



DOCUMENTATION AND PUBLICATION OF **ENDANGERED AND HIGH-VALUE BIODIVERSITY** IN BAGAMATI PROVINCE



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Ministry of forest and environment
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Contents

Contents	i
List of Table	ii
List of Figure	ii
Acronyms	iii
Executive Summary	iv
1. Introduction	1
1.1. Background	1
1.2. Objectives	2
1.3. Scope and limitation of the study	3
2. Literature review.....	4
3. Materials and Methods	7
3.1. Study area	7
3.2. Field visit and data collection	8
3.3. Consultation and validation	9
3.4. Secondary data collection	9
3.5. Data analysis	9
4. Findings	11
4.1. Understanding of critical habitats and biodiversity hotspots	11
4.2. Critical ecosystems and habitats identified in consultations	11
4.3. Biodiversity importance of Bagmati province	15
4.4. Species diversity	18
4.4.1 Endemic, Endangered and High-Value Species at district level.....	18
4.4.2 Agrobiodiversity in Bagmati province.....	20
4.5. Habitat diversity	21
4.5.1 Forest and vegetation types	21
4.5.2 Protected area, conservation area and in-situ conservation areas.....	21
4.6. Threats constraining biodiversity	23
4.6.1 Forest cover change.....	23
4.6.2 Distribution of invasive species	23
4.6.3 Climate change	24
4.6.4 Forest fire.....	25
4.7. Critical habitats and ecosystems immediate for conservation	25
4.8. Strategies for management of critical habitats/hotspots.....	28
5. Conclusions and recommendations	30
5.1. Conclusions	30
References	32
Annexes	33
Annex 1. Checklist for ecological sampling	33
Annex 2. Checklist for social survey	34
Annex 3. Distribution of endemic plant species	35
Annex 4. Distribution of threatened plant species	39
Annex 5. BSO, Mother tree stands and in-situ sites in Bagmati province.....	41

List of Table

Table 1. List of protected areas in Nepal	1
Table 2. Important biodiversity zone and hotspots in Bagmati province	14
Table 3. Some Endangered and Vulnerable Plant Species in Bagmati Province (Based on the IUCN Red List, CITES Appendices, and Nepal's National Red List)	16
Table 4 Some Endangered and Vulnerable Fauna in Bagmati Province (Based on IUCN Red List & National Red List of Nepal)	17
Table 5. Some Endemic/Near-Endemic Species in Bagmati province	18
Table 6. Endangered, Endemic, and High-Value Flora and Fauna in Bagmati province	19
Table 7. Endemic and indigenous Agro-species and resources in Bagmati province	20
Table 8. District-wise overview of Bagmati province, detailing the number and type of Protected Areas, Botanical Gardens, Zoos/Zoological Parks	22
Table 9. Forest cover change Bagmati province between 2010 and 2020	23
Table 10. Forest fire incidences between 2000 and 2019 and its index in Bagmati province	25
Table 11. Critical ecosystems/hotspots in Bagmati	27
Table 12. List of potential critical habitats of Bagmati province	28

List of Figure

Figure 1: Digital Elevation Map of Bagmati province	7
Figure 2: Land cover map of Bagmati province	8
Figure 3: Distribution of IAPs in Bagmati province	24
Figure 4: Map showing critical habitats and hotspots of Bagmati province	28

Acronyms

CAMP:	Conservation Assessment and Management Planning
CBD:	Convention on Biological Diversity
CBS:	Central Bureau of Statistics
CFUGs:	Community Forest User Groups
CITES:	Convention on International Trade in Endangered Species of Wild Fauna and Flora
CoP:	Conference of Parties
DFO:	Division Forest Office/Divisional Forest Officer
DoF:	Department of Forests
DNPWC:	Department of National Parks and Wildlife Conservation
DPR:	Department of Plant Resources
EPA:	Environment Protection Act
FGDs:	Focus Group Discussions
GIS:	Geographical Information System
GoN:	Government of Nepal
ICIMOD:	International Centre for Integrated Mountain Development
IEE:	Initial Environment Examination
IUCN:	International Union for Conservation of Nature
MAPs:	Medicinal and Aromatic Plants
MOTFE:	Ministry of Tourism, Forests and Environment
MPFS:	Master Plan for Forestry Sector
NBSAP:	Nepal Biodiversity Strategy Action Plan
NPWC:	National Park and Wildlife Conservation
NTFPs:	Non-Timber Forest Products
NTNC:	National Trust for Nature Conservation
PAs:	Protected Areas
RECAST:	Research Centre for Applied Science and Technology
SCP:	Systematic Conservation Planning
SDGs:	Sustainable Development Goals
TMK:	Traditional Medicinal Knowledge
UNESCO	United Nations Educational, Scientific and Cultural Organization
VSOs:	Village Social Organizations
WWF:	World Wide Fund for Nature

Executive Summary

Bagmati Province is featured with diverse physiographic zones, ranging from the lowland Tarai to mid-hill regions to alpine habitats and snow-capped mountains. Forests in this province cover 53.73% of the total land area that support the biodiversity of and scale to five protected areas. The province, however, is experiencing significant environmental pressures, including habitat fragmentation, unsustainable land use, climate variability, and overharvesting. Conservation efforts are further limited by a lack of updated, accessible ecological data, hindering effective planning and monitoring. Addressing this gap is crucial for safeguarding biodiversity and ensuring evidence-based management interventions.

To overcome the limitation, Systematic Conservation Planning (SCP), is emphasized that collectively represent the full range of biodiversity, rather than relying on a few species-rich locations. SCP supports the identification of sites with high conservation importance, rare species distributions, and ecological functionality, thus achieving more comprehensive and representative conservation outcomes. By integrating SCP approaches into regional planning and filling data gaps through systematic biodiversity documentation, Bagmati Province can serve as a model for ecologically informed, socially inclusive, and economically sustainable conservation in Nepal. Given the biodiversity importance of the province and its increasing environmental threats, this study has emphasized in identifying and cataloguing the critical ecosystems that need immediate conservation for maintain biodiversity in long run. Desk review, field observation, community and stakeholder consultations and GIS mapping were used to consolidate the theoretical base, threats and drivers and strategic measures pertaining to biodiversity conservation and hotspots mapping.

Critical habitats and biodiversity hotspots are ecologically important areas that require special attention due to their rich biodiversity, unique ecosystems, and vulnerability to environmental threats. Local stakeholders have emphasized conserving several critical areas outside protected areas of the province since they boast several endemic and threatened species. Among many, Swayambhu groove of Kathmandu, Daman-Phulchoki complex of Lalitpur-Makawanpur, Panchpokhari area of Sindhupalchok, Chilime-Goljung-Gatlang area of Rasuwa, Ruby valley of Dhading, Rolwaling area of Dolakha, and lower GCA areas were considered as critical as large number of endemic, threatened and high value flora, fauna and aggroresources are found in these areas. Moreover, the associated districts of these areas are impacted by several threats including severe climate vulnerability, invasion by alien plant species and forest cover loss.

For the proper management of biodiversity, hotspots, and ecosystems in Bagmati Province, in-situ conservation, habitat management, community participation, scientific research, and policy integration is emphasized while maintaining habitat connectivity and ordering the climate change, land use change and invasion of plant species. Strengthening institutional capacity and promoting awareness at the local level are also essential to ensure long-term ecological balance and resilience. Strengthening the role of local governments and empowering communities through inclusive governance models will be essential to secure a resilient and biodiversity-rich future for Bagmati Province.

1. Introduction

1.1. Background

Nepal, though relatively small in land area, is globally recognized as a biodiversity hotspot due to its extraordinary range of ecosystems, altitudinal variation, and rich species diversity. The country harbors approximately 1.1% of the world's known plant species and 3.2% of known animal species, reflecting its exceptional ecological wealth (MoFSC, 2014). This includes 284 species of endemic flowering plants (DPR, 2013) and 160 endemic animal species, among which 14 herpetofauna species are found nowhere else in the world (MoFSC, 2005; Bhujju et al., 2007). Nepal has recorded 2,331 species of medicinal and aromatic plants (MAPs), of which around 300 species are currently under trade (Pyakurel et al., 2019; Rokaya et al., 2012), indicating their economic and pharmaceutical importance.

Among 13 protected areas and six conservation areas of Nepal, the Annapurna Conservation Area is considered to have the highest biodiversity hotspot, followed by the Shey Phoksundo National Park, and Gaurishankar Conservation Area (Shrestha et al., 2022) (Table 1). These protected areas represent not only high species richness but also ecological uniqueness, including rare, endemic, and threatened species. However, conservation prioritization based solely on biodiversity hotspots often overlooks rare and range-restricted species that are not necessarily concentrated in species-rich zones (Shrestha et al., 2019). Thus, while the biodiversity hotspot approach remains common due to its simplicity in implementation (Ribeiro et al., 2017), it is not sufficient to ensure the protection of all biodiversity features.

Table 1. List of protected areas in Nepal

Name	Area (km ²)	Type	Province(s)
Annapurna Conservation Area	7,629	Conservation Area	Gandaki
Shey Phoksundo National Park	3,555	National Park	Karnali
Gaurishankar Conservation Area*	2,179	Conservation Area	Bagmati
Kanchenjunga Conservation Area	2,035	Conservation Area	Koshi
Api Nampa Conservation Area	1,903	Conservation Area	Sudurpashchim
Langtang National Park*	1,710	National Park	Bagmati
Manaslu Conservation Area	1,663	Conservation Area	Gandaki
Makalu Barun National Park	1,500	National Park	Koshi
Sagarmatha National Park	1,148	National Park	Koshi
Bardiya National Park	968	National Park	Lumbini
Chitwan National Park*	952.63	National Park	Bagmati, Gandaki, Madhesh
Parsa National Park*	637.37	National Park	Madhesh, Bagmati
Banke National Park	550	National Park	Lumbini, Karnali
Shuklaphanta National Park	305	National Park	Sudurpashchim
Khaptad National Park	225	National Park	Sudurpashchim
Koshi Tappu Wildlife Reserve	175	Wildlife Reserve	Koshi
Shivapuri-Nagarjun National Park*	159	National Park	Bagmati
Rara National Park	106	National Park	Karnali
Blackbuck Conservation Area	15.95	Conservation Area	Lumbini

* Protected areas of Bagmati province

To overcome the limitations of hotspot-focused conservation, researchers and policymakers are increasingly turning to Systematic Conservation Planning (SCP), which is grounded in the principle of complementarity (Margules & Pressey, 2000). SCP emphasizes selecting a network of conservation areas that collectively represent the full range of biodiversity, rather than relying on a few species-rich locations. This method supports the identification of sites with high conservation importance, rare species distributions, and ecological functionality (Butchart et al., 2015; Venter et al., 2014), thus achieving more comprehensive and representative conservation outcomes.

In this context, Bagmati Province plays a particularly vital role in biodiversity conservation due to its diverse physiographic zones, ranging from the lowland Terai to mid-hill regions. Forests in this province cover 53.73% of the total land area and include five nationally protected areas (Chaudhary et al., 2020). Key conservation zones such as Chitwan National Park, Langtang National Park, Shivapuri Nagarjun National Park, and Panch Pokhari wetlands are home to numerous endangered, endemic, and economically valuable species. Likewise, wetlands such as Taudaha, Indra Daha, and Gosaikunda are critical habitats for migratory birds and aquatic biodiversity, but are under increasing threat from urbanization, invasive species, and pollution.

