर नेपालमा त्यो सफल भएन ।

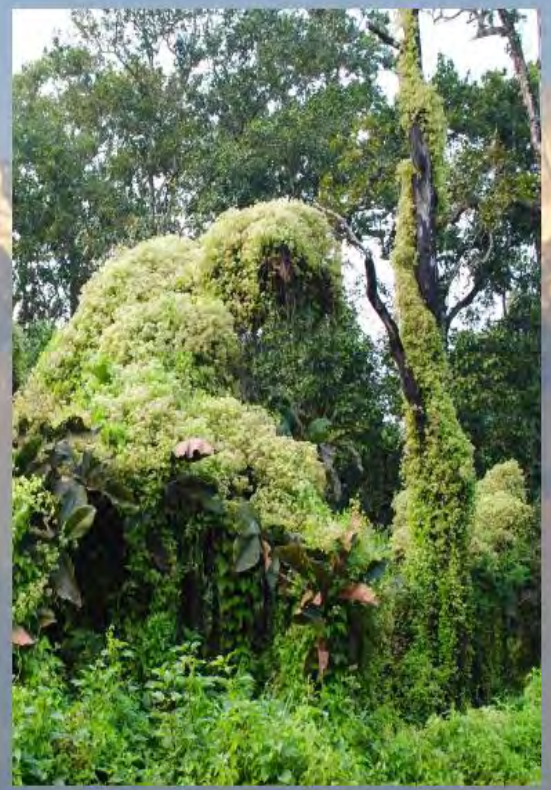
नेपाल (२००–३२०० मी., जंगल र बाटोको छेउछाउ, खेर गइ राखेको जग्गा र अतिक्रमण गरिएका जंगलहरू; पहिलो रिपोर्ट २००८), मध्य अमेरिकामा उत्पति भइ दक्षिण एसिया र विश्वका उपोष्ण र समशितोष्ण क्षेत्रहरु संयोगवश भित्रिएको ।



क, अतिक्रमण गरिएको बनमा बनमारा; ख,ग, फुलेको बिरुवा; घ, पात (माथिल्लो सतह); ङ, पात (तल्लो सतह) ।

FIELD GUIDE TO THE

INVASIVE ALIEN PLANTS OF NEPAL



To be published in 2021

FIELD GUIDE OF INSECT PESTS OF NEPAL

FIELD GUIDE TO FOREST DISEASES OF NEPAL

6. *Meeting the targets*:...