Despite its ecological richness, Bagmati Province is experiencing significant environmental pressures, including habitat fragmentation, unsustainable land use, climate variability, and overharvesting. Conservation efforts are further hampered by a lack of updated, accessible ecological data, hindering effective planning and monitoring. Addressing this gap is crucial for safeguarding biodiversity and ensuring evidence-based management interventions.

To address these challenges, Nepal has enacted the National Biodiversity Strategy and Action Plan (NBSAP) 2014-2020, in alignment with the Convention on Biological Diversity (CBD) and the Sustainable Development Goals (SDGs) (MoFSC, 2014). In line with national efforts, Bagmati Province has initiated localized biodiversity action planning to identify and conserve sensitive ecosystems and species. These initiatives emphasize community engagement, indigenous knowledge, equitable benefit sharing, and the systematic documentation of species particularly those that are endangered, endemic, or economically significant to support ecosystem resilience, climate adaptation, and sustainable livelihoods.

Ultimately, achieving maximum conservation benefit requires that prioritized conservation areas be fully representative of extant biodiversity (Margules & Pressey, 2000; Pimm et al., 2018). By integrating SCP approaches into regional planning and filling data gaps through systematic biodiversity documentation, Bagmati Province can serve as a model for ecologically informed, socially inclusive, and economically sustainable conservation in Nepal.

1.2. Objectives

General Objective:

To document endangered and high-value biodiversity in Bagmati Province and to propose strategies for its conservation and sustainable management.

Specific Objectives:

- Identify and catalog endangered and high-value ecosystems throughout Bagmati Province.
- Assess the scientific, ecological, economic, and cultural importance of these ecosystems.
- Analyze key threats and conservation challenges affecting them.
- Develop practical and evidence-based recommendations for their conservation and sustainable use.

1.3. Scope and limitation of the study

- **Data Gaps:** Limited availability of updated and accessible biodiversity data, especially for lesser-known taxa like fungi, invertebrates, and non-commercial plants.
- **Seasonal and Spatial Gaps:** Incomplete seasonal and geographic coverage may have excluded migratory species and remote biodiversity hotspots.
- **Taxonomic Constraints:** Shortage of skilled taxonomists affected accurate identification of endemic and cryptic species.
- **Dynamic Land Use:** Rapid socio-political and land-use changes, especially in urban areas, may not be fully reflected.
- **Limited Community Input:** Inconsistent application of participatory methods limited integration of local and indigenous knowledge.

2. Literature review

We thoroughly reviewed existing literature, including research papers, government reports, and other relevant documents related to the biodiversity of Bagmati province. This review provided a comprehensive understanding of the region's ecological background, current threats, and the history of biodiversity research-particularly regarding biodiversity hotspots. The insights gained were instrumental in guiding the drafting of this report.

Forest Act (2019) and Regulation (2022): The Forest Act 2019 classifies birds, wildlife, trophies, tree products, and MAPs as forest products. The act allows the government to designate areas of national forests with special significance as protected forests. The Act and the 2022 Forest Regulations impact the conservation and sustainable use of biodiversity, including MAPs, across various forest types. The Regulations set royalty rates and procedures for MAPs collection, use, trade, processing, and export. About 30% of Nepal's national forests are now community-managed, giving locals rights to manage and use these forests, including MAPs, while Divisional Forest Officers retain regulatory rights over collection, trade, and export.

National Park and Wildlife Conservation Act (1973): Nepal began its modern wildlife conservation efforts with the NPWCA, 1973. This Act empowers the government to establish or modify Protected Areas (PAs) through a gazette notification and prohibits hunting without written permission. However, hunting protected species listed in Appendix 1 is always forbidden. The Act also restricts the collection and trade of MAPs in National Parks and Reserves, except in some mountainous regions. Field visits revealed that villagers illegally collect and sell some local species for household and commercial use.

NTNC Act (1982): The NTNC Act (1982) established the National Trust for Nature Conservation (NTNC) as an autonomous, non-profit organization for nature conservation. NTNC manages three conservation areas (Annapurna, Gaurishankar, and Manaslu) and the Central Zoo, focusing on sustainable management and wise use of non-timber forest products. The Act is supported by NTNC Regulations, 1984.

Master Plan for Forestry Sector (1989) and the Forestry Sector Strategy (2016): The Master Plan for Forestry Sector (MPFS) 1989 focused on sustainably managing forest resources to meet people's basic needs. It emphasized policy decentralization, empowerment, employment generation, participation, and public/private partnerships, with production forestry and livelihood promotion as major concerns. The plan set MAPs royalty rates at 10% of market prices. It was replaced by the Forestry Sector Strategy in 2016, which runs for 10 years. This strategy emphasizes expanding NTFPs/MAPs cultivation, improving in-situ resource management, collaborating with local communities for marketing, and increasing exports from NRs 6 billion in 2014 to NRs 18 billion annually by 2024.

IUCN (1994): The IUCN (1994) prioritized conserving threatened and endangered medicinal plant species by categorizing them in the Red List as Critical, Rare, Vulnerable, Endangered, and Threatened. In December 2006, the list included 34 global plant species, with 28 indigenous to Nepal. This list contains both common and uncommon species due to inadequate data on species distribution and conservation status in Nepal.

CITES (1995) and Act 2017: Nepal has been a signatory of the Convention on International Trade in Endangered Species (CITES) of Wild Flora and Fauna since 1975 and a number of plant species (18) are listed in CITES under various appendices (CoP 17, CITES 2017). There are two species (*Paphiopedilum insigne* (W. Wall ex Lindl.) Pfitzer, *Paphiopedilum venustum* (Wall. ex Sims) Pfitzer ex Stein) in Appendix I, 165 species (*Dioscorea deltoidea* Wallich ex Kunth, *Rauwolfia serpentina* Benth. ex Kurz, *Podophyllum hexandrum* Royle *Alsophila gigantea* Wall ex Hook, *Cyathea*-3, *Cycas pectinata* Buch. - Ham. *Euphorbia* -3, *Dalbergia*-6, *Taxus*-2, Orchid-144, *Picrorhiza kurrooa* Royle ex Benth., *Nardostachys grandiflora* DC.) in Appendix II and 4 (*Gnetum montanum* Markgraf, *Meconopsis regia* G. Taylor, *Podocarpus neriifolius* D. Don in Lambert, *Tetracentron sinense* Oliver) species in Appendix III. However, recently the government has formulated a CITES act 2017, which clearly mentions CITES species that can and cannot be exported. The frequent changes in rules and legislation without any consultation with the stakeholders, more particularly the village collectors, and empirical research have created confusion in the collection and trade of MAP species.

Environment Protection Act 2019 (EPA) and Regulation 2020 (EPR): The EPA (2019) was the first Nepali legislation to define biodiversity. The Environment Protection Act of 2019 and the Environment Protection Regulations of 2020 mandate initial environmental examinations (IEE) or environmental impact assessments (EIA) for forest, agriculture, and hydropower developments. The EIA processes under the Environmental Protection Act (2019) are criticized for insufficiently considering biodiversity conservation and the participation of poor and indigenous people. According to the regulations, up to 50 tons of a MAP species can be harvested in a district with IEE approval, but an EIA is required to extract more than this limit. The Department of Forests (DoF) or Provincial Forest Directorate can approve IEE for MAPs extraction up to 50 tons per species per district. For extraction beyond 50 tons, an EIA must be conducted and approved by the Ministry of Forests and Environment. The preparation and approval of an EIA document are costly and time-consuming processes.

Conservation Assessment and Management Planning (2001): The Conservation Assessment and Management Planning (CAMP) 2001 prioritized 51 plant species from the mid hills and mountain areas for conservation. These species were considered threatened by overexploitation, driven by increasing commercial demands, which could seriously impact their populations and lead to habitat loss.

Protected Plants of Nepal (Government of Nepal) (2001): Under the Forest Act 1993 and Forest Regulation 1995, and their amendment in article 70, the Government of Nepal has notified restriction on utilization of plant and their products since February 12, 2001. The Government has imposed restriction on export of 12 plant species. Moreover, seven tree species are banned for felling, transportation and export. Of the listed species, 10 species are under IUCN and CAMP list and four species under CITES list. *Dactylorhiza hatagirea*, *Nardostachys grandiflora*, *Taxus wallichiana* and, *Rauwolfia serpentina* are common protected species of Government of Nepal, and CITES. Latest Forest Act 2019 and Forest Regulation 2022 and CITES Act 2017 made changes on previous plant species list according to their priority of conservation.

Herbs and NTFP Development Policy (2004): The Herbs and NTFP Development Policy (2004) aims to boost Nepal's economy by conserving high-value herbs and NTFPs and establishing Nepal as a key global source by 2020. It sets six objectives, including regeneration, ex-situ conservation, local processing, business development services, inclusion of disadvantaged groups, and earning foreign currency through competitive NTFP development. Although it lacks provisions for risk identification and mitigation, the policy provides essential direction and support for NTFP development. Following the policy guidelines, the Nepalese government prioritized 30 medicinal and aromatic plants for research and cultivation in 2006, added 3 more species in 2016 and all total 33 species.

Bagmati Province Forest Act (2019): The Bagmati Province Forest Act 2019 aims to ensure the sustainable management, conservation, and utilization of forest resources within Bagmati Province, Nepal. Its primary objectives are to manage forest resources in a manner that meets current needs without compromising future generations' ability to do the same, and to conserve the region's rich biodiversity, including wildlife habitats and genetic resources. The Act emphasizes the importance of community participation, encouraging local communities and indigenous peoples to be actively involved in forest management and decision-making processes. Additionally, it aims to boost economic benefits from forests-such as timber, non-timber products, and ecotourism-thereby improving local livelihoods. Recognizing the critical role forests play in climate change mitigation, the Act promotes conservation and afforestation activities to enhance carbon sequestration. It seeks to protect forests from illegal activities like logging and encroachment, strengthen the capacity of forest management institutions, and ensure effective law enforcement. Moreover, the Act encourages research, education, and awareness initiatives related to forest conservation and sustainable use.

Bagmati Province Environmental Protection Act (2020): The Bagmati Province Environmental Protection Act 2020 is designed to safeguard and enhance environmental quality throughout the province of Bagmati in Nepal. Its overarching aim is to ensure the conservation and sustainable use of natural resources and ecosystems. The Act seeks to achieve this through several key objectives: firstly, by implementing measures to control and mitigate various forms of pollution, including air, water, and soil contamination, thereby improving overall environmental health. Secondly, it addresses climate change by promoting practices that reduce greenhouse gas emissions and enhance resilience to climate impacts.

Moreover, the Act aims to manage natural resources such as water, land, and minerals in a sustainable manner to support both present and future needs. It emphasizes the protection of public health by reducing environmental hazards and promoting clean living environments. Community engagement and participation are also integral to the Act's objectives, encouraging local involvement in environmental decision-making processes and fostering awareness and responsibility towards environmental conservation. Finally, the Act provides a robust legal framework for environmental governance, defining rights, responsibilities, and enforcement measures to ensure compliance and accountability in environmental management practices across Bagmati province.

3. Materials and Methods

3.1. Study area

Bagmati Province, situated in central Nepal, spans approximately 20,300 km² and showcases a remarkable ecological and topographical diversity from the subtropical lowlands of the Terai to the temperate mid-hills and the alpine regions of the central Himalayas. This wide elevational gradient supports a rich array of ecosystems, including tropical forests, temperate broadleaf and coniferous forests, alpine meadows, and freshwater wetlands. The province is home to five nationally protected areas: Chitwan National Park, Shivapuri-Nagarjun National Park, Langtang National Park, Gaurishankar Conservation Area, and part of Parsa National Park providing habitat for numerous endangered, endemic, and economically important species (Figure 1).

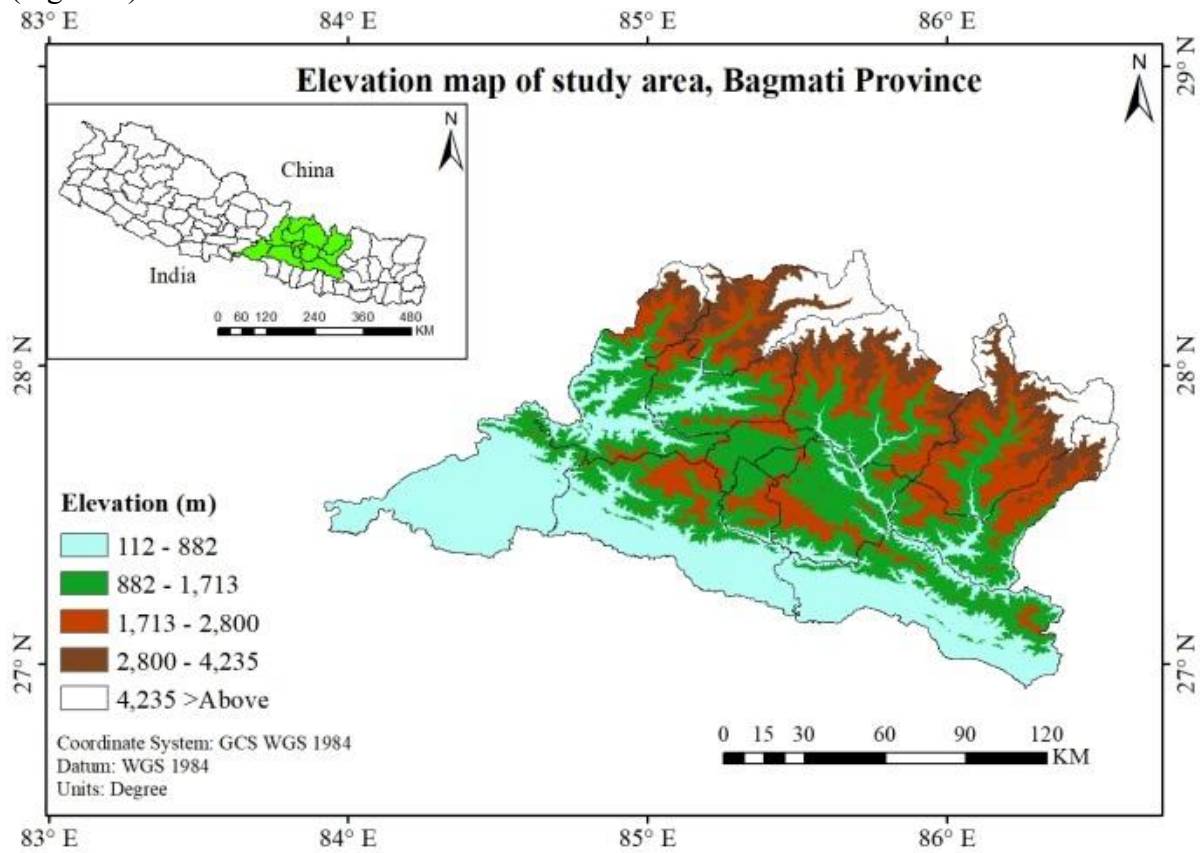


Figure 1: Digital Elevation Map of Bagmati province

Notable biodiversity-rich areas such as Ruby Valley and Panch Pokhari further enhance the ecological significance of the province. Ruby Valley, lying between the Ganesh Himal and Langtang ranges, is known for its remote alpine ecosystems and rich medicinal plant diversity. Panch Pokhari, a high-altitude wetland complex and pilgrimage site, is recognized both for its religious importance and its role in supporting rare alpine flora and fauna. These areas also serve as vital water sources and cultural heritage landscapes, underscoring the close inter linkages between biodiversity and traditional practices.

Bagmati Province is also Nepal's most populous region, with over 6 million inhabitants (CBS, 2021), including the Kathmandu Valley Nepal's political, economic, and cultural heart. The province is ethnically and culturally diverse, home to groups such as the Newar, Tamang, Magar, Brahmin, Chhetri, and Rai, who maintain rich traditions of natural resource use, conservation, and indigenous knowledge. Sacred forests, spiritual landscapes, and community-based conservation efforts reflect the deep cultural connections to nature (Bhattarai et al., 2020; Dahal et al., 2021). However, the province also faces growing threats from urban expansion, infrastructure development, and resource overexploitation. These dynamics make Bagmati Province a crucial and representative setting for biodiversity research, conservation planning, and the study of human-nature interactions (Figure 2).

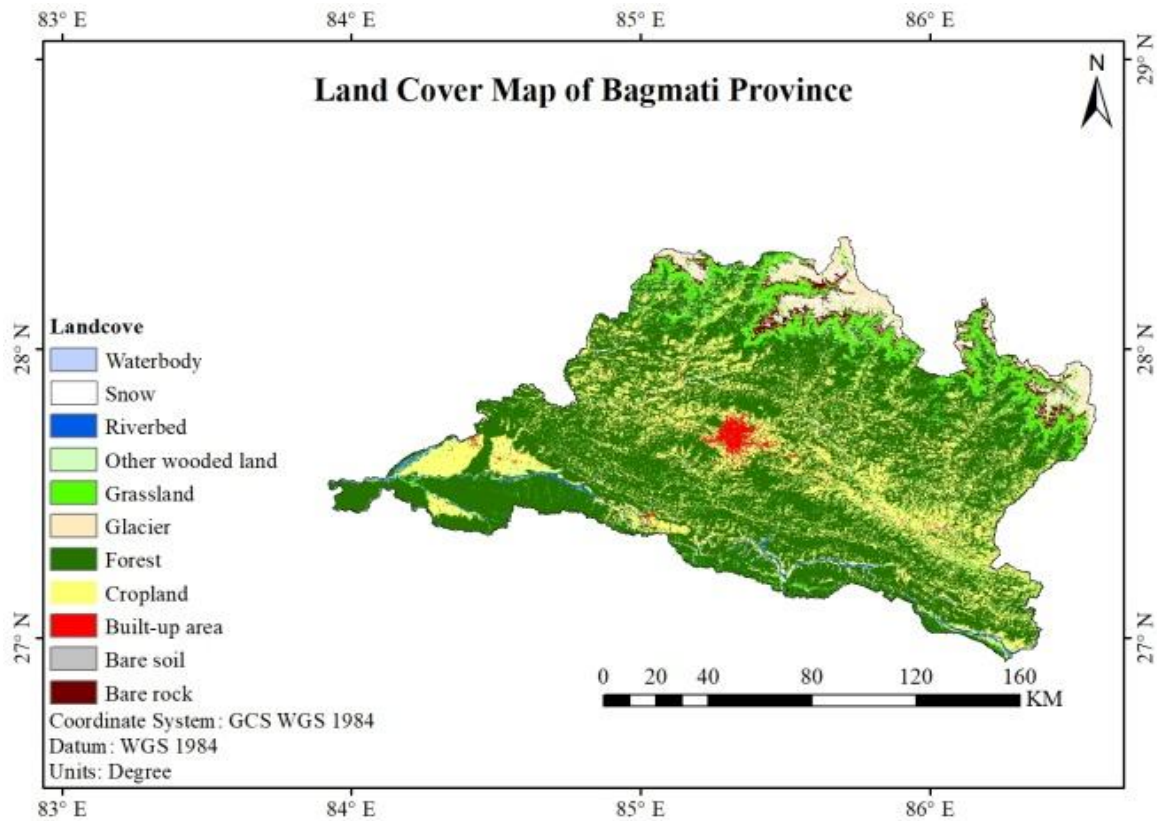


Figure 2: Land cover map of Bagmati province

3.2. Field visit and data collection

Following the diverse physiographic and bioclimatic zones within the province, the selection of study districts for field visits and verification was carried out with careful consideration to ensure ecological representativeness. The final list of districts was determined in consultation with the Ministry of Forests and Environment at the provincial level to align with regional conservation and management priorities. The study covered five districts (Kathmandu, Lalitpur, Chitwan, Makawanpur, Dhading), representing biodiversity rich sites, protected area, degraded and deforested areas, community conserved sites, sacred sites, zoos and botanical gardens. A field visit was conducted across these districts to observe and assess the spatial distribution and abundance of biodiversity, with particular focus on identifying biodiversity hotspots. These field observations allowed for the evaluation of ecological variation across physiographic and climatic zones, as well as the validation of data collected from secondary sources and stakeholder consultation meetings.

During the fieldwork, comprehensive data were systematically recorded on species diversity, distribution patterns, threats, conservation initiatives, etc. Rapid surveys and species identification were carried out collaboratively with the support of local communities, forestry professionals, and experienced botanists. This participatory approach not only enhanced the accuracy of plant identification but also ensured the incorporation of traditional ecological knowledge. The integration of local insights and scientific observations contributed significantly to understanding the current status, challenges, and opportunities related to the identification and conservation biodiversity important sites.

3.3. Consultation and validation

As part of the biodiversity hotspot assessment, extensive stakeholder consultations were conducted at multiple administrative levels to ensure robust data collection and validation. A total of three community-level focus group discussions (FGDs), two district-level meetings, and one province-level workshops were organized to gather insights on the status, conservation efforts, and threats to biodiversity. Additionally, two meetings with provincial ministry officers one before and one after the fieldwork ensured alignment with provincial priorities and facilitated policy-level input. Field data collection was guided by checklists (See annex), and community perceptions were systematically recorded to capture localized knowledge on biodiversity hotspots.

A total of 52 individuals representing diverse ethnic backgrounds, age groups, gender and institutions were consulted during formal and informal discussions. Moreover, ten key informants were consulted for validation of the data, ensuring the reliability and accuracy of community-based knowledge. Finally, past and ongoing conservation initiatives within biodiversity hotspots across the province were mapped through district-level consultations and an in-depth review of relevant literature.

3.4. Secondary data collection

Secondary data on biodiversity hotspots in Bagmati Province were compiled from a wide range of published sources, including research reports, documents from national parks (NPs), Divisional Forest Offices (DFOs), community forest user groups, and records from medicinal plant (MP) traders and traditional healers. To complement this, additional information on plant and animal diversity was gathered through discussions with local resource users, traditional healers, and traders actively involved in the collection and use of biological resources. Up-to-date biodiversity records were obtained from DFOs and NPs to assess the current status of floral and faunal diversity across different ecological zones within the province. These diverse datasets provided critical insights into the distribution and status of vulnerable, endangered, rare, and threatened species. Furthermore, the data supported the documentation of traditional ecological knowledge and practices related to the collection, conservation, harvesting, utilization, and trade of biodiversity particularly for species considered at risk.

3.5. Data analysis

The collected data were analyzed using a mixed-methods approach to understand the biodiversity status, conservation challenges, and traditional practices in Bagmati Province. Qualitative data from community focus group discussions, district and provincial consultations,

and key informant interviews were thematically categorized to identify patterns related to species richness, threats, conservation practices, and the cultural importance of biodiversity. Secondary data from Division Forest Offices, national parks, community forest groups, and medicinal plant traders were reviewed and cross-verified with national and international conservation lists (e.g., IUCN Red List) to assess the status of vulnerable, endangered, rare, and threatened species. Information from local healers and traders was triangulated to document traditional knowledge, harvesting methods, and trade dynamics of key species. Descriptive statistics were used to summarize species diversity, frequency of use, and perceived threats, while validation by key informants and provincial-level stakeholders ensured the accuracy and relevance of findings.