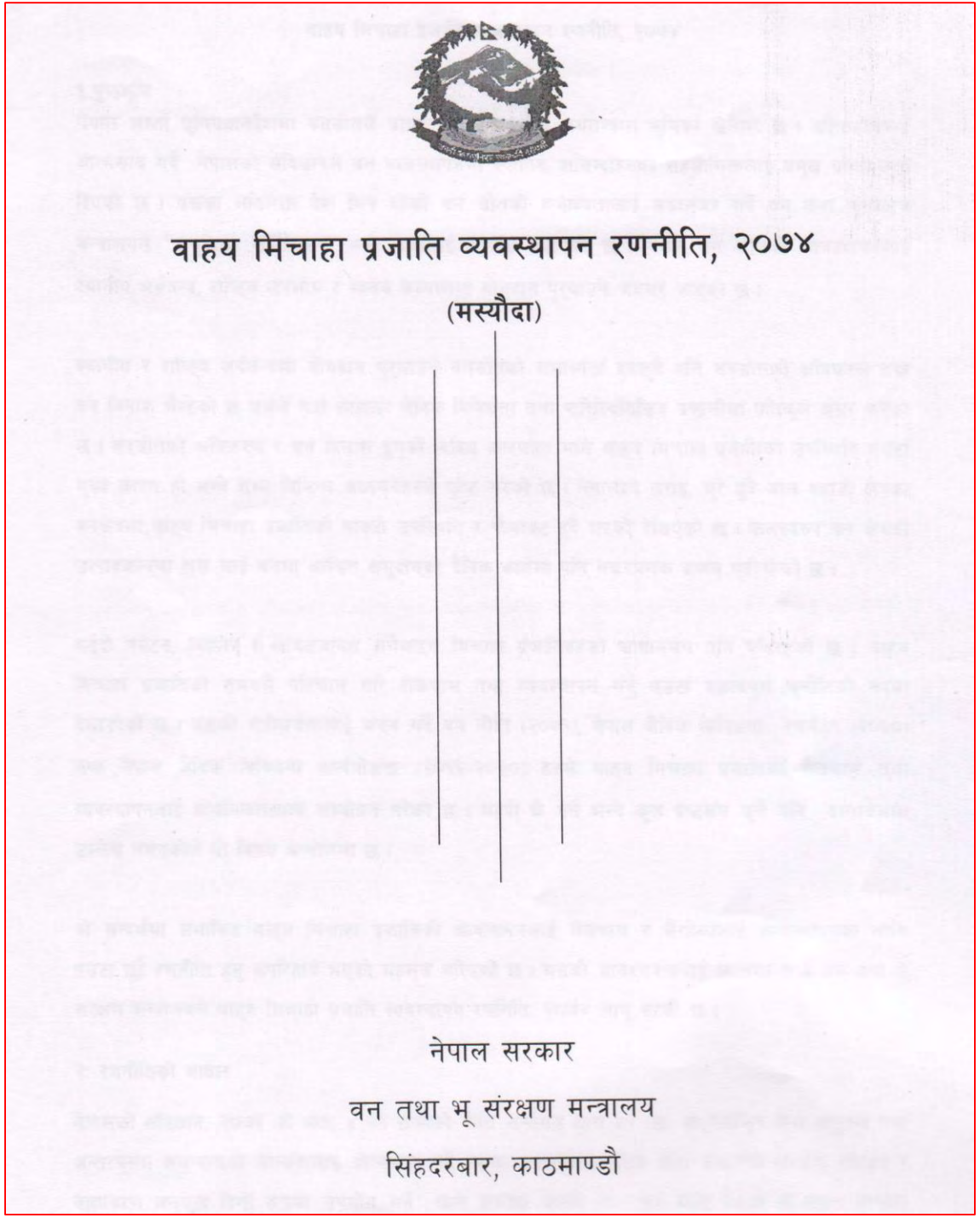
Targets	National document	Progress
Enhancing quarantine and detecting capacity of custom and quarantine offices	National Biodiversity Strategy and Action Plan (2014)	Not known (?)
Development and implementation of programme to **raise awareness** of local people on invasive alien species, their impacts and control measures.	National Biodiversity Strategy and Action Plan (2014)	Partially achieved
Development, testing and application of appropriate **biological control agents**.	National Biodiversity Strategy and Action Plan (2014)	No progress

6. *Meeting the targets*:...

Aichi Biodiversity Target 9 of CBD	Progress at national level in Nepal
By 2020, invasive alien **species** and **pathways** are **identified and prioritized**,	Partially achieved (Species identified but not pathways)
Priority species are **controlled** or **eradicated**, and	Very low progress
Measures are in place to manage pathways to **prevent their introduction and establishment**	No progress

Ministry of Forest and Soil Conservation is working for the preparation of **Invasive Alien Species Management Strategy**

Drafted in 2016 but not approved yet!



7. Future options: What are the options for effective management of IAS?

- Filling the **data** and **knowledge** gaps
  - Introduction pathways
  - Status of invasive animal species
  - Ecological and evolutionary impacts
  - Economic valuation of invasive alien species impacts and management
  - Prioritization of species and sites/ecosystems for control/management

7. Future options:...

- Initiation of biological control program
- Education and awareness among all stakeholders including policy makers
- Community participation
- Institution and Governance
- Integration with responses to other components of global environmental changes, particularly the climate change, and land use and land cover change
- National Strategy of Invasive Alien Species Management

Take home message

- Invasive alien species are already widespread with wide ranging ecological and socioeconomic impacts which are most likely to increase continuously in future under '*business-as-usual*' scenarios.
- Minimum information required for management of IAS is currently available, though incomplete.
- What is needed now is an acknowledgement of the seriousness of the problem by policy makers and implementation of science-based management interventions.

THANK YOU

Any queries and questions are welcome

Participation of local community