For mapping critical ecosystems and hotspots, Geographic Information System (GIS) and related software tools were used to analyze spatial data and visualize biodiversity patterns across Bagmati Province. Species endemism, threatened species, richness of indigenous agri-bio-resources, invasive species, forest cover change, inventory of protected area, in-situ ex-situ sites in districts, etc. were recorded and indexed for mapping purpose. GIS tool enabled us the mapping of ecosystems, species distribution, and biodiversity hotspots by integrating field data with existing geospatial layers. GIS analysis helped identify areas of ecological importance, land-use changes, and zones under pressure, supporting data-driven conservation planning and decision-making.

4. Findings

4.1. Understanding of critical habitats and biodiversity hotspots

Critical habitats and biodiversity hotspots are ecologically important areas that require special attention due to their rich biodiversity, unique ecosystems, and vulnerability to environmental threats. In the context of Bagmati province, Nepal, these areas are particularly significant given the province's diverse topography, ranging from lowland forests to high-altitude alpine ecosystems. The identification of such habitats is based on a combination of geographic information system (GIS) mapping, ecological field studies, and assessments of species diversity, ecosystem functions, and threat levels.

In Bagmati province, areas such as Langtang National Park, Shivapuri Nagarjun National Park, and the Gaurishankar Conservation Area have been highlighted as biodiversity-rich zones. These sites are home to a variety of endangered species, including the red panda, clouded leopard, and several endemic plants. They also serve as crucial watersheds and provide ecosystem services such as freshwater supply, erosion control, and carbon sequestration to surrounding communities and cities, including the Kathmandu Valley.

What makes these habitats critical is not only their biological richness but also their exposure to pressures like urban expansion, deforestation, infrastructure development, and climate variability. The ecological integrity of these regions is essential for maintaining both biodiversity and the natural systems that support human life. Effective conservation of such habitats in Bagmati province will require integrated land-use planning, community engagement, and strengthened legal protection to ensure their long-term sustainability and resilience.

4.2. Critical ecosystems and habitats identified in consultations

The following areas were identified as critical habitats for biodiversity conservation, stated by several participants of group discussion and key informants.

A. Chitwan National Park and its buffer zone (Tropical and Subtropical Zone, <500 m)

This area features subtropical forests and grasslands primarily dominated by:

Sal forest (*Shorea robusta*)-Dominant canopy species; Mixed hardwoods- *Terminalia tomentosa*, *Dillenia pentagyna*, *Lagerstroemia parviflora* and Riverine and floodplain flora- *Saccharum spontaneum*, *Imperata cylindrica*, *Dalbergia sissoo*, *Acacia catechu*. The park also supports several medicinal plants and epiphytic orchids. Invasive species like *Mikania micrantha* pose major ecological threats.

Chitwan National Park, a UNESCO World Heritage Site, is one of Nepal's most important faunal refuges. It harbors: Mammals: Bengal Tiger (*Panthera tigris*-Endangered), One-horned Rhinoceros (*Rhinoceros unicornis* - Vulnerable), Asian Elephant (*Elephas maximus* - Endangered), Sloth Bear, and Gaur. Birds: Over 600 bird species including the Bengal Florican (*Houbaropsis bengalensis* -Critically Endangered), Giant Hornbill, and Lesser Adjutant. Reptiles: Gharial (*Gavialis gangeticus* - Critically Endangered), Mugger Crocodile (*Crocodylus palustris*), and Indian Rock Python.

These faunal groups thrive in the riverine forests, grasslands, and wetlands of the Rapti-Narayani floodplains of CNP.

B. Chure area (200-1,500 m)

The Chure Range, also known as the Siwalik Hills, forms the southernmost ecological belt of Bagmati Province and plays a vital role in supporting biodiversity, regulating watersheds, and maintaining ecological connectivity. Stretching across districts like Makwanpur, Sindhuli, Ramechhap, and parts of Chitwan and Sarlahi, the Chure extends from about 200 to 1,500 m in elevation. Its forests are predominantly tropical and subtropical, with dominant vegetation including Sal (*Shorea robusta*) and mixed deciduous species like *Terminalia*, *Anogeissus*, and *Acacia*. Ecologically, the Chure serves as a critical transition zone between the Terai plains and mid-hills and functions as a biodiversity corridor, allowing the movement of key wildlife species such as leopards, sloth bears, Indian pangolins, wild boars, and spotted deer. The region is also rich in bird diversity, home to species such as the Spiny Babbler (Nepal's only endemic bird), Indian peafowl, crested serpent eagle, and lesser adjutant stork. Several rivers, including the Bagmati, Kamala, and East Rapti, originate from the Chure, making it a crucial watershed area. Despite its importance, the Chure is highly fragile and faces serious threats from deforestation, overgrazing, and rampant extraction of riverbed materials.

C. Daman-Phulchoki region (1,500-2,800 m)

Daman-Phulchoki region, located in the mid-hills of Bagmati Province, is a remarkable biodiversity hotspot renowned for its rich floral and faunal diversity. Ranging from approximately 1,500 to 2,800 m asl, this region includes lush evergreen broadleaved forests, temperate oak-rhododendron woodlands, and mixed coniferous forests. Phulchoki, the highest hill near the Kathmandu Valley, is particularly noted for its incredible plant diversity, *Quercus semicarpifolia*, *Rhododendron arboreum*, *Magnolia campbellii*, and *Michelia kisopa*, along with a rich variety of ferns, orchids, and mosses. Daman, on the other hand, is famous for its panoramic mountain views and temperate forests dominated by *Acer*, *Betula*, and *Pinus roxburghii*, supporting seasonal blooms and unique microhabitats. The region is also one of Nepal's most important sites for birdwatching, with over 300 species of birds recorded, including the Spiny Babbler (*Turdoides nipalensis*), *Himalayan cutia*, *Scarlet minivet*, Kalij pheasant, and migratory raptors. It serves as a corridor for bird movement between lower valleys and higher Himalayan regions. In addition, mammals such as barking deer, Indian civet, Himalayan black bear, and leopard inhabit these forests. Due to its ecological richness, proximity to urban centers, and cultural value, the Daman-Phulchoki landscape plays a critical role in urban biodiversity conservation, eco-tourism, and environmental protection.

D. Langtang National Park and its buffer zone (Mid-hill to Alpine, 1,000-7,000 m)

Langtang National Park, situated in Bagmati Province, stretches from the mid-hills to the towering Himalayan peaks, covering an elevational range of approximately 1,000 to over 7,000 m asl. This altitudinal gradient gives rise to an extraordinary variety of ecosystems and vegetation zones. In the temperate forests of Langtang, key species include *Quercus lamellosa*, *Acer* species, *Tsuga dumosa*, *Abies spectabilis*, and the striking *Rhododendron arboreum*, along with the notable Langtang Larch (*Larix himalaica*). As one ascends to the subalpine and alpine zones, the landscape transitions into scrubs and meadows dominated by *Juniperus indica*, *Rhododendron campanulatum*, *Potentilla species*, and *Primula species*. The high-

altitude regions harbor a rich diversity of MAPs, including valuable species such as *Nardostachys jatamansi*, the caterpillar fungus *O. sinensis*, and *Rheum australe*, which hold both ecological and economic importance. The park is also a stronghold for rare and endangered fauna, including the red panda (*Ailurus fulgens*), snow leopard (*Panthera uncia*), musk deer (*Moschus leucogaster*), and Himalayan tahr (*Hemitragus jemlahicus*). Avian diversity is equally impressive, with species such as the Himalayan monal, *Satyr tragopan*, and blood pheasant. In addition to its biodiversity, Langtang holds deep cultural value for indigenous Tamang communities and is renowned for sacred sites like Gosaikunda Lake, making it a hub for both conservation and eco-cultural tourism.

E. Ruby Valley (1,300-4,000 m)

Ruby Valley, located in Dhading District at an elevation range of 1,300 to 4,000 meters, is a biologically and culturally diverse region situated between the Langtang and Manaslu Himalayan ranges. The valley encompasses a wide variety of ecosystems, from subtropical forests in the lower elevations to alpine meadows at higher altitudes. Its flora includes species such as *Schima wallichii*, *Castanopsis indica*, *Quercus lamellosa*, *Acer species*, *Tsuga dumosa*, and *Rhododendron arboreum*, with *Abies spectabilis*, *Betula utilis*, and *Juniperus species* dominating the subalpine zone. Alpine meadows are rich in medicinal plants like *Swertia chirayita*, *Aconitum ferox*, *Nardostachys jatamansi*, and *Picrorhiza kurroa*, while moist habitats support a diversity of orchids and ferns. The fauna of Ruby Valley includes endangered and vulnerable species such as the Red Panda, Musk Deer, and Snow Leopard, along with the Himalayan Tahr, Himalayan Black Bear, langurs, wild boar, and a variety of bird species including Himalayan Monal, Khalij pheasant, tragopans, partridges, and raptors. Culturally, the valley is predominantly inhabited by Tamang communities, who practice Tibetan-influenced Buddhism and possess rich traditional ecological knowledge, particularly related to medicinal plants and transhumance.

F. Panch Pokhari (High-altitude Wetlands, 4,100 m)

Panch Pokhari, located in the Sindhupalchok District of Nepal at an elevation ranging from approximately 2,800 to 4,100 meters, is a region of high ecological and cultural importance. Named after the sacred “Five Lakes,” it is one of Nepal’s revered pilgrimage sites and also a biodiversity hotspot in the eastern Himalayas. The area features a diverse range of ecosystems, from temperate forests in the lower elevations to alpine meadows and glacial lakes at higher altitudes. Its flora includes species such as *Quercus semecarpifolia*, *Rhododendron arboreum*, *Tsuga dumosa*, *Acer species*, and *Abies spectabilis*, with higher zones supporting alpine plants like *Nardostachys jatamansi*, *Aconitum species*, *Swertia chirayita*, and *Meconopsis species*. Moist habitats in the region support a variety of orchids, ferns, and mosses, especially around stream banks and forest understoreys.

The fauna of Panch Pokhari includes several Himalayan species of conservation concern. Mammals such as the Red Panda, Snow Leopard, and Himalayan Black Bear inhabit the higher forested and alpine regions, while musk deer, Himalayan Tahr, and langurs are also found. Birdlife includes Himalayan Monal, various pheasants, partridges, and raptors, as well as smaller forest birds. The region's cultural landscape is equally rich, with Tamang and Sherpa communities forming the majority of the population. These communities maintain deep spiritual ties to the landscape, with traditions that include shamanic healing, Buddhist rituals,

and sustainable harvesting of wild plants. Dalit communities and some Brahmin-Chhetri households are also present in lower areas, contributing to the region's cultural diversity.

G. Other important areas

Bagmati Province hosts several ecologically significant hotspots that support diverse species and habitats. In Kathmandu and Nuwakot, the Shivapuri Hill Ridges outside the core national park area feature mid-hill mixed forests and important watershed recharge zones, home to species such as the Himalayan black bear, Kalij pheasant, and diverse flora including *Rhododendron arboreum* and orchids. The Mahabharat Corridor spanning Makwanpur and Chitwan acts as a crucial connectivity zone between Terai and hill ecosystems, sheltering leopards, pangolins, and valuable tree species like *Shorea robusta* and *Terminalia bellirica*. Kavrepalanchok's Bhumidanda-Namobuddha Forest Belt is a community-managed mosaic rich in cultural landscapes, hosting barking deer, owls, and medicinal plants such as *Swertia chirayita*. The high-altitude Rolwaling Valley in Dolakha presents unique alpine flora and fauna including snow leopards and blue sheep.

In Rasuwa, the Chilime-Goljung-Gatlang Belt serves as a buffer to Langtang National Park, featuring agro-ecosystems inhabited by red pandas and Himalayan monals, along with important plants like *Paris polyphylla*. Sindhupalchok's Helambu Region contains highland pastures and sacred forests, supporting musk deer and medicinal plants such as *Nardostachys jatamansi*. Dhading's Ganesh Himal fringe area is characterized by remote mixed conifer forests and landslide-prone hills, home to Himalayan thar and species like *Aconitum ferox*. The Godavari Botanical Ridge in Lalitpur, near the urban fringe, preserves semi-natural hill forests with endemic plants including rhododendrons and *Camellia kissi*. Bhaktapur's Nagarkot Hill area represents a forest-farmland interface with diverse small mammals and plant species like *Morus serrata*. Finally, Sindhuli's Kamalamai and Marin River Valleys lie within the Siwalik transition zone, important for both aquatic and terrestrial biodiversity, supporting freshwater fish and trees like *Anogeissus latifolia*. These hotspots (Table 2) highlight the ecological richness and conservation value of Bagmati Province.

Table 2. Important biodiversity zone and hotspots in Bagmati province

Location/District	Zone/Hotspot	Features	Key Species / Biodiversity
Kathmandu, Nuwakot	Shivapuri Hill Ridges (outside NP core)	Mid-hill mixed forests, watershed recharge areas	Himalayan black bear, Kalij pheasant, <i>Rhododendron arboreum</i> , <i>Osmanthus suavis</i> , orchids
Makwanpur, Chitwan	Mahabharat Corridor	Connectivity zone between Terai and hill ecosystems	Leopard, pangolin, wild boar, <i>Shorea robusta</i> , <i>Terminalia bellirica</i> , <i>Dillenia pentagyna</i>
Kavrepalanchok	Bhumidanda-Namobuddha Forest Belt	Community managed forest mosaic, cultural landscapes	Barking deer, owls, <i>Schima wallichii</i> , <i>Castanopsis indica</i> , <i>Swertia chirayita</i>
Dolakha	Rolwaling Valley	High-altitude glacial valley with unique alpine flora	Snow leopard, blue sheep, <i>Rhododendron anthopogon</i> , <i>Saussurea gossypiphora</i> , lichens

Location/District	Zone/Hotspot	Features	Key Species / Biodiversity
Rasuwa	Chilime-Goljung-Gatlang Belt	Buffer area to Langtang NP, ethnic agro-ecosystems	Red panda, Himalayan monal, <i>Arundinaria maling</i> , <i>Paris polyphylla</i> , <i>Rheum austral</i>
Sindhupalchok	Helambu Region	Highland pastures, traditional grazing lands, sacred forests	Musk deer, <i>Nardostachys jatamansi</i> , <i>Dactylorhiza hatagirea</i> , <i>Bergenia ciliata</i>
Dhading	Ganesh Himal Fringe Areas	Remote mixed conifer forests, landslide-prone hills	Himalayan thar, <i>Pinus roxburghii</i> , wild mushrooms, <i>Aconitum ferox</i>
Lalitpur	Godavari Botanical Ridge	Semi-natural hill forest near urban fringe, rich in endemic plants	Rhododendrons, butterflies, <i>Aesculus indica</i> , <i>Camellia kissi</i> , <i>Michelia champaca</i>
Bhaktapur	Nagarkot Hill Area	Forest-farmland interface, scenic ridge ecosystems	Small mammals, <i>Morus serrata</i> , <i>Myrica esculenta</i> , <i>Viburnum erubescens</i>
Sindhuli	Kamalamai and Marin River Valleys	Siwalik transition zone, important for aquatic and terrestrial diversity	Freshwater fish, <i>Anogeissus latifolia</i> , <i>Bauhinia vahlii</i> , <i>Clerodendrum infortunatum</i>

4.3. Biodiversity importance of Bagmati province

Based on various botanical studies, herbarium records, and field observations, the protected areas and buffer zones of Bagmati Province support a rich diversity of flora, shaped by variations in altitude, climate, and habitat type. In the lowland Terai region, Chitwan National Park and its buffer zone are known for their tropical and subtropical vegetation, comprising over 700 species of vascular plants, including grasses, sal (*Shorea robusta*) forests, riverine forests. In the mid-hill zone, Shivapuri Nagarjun National Park is home to over 1,000 species of vascular plants, including important medicinal and endemic species. Its forests transition from subtropical to temperate types include oak (*Quercus spp.*), rhododendron (*Rhododendron arboreum*), and alder (*Alnus nepalensis*), making it an important botanical hotspot near urban Kathmandu. Further north, Langtang National Park spans temperate to alpine zones and is one of the richest protected areas in terms of alpine flora, with over 1,500 species of vascular plants recorded. It includes diverse forest types (e.g., fir, birch, juniper, and rhododendron), alpine meadows, and high-altitude medicinal plants like *Nardostachys jatamansi*, *Delphinium spp.*, and *Saussurea spp.* In the Gaurishankar Conservation Area, more than 1,200 plant species have been recorded, including a wide range of high-altitude herbs, shrubs, and endangered medicinal plants such as *Dactylorhiza hatagirea*, *Cordyceps sinensis*, and *Rheum australe*.

A fieldwork in GCA area shows that there are over 60 tree species with dominance of Oaks (six species), Rhododendron (five species including shrubs), and laurels. The most dominant and widely distributed tree species are *Rhododendron arboreum* followed by *Lyonia valifolia*.

Other tree species of dominance are *Euonymus* species, *Schima wallichii*, *Rhododendron campanulatum*, *Symplocos ramosissima*, *Quercus lanata*, *Abies spectabilis* etc.

Based on secondary literature and deposited specimens at KATH, TUCH and herbaria of abroad shows that there are 2877 taxa of plants and 15 species of gymnosperm recorded. Among over 1000 wildlife including birds recorded, total 116 birds, 44 mammals, 12 reptiles were recorded as threatened.

Based on the data presented on endemic plant taxa and species richness across different districts, Rasuwa District shows the highest concentration, with 29 endemic taxa and 23 endemic species, reflecting its ecological significance within high-altitude zones, including parts of Langtang National Park. Districts like Dhading, Kathmandu, and Dolakha also show notably high endemic richness, each recording 12 endemic taxa and 8 to 9 endemic species, likely influenced by their varied topography and forest cover. Ramechhap and Lalitpur follow with moderate values 8 and 7 taxa, respectively. In contrast, Chitwan, Makawanpur, and Nuwakot report relatively low endemic richness (2 taxa, 1 species each), while Sindhuli and Sindhupalchok show minimal endemism with 1-3 taxa and species. Bhaktapur and Kabhrepalanchok lack recorded values in this dataset, possibly due to limited surveys or lower endemism. Table 3 and 4 lists some endangered and vulnerable plant and animal species respectively in Bagmati province.

Table 3. Some Endangered and Vulnerable Plant Species in Bagmati Province (Based on the IUCN Red List, CITES Appendices, and Nepal's National Red List)

Common Name	Scientific Name	Conservation Status	Habitat/Location
Himalayan Yew	<i>Taxus wallichiana</i>	Endangered (IUCN), CITES Appendix II	Moist temperate forests (Phulchoki, Shivapuri, Langtang)
Spikenard	<i>Nardostachys jatamansi</i>	Critically Endangered (Nepal)	Alpine meadows (Langtang, Gaurishankar, Rubi Valley)
Kutki	<i>Neopicrorhiza scrophulariiflora</i>	Vulnerable (IUCN)	Alpine scree and grasslands (Langtang, Rasuwa)
Rhododendron	<i>Rhododendron arboretum</i>	Least Concern (but protected in Nepal)	Mid to high elevation forests (Phulchoki, Daman, Shivapuri)
Chiraito	<i>Swertia chirayita</i>	Vulnerable (Nepal)	Forest clearings, highland pastures (Gaurishankar, Daman)
Satuwa	<i>Paris polyphylla</i>	Vulnerable (Nepal)	Moist forest understorey (Shivapuri, Phulchoki, Langtang)
Lauth Salla (Himalayan Fir)	<i>Abies spectabilis</i>	Near Threatened	Subalpine forests (Langtang, Gaurishankar, Rubi Valley)
Gobre Sallo (Himalayan Pine)	<i>Pinus wallichiana</i>	Least Concern	Temperate zones (Daman, Shivapuri, Kavre)

Table 4 Some Endangered and Vulnerable Fauna in Bagmati Province (Based on IUCN Red List & National Red List of Nepal)

Common Name	Scientific Name	Conservation Status	Habitat/Location
Red Panda	<i>Ailurus fulgens</i>	Endangered	High-altitude forests of Rasuwa, Langtang, and Gaurishankar
Snow Leopard	<i>Panthera uncia</i>	Vulnerable	High alpine areas, Rubi Valley, Langtang
Himalayan Musk Deer	<i>Moschus leucogaster</i>	Endangered	Subalpine to alpine forests, Langtang, Gaurishankar
Common Leopard	<i>Panthera pardus</i>	Vulnerable	Widely distributed in mid-hills, including Shivapuri and Phulchoki
Asiatic Black Bear	<i>Ursus thibetanus</i>	Vulnerable	Mid- to high-hill forests, Shivapuri-Nagarjun, Langtang
Chinese Pangolin	<i>Manis pentadactyla</i>	Critically Endangered	Forest edges, agricultural fields (Phulchoki, Daman, Makwanpur)
Indian Pangolin	<i>Manis crassicaudata</i>	Endangered	Lower hills and sal forest zones, including Makwanpur
Himalayan Goral	<i>Naemorhedus goral</i>	Near Threatened	Rocky and forested slopes (Langtang, Daman)
Black-necked Crane	<i>Grus nigricollis</i>	Vulnerable	Rare winter visitor, occasionally recorded in wetlands like Bishajari
White-rumped Vulture	<i>Gyps bengalensis</i>	Critically Endangered	Lowland forests and open fields (Makwanpur, Chitwan fringe)
Slender-billed Vulture	<i>Gyps tenuirostris</i>	Critically Endangered	Rare, formerly widespread in mid-hills
Himalayan Monal	<i>Lophophorus impejanus</i>	Least Concern (National Bird)	Found in alpine forests (Langtang, Gaurishankar)

Based on various scientific documents, biodiversity checklists, and field observations, the protected areas and buffer zones of Bagmati Province exhibit remarkable faunal diversity across different ecological zones from tropical lowlands to alpine regions. In the Terai region, Chitwan National Park and its buffer zone are among the most biodiverse, supporting approximately 68 mammal species, over 600 bird species, around 56 herpeto-faunal species (including 17 amphibians and 39 reptiles), and 126 fish species, according to national park records and scientific surveys. This includes flagship species like the Bengal tiger, one-horned rhinoceros, gharial (*Gavialis gangeticus*), and giant hornbill (*Buceros bicornis*). In the mid-hill zone, Shivapuri Nagarjun National Park harbors around 65 species of mammals, over 318 bird species, 23 reptiles, 14 amphibians, and over 20 fish species in its rivers and streams highlighting its role in watershed conservation and ecological connectivity. Further north, Langtang National Park spans temperate to alpine ecosystems and supports approximately 46 mammals, more than 250 bird species (including Himalayan monal, satyr tragopan), 30 reptiles and amphibians, and native cold-water fishes in high-altitude streams. Adjacent to it, the Gaurishankar Conservation Area hosts around 34 mammal species, over 235 bird species, along with a modest diversity of reptiles, amphibians, and alpine fishes, based on community

forest user group reports and national inventories. Table 5 lists some endemic/near-endemic species in Bagmati province.

Table 5. Some Endemic/Near-Endemic Species in Bagmati province

Scientific Name	Status	Habitat/Location
<i>Saussurea lanata</i>	Endemic to Nepal	Alpine meadows (Langtang, Rubi Valley)
<i>Meconopsis villosa</i>	Endemic to Nepal	High-altitude rocky areas (Langtang, Gaurishankar)
<i>Aconitum spicatum</i>	Nepal-Himalayan endemic	Alpine scrublands (Rasuwa, Daman)
<i>Clematis buchananiana</i>	Nepal endemic	Mid-hill forests (Phulchoki, Shivapuri)
<i>Primula gracilipes</i>	Endemic	Alpine meadows and mossy slopes (Langtang Valley)
<i>Saussurea lanata</i>	Endemic to Nepal	Alpine meadows (Langtang, Rubi Valley)
<i>Meconopsis villosa</i>	Endemic to Nepal	High-altitude rocky areas (Langtang, Gaurishankar)
<i>Aconitum spicatum</i>	Nepal-Himalayan endemic	Alpine scrublands (Rasuwa, Daman)
<i>Clematis buchananiana</i>	Nepal endemic	Mid-hill forests (Phulchoki, Shivapuri)
<i>Primula gracilipes</i>	Endemic	Alpine meadows and mossy slopes (Langtang Valley)
Nepal Gray Langur <i>Semnopithecus schistaceus</i>	Nepal-endemic subspecies	Mid- to high-hill forests (Phulchoki, Shivapuri, Langtang)
Spiny Babbler <i>Turdoides nipalensis</i>	Endemic to Nepal	Scrub forests around Phulchoki and Godavari area
Nepal Warty Frog <i>Nanorana liebigii</i>	Near-endemic to Himalaya	Streams and high-elevation wetlands (Langtang, Rasuwa)
Assam Macaque <i>Macaca assamensis</i>	Near-endemic	Forested mid-hills and river valleys (Shivapuri, Daman)

These high-altitude zones are also habitats for rare and threatened fauna such as the Red Panda (*Ailurus fulgens*), Snow Leopard (*Panthera uncia*), Himalayan Tahr (*Hemitragus jemlahicus*), and Blood Pheasant (*Ithaginis cruentus*). Riverine systems associated with the Bagmati, Trishuli, and Sunkoshi rivers in Makwanpur, Dhading, and Ramechhap support riparian vegetation along with aquatic fauna including Mahseer fishes, Otters, and amphibians like *Nanorana* species. Wetlands such as Taudaha Lake, Rani Pokhari, Indra Daha in Thankot, and Bishajari Lake in Chitwan provide critical habitats for diverse aquatic and semi-aquatic species, including migratory birds such as the Common Teal, Ferruginous Duck, and Black-crowned Night Heron, as well as wetland flora like Typha, Nymphaea, and Nelumbo.

4.4. Species diversity

4.4.1 Endemic, Endangered and High-Value Species at district level

Bagmati Province harbors several endemic species that are uniquely adapted to its diverse ecological zones ranging from mid-hills to high mountains. Among the endemic flora, notable species include *Rhododendron lowndesii*, a shrub native to high-altitude zones, and *Swertia multicaulis*, a medicinal herb restricted to specific alpine habitats. These plants are not only ecologically significant but also culturally and medicinally valued by local communities. In terms of endemic fauna, the province is home to the Spiny Babbler (*Turdoides nipalensis*), the only bird species endemic to Nepal, often found in shrubland and forest edges within Bagmati's mid-hill region. Additionally, the area supports endemic herpetofauna and invertebrates that are yet to be fully documented but are believed to exist due to the province's habitat diversity and elevation gradient. Table 6 lists the endangered, endemic and high-value flora and fauna in Bagmati province.

Table 6. Endangered, Endemic, and High-Value Flora and Fauna in Bagmati province

Districts	Flora			Fauna		
	Endangered	Endemic	High-value	Endangered	Endemic	High-value
Bhaktapur	<i>Swertia chirayita</i>	<i>Thunbergia kasajuana</i>	<i>Bergenia ciliata</i> , <i>Valeriana jatamansi</i>	Clouded leopard	Himalayan musk deer	
Chitwan	<i>Paris polyphylla</i>	<i>Eria nepalensis</i> , <i>Begonia tribenensis</i>		Bengal tiger, one-horned rhinoceros	Kalij pheasant, <i>Neoanguilla nepalensis</i> fish in Narayani	Gharial (crocodile), Bengal Tiger
Dhading	<i>Taxus wallichiana</i> (Himalayan yew)	<i>Saxifraga ganeshii</i> , <i>Roscoeia ganeshensis</i>	<i>Bergenia ciliata</i> , <i>Valeriana jatamansi</i> , <i>Nardostachys jatamansi</i>	Common leopard	<i>Rhesus macaque</i>	Himalayan red panda
Dolakha	<i>Aconitum</i> spp.	<i>Aconitum bhedingense</i> ,	<i>Swertia chirayita</i>	Clouded leopard, Himalayan black bear	Kalij pheasant	Red Panda
Kathmandu	<i>Swertia chirayita</i>	<i>Sinocarum normanianum</i> , <i>Isodon phulchokiensis</i>	<i>Bergenia ciliata</i> ,	Musk deer, Common leopard	Himalayan Monal (in Langtang area), <i>Myersglanis blythii</i> fish in Pharping	Asiatic black bear
Kavre	<i>Taxus wallichiana</i>		<i>Bergenia ciliata</i> , <i>Asparagus racemosus</i>	Clouded leopard	Himalayan Monal, <i>Turcinoemacheilius himalaya</i> fish in Indrawati	
Lalitpur	<i>Taxus wallichiana</i>	<i>Cirsium phulchokiense</i> , <i>Stellaria rajbhandaryi</i>	<i>Asparagus racemosus</i> , <i>Valeriana jatamansi</i> , <i>Zanthoxylum armatum</i>	Common leopard	Himalayan Monal	
Makawanpur	<i>Paris polyphylla</i>	<i>Habenaria wallichii</i>	<i>Valeriana jatamansi</i> , <i>Zanthoxylum armatum</i>	Indian pangolin, clouded leopard	Spiny Babbler	
Nuwakot	<i>Aconitum</i> spp.	<i>Begonia nuwakotensis</i>	<i>Asparagus racemosus</i> , <i>Valeriana jatamansi</i>	Common leopard	Himalayan musk deer, <i>Pseudecheneis eddsi</i> fish	
Ramechhap	<i>Shorea robusta</i> (Sal tree)	<i>Saxifraga mallae</i>	<i>Asparagus racemosus</i> , <i>Valeriana jatamansi</i>		Gangetic dolphin	
Rasuwa	Orchids (<i>Dendrobium</i> spp.)	<i>Rhododendron cowanianum</i>	<i>Swertia chirayita</i> , <i>Nardostachys jatamansi</i>	Snow leopard	Kalij pheasant	Himalayan Tahr
Sindhuli						
Sindhupalchok	<i>Michelia champaca</i>	<i>Strobilanthes saccata</i>	<i>Asparagus racemosus</i> , <i>Zanthoxylum armatum</i>	Common leopard	Kalij pheasant	

Bagmati province harbors several endangered species of both flora and fauna that are under threat due to habitat loss, overexploitation, and climate change. Endangered plants like *Taxus wallichiana*, *Neopicrorhiza scrophulariiflora*, and *Dactylorhiza hatagirea* are highly valued for their medicinal properties but face population decline from unsustainable harvesting. Among fauna, species such as the Red Panda (*Ailurus fulgens*), Himalayan Musk Deer (*Moschus leucogaster*), and Clouded Leopard (*Neofelis nebulosa*) are listed as endangered and are primarily threatened by forest degradation and human disturbances. These findings emphasize the urgent need for habitat protection and species-specific conservation measures in the province.

Bagmati province is rich in high-value species of both flora and fauna that hold significant ecological, medicinal, and economic importance. High-value plant species such as *Paris polyphylla*, *Valeriana jatamansii*, *Dactylorhiza hatagirea*, and *Zanthoxylum armatum* are widely used in traditional medicine and are in high demand for their therapeutic properties. Similarly, high-value fauna like the Himalayan Musk Deer (*Moschus leucogaster*) for its musk, and the Asiatic Black Bear (*Ursus thibetanus*) for bile and body parts, are often targeted by poaching and illegal trade.

4.4.2 Agrobiodiversity in Bagmati province

Bagmati Province, with its varied geography ranging from the lowland plains to high mountain regions, supports a wide range of agricultural biodiversity. This diversity is reflected in the cultivation of numerous traditional crops, vegetables, fruits, and the rearing of indigenous livestock breeds adapted to local conditions. Farmers in this province have historically developed and maintained a rich variety of seeds and farming practices that are well-suited to different microclimates and soil types found across the region.

The mid-hill and highland areas of Bagmati are known for traditional crops like millet, barley, buckwheat, and local varieties of maize and rice, which are often cultivated using organic and low-input methods. In the lower elevations, vegetables, citrus fruits, and other commercial crops are widely grown, contributing to both food security and local economies. The province is also home to several indigenous livestock breeds, such as Chauris (yak-cow hybrids) in the higher altitudes and native poultry and goats in the mid-hills.

Agrobiodiversity in Bagmati not only enhances ecosystem resilience but also supports cultural practices and dietary diversity. However, this rich agricultural heritage is increasingly threatened by the spread of high-yielding hybrid varieties, loss of traditional knowledge, changing land-use patterns, and climate change. To safeguard this diversity, it is important to promote sustainable agricultural practices, support community seed banks, and encourage the conservation of indigenous crops and breeds through participatory research and extension services. Table 7 lists endemic agro-species in Bagmati province.

Table 7. Endemic and indigenous Agro-species and resources in Bagmati province

SN	Location	Crop	Landrace
1.	Bhaktapur	Cucumber	Local
2.	Chitwan	Sesame	Nawalpur khario til
3.	Dolakha (Mudhe)	Potato	Mude
4.	Kathmandu (Farping)	Pear and Kalo bhatmas	Naspati

SN	Location	Crop	Landrace
5.	Lalitpur (Dalchoki, Malta)	Wheat (Mudule), Mustard (Gujmuje, Dunde rayo), Malta ko mas	Mudule
6.	Nuwakot (Kimtang, Sikharbesi)	Wheat (Kadu), Rice (Samundra fini, Asange, Kalikathe)	Kadu
7.	Nuwakot (Trishuli)	French bean	Trishuli simi
8.	Rasuwa (Gatlang, Goljung)	Lentil (Kalo masuro), Gatlang bean, Sthaniya potato,	Kalo musuro
9.	Sindhuli	Orange	Junar
10.	Sindhupalchok (Helambu, Marming)	Black gram (Malneta), Sthaniya karu, Asare simi, Helambu potato	Malneta

4.5. Habitat diversity

4.5.1 Forest and vegetation types

The districts of Bagmati province exhibit significant habitat and forest type diversity, shaped by elevation gradients and climatic variation. The province has all types of forest regime including community forests, leasehold forest, religious forests, private forest, protected forest and forest conservation areas. In Makwanpur, 2,837 community forests span 14,118 hectares, covering Siwalik Sal forests, mid-hill Oak-rhododendron, and subalpine conifer-bamboo habitats. Dhading, with 771 community forests across 29,724.34 hectares, ranges from subtropical Sal dominated forests to alpine fir and rhododendron zones. Kathmandu, though urbanized, retains mid-hill broadleaf and riverine patches within 71 community forests (2,540.53 ha), including urban greening plots like Ranibari and Shivapuri. In contrast, Rasuwa features alpine meadows, oak-fir forests, and subalpine juniper habitats, though its 2,502 community forests cover only 259.32 hectares.

4.5.2 Protected area, conservation area and in-situ conservation areas

Bagmati province encompasses several important protected areas, botanical gardens, zoological facilities, and vibrant community organizations supporting conservation and sustainable resource management. Notably, Shivapuri-Nagarjun National Park spans multiple districts including Kathmandu, Lalitpur, Nuwakot, and Sindhupalchok, serving as a key conservation area. Langtang National Park covers Rasuwa and parts of Sindhupalchok, while Chitwan National Park and Parsa National Park protect habitats in Makwanpur and Chitwan districts. Botanical gardens such as the Godawari Botanical Garden in Kathmandu and Lalitpur and the Brindaban and Mountain Botanical Gardens in Daman and Tistung (Makwanpur) play vital roles in plant conservation and research. The Central Zoo in Jawalakhel, Lalitpur provides zoological education and species conservation support for the valley. Across districts, numerous Village Social Organizations (VSOs) and watershed groups often linked with projects like the Bagmati Integrated Watershed Management Project (BIWMP) actively participate in community forestry, watershed conservation, and biodiversity protection, strengthening local stewardship and ecological resilience throughout the province. Table 8 shows district wise overview of Bagmati province detailing the number and type of protected areas, botanical gardens, zoo or zoological parks.

Table 8. District-wise overview of Bagmati province, detailing the number and type of Protected Areas, Botanical Gardens, Zoos/Zoological Parks

District	Protected Area (NP, CA, HR, BZ)	Botanical Garden	Zoo / Zoological Park	Imp Bird Area / Imp Plant Area	Others	BSO, MTS for spp	Total sites
Bhaktapur	None active		Bhaktapur Zoo			1	2
Chitwan	<i>Chitwan National Park</i> (major NP)			CNP, Gadhi- Siraichuli, Rampur valley		8	4
Dhading	Joins <i>Shivapuri- Nagarjun NP</i>				Ruby valley	4	3
Dolakha	<i>Gaurishankar Conservation Area</i>			GCA		5	2
Kathmandu	<i>Shivapuri- Nagarjun National Park</i> (also covers Nuwakot & Sindhupalchok)			SNNP	Swayambhu	7	3
Kavre	None specific (falls within Bagmati watershed zones)				Dhunkharka	4	1
Lalitpur		Godawari Botanical Garden	Central Zoo	Phulchoki mountain	Phulchoki	4	5
Makwanpur	<i>Chitwan National Park</i> (southern fringes), part of Parsa NP	Brindaban, Mountain BGs in Daman, Tistung			Daman Sim bhanjyang	8	4
Nuwakot	<i>Shivapuri- Nagarjun NP</i> (portion)				Kakani	4	2
Ramechhap	<i>Gaurishankar Conservation Area</i> (partially)				Lower GCA area	1	2
Rasuwa	<i>Langtang National Park</i> (primary), <i>Rasuwa Ft.</i> historical buffer area			LNP	Gatlang		2
Sindhuli	None specific					2	2
Sindhupalchok	<i>Langtang NP</i> (partial), <i>Shivapuri- Nagarjun NP</i> (southern edge)				Helambu, Attarpur	5	2

IBA = Important Bird Area, IPA = Important Plant Area; Others= identified by communities

4.6. Threats constraining biodiversity

4.6.1 Forest cover change

The data (Table 9) shows forest cover change across various districts of Bagmati province between 2010 and 2020, with figures reflecting the total area (in square kilometers). Over the 10-year period, several districts experienced notable changes. Districts such as Dhading (+88.38), Nuwakot (+79.48), Makawanpur (+46.46), Kavre (+46.35), and Chitwan (+41.60) saw significant increases, suggesting possible expansion in land use or forest cover. In contrast, Dolakha (-84.31), Ramechhap (-65.85), Sindhupalchok (-59.87), and Kathmandu (-5.47) experienced reductions, possibly due to urbanization, infrastructure development, or land degradation. Bhaktapur, Lalitpur, and Rasuwa also recorded slight to moderate declines.

Table 9. Forest cover change Bagmati province between 2010 and 2020

Districts	2010 (km ²)	2020 (km ²)	Change in 10 years (km ²)
Bhaktapur	35.1639	25.9092	-9.2547
Chitwan	1421.337	1462.938	41.6016
Dhading	971.1972	1059.579	88.3818
Dolakha	994.2606	909.9513	-84.3093
Kathmandu	157.4523	151.9776	-5.4747
Kavre	762.9327	809.28	46.3473
Lalitpur	234.927	207.684	-27.243
Makawanpur	1723.768	1770.232	46.4634
Nuwakot	590.3595	669.8421	79.4826
Ramechhap	711.2574	645.4044	-65.853
Rasuwa	479.8251	452.7666	-27.0585
Sindhuli	1760.241	1787.836	27.5949
Sindhupalchok	1333.049	1273.178	-59.8716

Source: ICIMOD

4.6.2 Distribution of invasive species

The IPBES (Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services) identifies invasive alien species (IAS) as one of the top five direct drivers of biodiversity loss. Invasion of alien species is increasing, leading to global biodiversity loss, with widespread ecological and economic consequences (Bellard et al., 2016; Diagne et al., 2021). When human activity intentionally or unknowingly transports species beyond of their natural geographic range, they establish, spread, and have a detrimental impact on local ecosystems (IPBES, 2023). Forests, woodlands, grasslands, and agricultural fields are among the terrestrial habitats that are now seriously threatened by invasive alien plant species (IAPS). Through outcompeting native vegetation, changing the characteristics of the soil, and upsetting ecological processes, IAPS drastically lowers ecosystem resilience and biodiversity.

IAPs is one of the major drivers of biodiversity loss, identified by MOFE (2018). More than 220 established alien flowering plant species have been reported from Nepal (Shrestha et al. 2022). Among them, 30 species are reported to be invasive with range of ecological and socioeconomic impacts (Adhikari et al. 2022, Shrestha et al. 2024a). The highest number of IAPs belong to family Asteraceae (12 spp.). The number of IAPs reported in districts of Nepal showed a large variation with >20 species reported in six districts located mainly in the Tarai and Siwalik regions (e.g. Makawanpur, Chitwan) and <6 species in five mountain districts (e.g., Bhaktapur) (Figure 3).

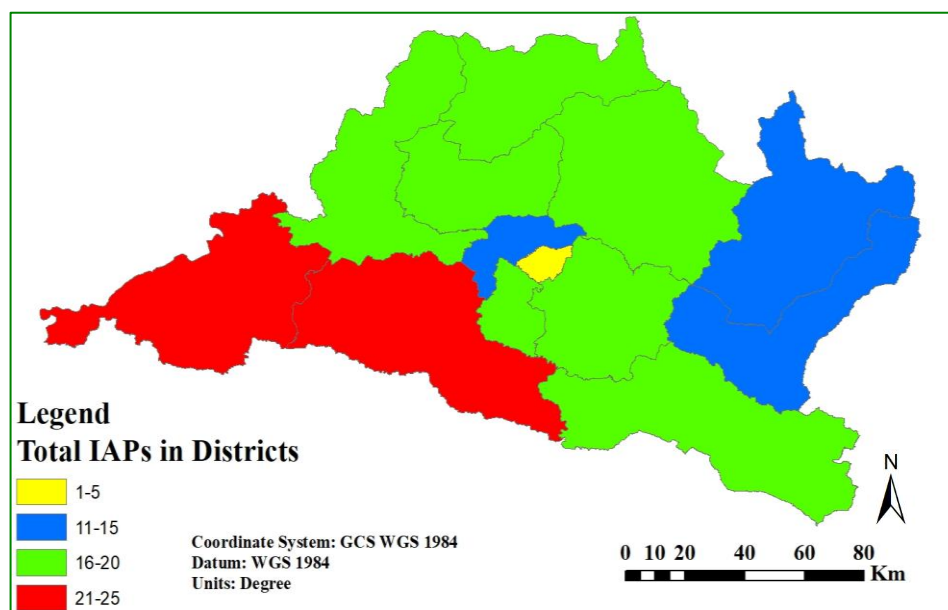


Figure 3: Distribution of IAPs in Bagmati province

4.6.3 Climate change

Climate change is a major and growing driver of biodiversity loss. It poses a significant threat to global biodiversity by altering habitats, increasing the frequency of extreme weather events, and disrupting ecological relationships. These changes force species to migrate, adapt, or face extinction, leading to a decline in overall biodiversity. Human activities, including habitat destruction and pollution, exacerbate these effects, contributing to what some scientists call the sixth mass extinction. Nepal's temperature is rising faster than the global average, and rainfall is becoming unpredictable. Himalayas are warming faster than the global average. Specifically, the Hindu Kush Himalaya (HKH) region is experiencing a rate of warming that exceeds the global average, with potential for significant impacts on glaciers, water resources and biodiversity.

The country's ability to adapt to the adversities has direct implications in its strategies on biodiversity conservation. Adaptation to climate change has emerged as a challenge as mitigation is not taking place as needed (Eriksen et al 2011). However, adaptation is becoming complicated in practice as climate change and its impacts are faster than the natural process can sustain and they are embedded with social, cultural and political process of the country. Based on assessment indexing the values of ecological, socioeconomic, political, cultural, physiographic and available infrastructure, Kathmandu, Makawanpur and Dhading are categorized as highly vulnerable followed by moderately vulnerable Chitwan, Sindhuli, Ramechhap, Dolkha, Sindhupalchowk and least vulnerable Bhaktapur, Lalitpur, Kavre, Nuwakot, Rasuwa.

Besides these, Bagmati Province faces several other ongoing challenges. Habitat fragmentation, rapid infrastructure development, and climate-induced changes in alpine ecosystems continue to put pressure on biodiversity. Illegal wildlife trade and limited technical and financial resources also hinder effective conservation. Addressing these issues requires strategic actions such as expanding ecological corridors, enhancing multi-stakeholder coordination, and investing in research, technology, and climate adaptation measures.

4.6.4 Forest fire

Forest fire, next to deforestation, is the second most crucial threat to worsening the forest ecosystem in Nepal (MoFSC 2014). About 30% of forest areas will likely catch forest fire yearly (Reddy et al. 2019). The Forest Monitoring and Detection System Nepal recorded 5,626 forest fire incidents across the country from November 2020 to April 2021 (Mandal 2021). Forest fires in Nepal burned around 0.172 million ha of forests annually, leading to 7.07 million tons of biomass loss and 3.3 million tons of carbon emission (Bhujel et al. 2022). Frequent and recurrent forest fires severely damage and prohibit the regeneration and growth of seedlings, destroy non-timber forest products, and promote invasive species (Baral et al. 2017, Paudel 2022).

Forest fire incidences of last two decades (2000-2019) shows that Bagmati province is vulnerable to forest fire while the district Chitwan is most vulnerable. There were over 6000 forest fire incidences in Bagmati and about 1/3 were only from Chitwan district revealed that the district is highly vulnerable followed by Makawanpur (Table 10).

Table 10. Forest fire incidences between 2000 and 2019 and its index in Bagmati province

Districts	Rank	Incidences	Index
Bhaktapur	77	3	0.006954264
Kathmandu	76	9	0.020862792
Lalitpur	73	64	0.148357635
Nuwakot	59	140	0.324532326
Ramechhap	66	88	0.203991748
Kavre	61	121	0.280488653
Dolakha	47	238	0.551704954
Rasuwa	41	298	0.690790236
Sindhupalchok	39	323	0.748742437
Dhading	26	530	1.228586662
Sindhuli	19	743	1.722339414
Makawanpur	13	990	2.294907161
Chitwan	2	2579	5.978349058

4.7. Critical habitats and ecosystems immediate for conservation

Bagmati Province exhibits a wide variety of flora ecosystems and habitats across its districts. Kathmandu's temperate broadleaf forests dominated by *Schima-Castanopsis* occur along forest edges, sacred groves, and hillsides. Bhaktapur contains urban and peri-urban forest remnants, mainly in community woodlots and private gardens. Lalitpur supports mid-hill forests and pine plantations with parklands and riverbanks providing important vegetation zones. In Chitwan, tropical sal forests and riverine grasslands within Chitwan National Park represent key lowland habitats. Makawanpur's sal and Siwalik hill forests along the Bara corridor and near settlements support diverse plant communities, while Dhading's mid-hill mixed forests thrive along river valleys and slopes. High-altitude areas like Rasuwa and Dolakha harbor subalpine and alpine meadows, rhododendron forests, and coniferous zones, rich in specialized vegetation.

Similarly, Ramechhap, Sindhupalchok, Sindhuli, Kavrepalanchok, and Nuwakot districts feature a mosaic of hardwood, pine, and mixed deciduous forests, often associated with community-managed areas and buffer zones of protected parks.

The fauna of Bagmati Province occupies diverse ecosystems ranging from urban-adapted zones to alpine habitats. In Kathmandu and Lalitpur, wildlife is found in mixed temperate forests, riverbanks, and fragmented patches including urban-rural interfaces. Bhaktapur's fauna adapts to wetlands, temple forests, and agricultural edges. Chitwan's Terai lowland fauna thrives in sal forests, wetlands, and riverine corridors within and around Chitwan National Park. Makwanpur's fauna inhabits Terai hill transition ecosystems, particularly near Parsa National Park buffer zones. Dhading and Rasuwa provide habitats for mixed hill and alpine species, including red pandas in Langtang National Park. Dolakha's high mountain zones support musk deer and pheasants, while Ramechhap and Sindhupalchok accommodate species utilizing seasonal migration corridors and forest edges. Sindhuli, Kavrepalanchok, and Nuwakot serve as critical wildlife corridors and buffer zones linked to major protected areas, highlighting the province's role in sustaining regional biodiversity and ecological connectivity. Table 11 shows critical hotspots in Bagmati province.

Table 11. Critical ecosystems/hotspots in Bagmati

District	Forest cover change	No. of IAPs	Climate vulnerability	Endemic sp plants	Threatened sp plants	Indg. Agro species	Conservation sites	Final score
Kathmandu	-5.4747 (2)	12 (2)	High (3)	15 (3)	24 (3)	2 (3)	3 (2)	18
Dhading	88.3818 (1)	16 (3)	High (3)	19 (3)	14 (3)	0 (1)	3 (2)	16
Rasuwa	-27.0585 (2)	7 (1)	Low (1)	40 (3)	30 (3)	3 (3)	2 (2)	15
Sindhupalchok	-59.8716 (3)	13 (2)	Medium (2)	2 (2)	2 (1)	3 (3)	2 (2)	15
Dolakha	-84.3093 (3)	7 (1)	Medium (2)	13 (3)	0 (1)	1 (2)	2 (2)	14
Ramechhap	-65.853 (3)	12 (2)	Medium (2)	8 (2)	5 (2)	0 (1)	2 (2)	14
Chitwan	41.6016 (1)	20 (3)	Medium (2)	3 (2)	7 (2)	1 (2)	4 (1)	13
Makwanpur	46.4634 (1)	16 (3)	High (3)	1 (2)	7 (2)	0 (1)	4 (1)	13
Nuwakot	79.4826 (1)	12 (2)	Low (1)	2 (2)	1 (1)	3 (3)	2 (2)	12
Bhaktapur	-9.2547 (2)	12 (2)	Low (1)	1 (2)	2 (1)	1 (2)	2 (2)	12
Sindhuli	27.5949 (1)	13 (2)	Medium (2)	1 (2)	1 (1)	1 (2)	2 (2)	12
Lalitpur	-27.243 (2)	12 (2)	Low (1)	7 (2)	2 (1)	3 (3)	5 (1)	11
Kavrepalanchok	46.3473 (1)	13 (2)	Low (1)	0 (1)	2 (1)	0 (1)	1 (3)	10

Number in parenthesis is scale, ranging from 1-3 (1 = low, 2 = medium, 3 = maximum intensity)

Districts with maximum (-) land use change, invasive species presence, climate vulnerability, and the number of endemic and threatened species refuge deem intensive conservation and they should be in conservation priority if the districts hold the least cover of the protected areas and in-situ and ex-situ measures. The adjoining areas of the conservation sites and in-situ and ex-situ measures of the districts were emphasized and mapped as critical habitats in order to secure the habitat connectivity, eases the biological corridors and trans-boundary conservation.

From the analysis Kathmandu, Dhading, Rasuwa Sindhupalchok, Dolakha and Ramechhap were ranked as conservation priority districts and their sacred sites, forest patches and key biodiversity areas (Table 12) that work as a corridor for biodiversity were considered as critical habitats for the Bagmati province.

Table 12. List of potential critical habitats of Bagmati province

Districts	Sites	Significance
Kathmandu-Lalitpur-Makwanpur	Swayambhu groove, Phulchoki-Dakshinkali-Daman complex	Prehistoric floral records, wetlands, Dakshinkali sacred grooves
Rasuwa	Chilime-Goljung-Gatlang	Mountainous and endemic
Dhading	Ruby valley	Mountainous-Midhill
Rasuwa-Sindhupalchok	Helambu to Panchpokhari	Gosaikuda-Panchpokhari- cultural
Dolakha	Rolwaling	Transhumance, summer grazing
Ramechhap	Lower belt of GCA	Agrospecies

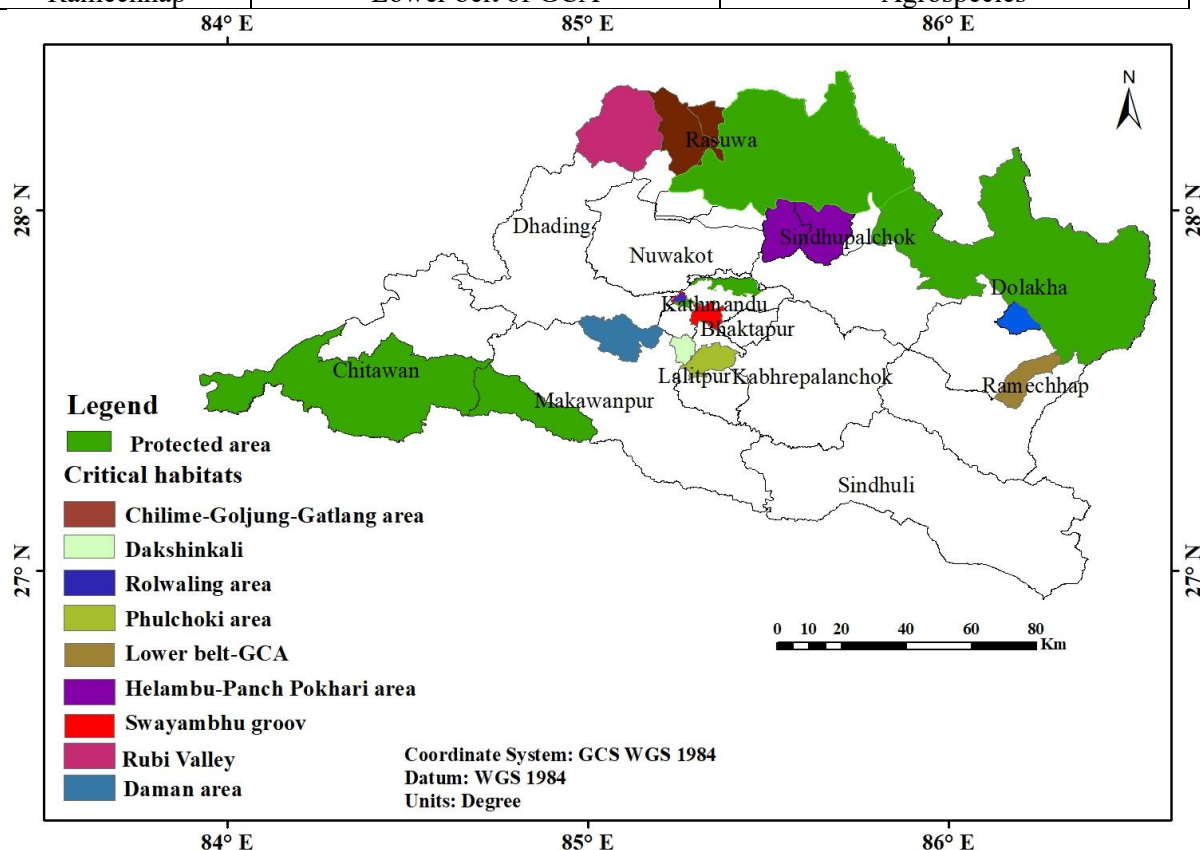


Figure 4: Map showing critical habitats and hotspots of Bagmati province

4.8. Strategies for management of critical habitats/hotspots

For the proper management of biodiversity, hotspots, and ecosystems in Bagmati Province, the following strategies are needed for sustainable management. These strategies should focus on habitat conservation, community participation, scientific research, and policy integration. Strengthening institutional capacity and promoting awareness at the local level are also essential to ensure long-term ecological balance and resilience.

Biodiversity conservation in Bagmati Province requires a comprehensive, region-specific approach that addresses ecological, social, and institutional dimensions. Habitat and ecosystem management begins with the delineation of core, buffer, and transition zones within protected areas such as Chitwan National Park, Langtang National Park, and Panch Pokhari. Core zones should be maintained with stringent protection, while buffer and transition areas allow regulated use and conservation-compatible activities. Restoration of disturbed forest patches through native and endemic plant species is crucial, particularly in river corridors and high-

altitude regions. Natural regeneration should be encouraged wherever feasible to support ecosystem recovery. Ensuring landscape connectivity through the development of ecological corridors such as the Langtang-Ruby Valley-Manaslu route is essential to facilitate wildlife movement and gene exchange. Infrastructure development pressures, including roads and hydropower, must be mitigated to prevent habitat fragmentation. Likewise, integrated management of wetlands and watersheds like Taudaha, Indrasarovar, and mid-hill streams is important for sustaining aquatic biodiversity, with attention to catchment-level soil and water conservation.

Community-based and institutional mechanisms form the backbone of conservation at the grassroots level. Community Forest User Groups (CFUGs) and Buffer Zone Management Committees should be supported in biodiversity mapping, anti-poaching patrols, and fire risk management. Inclusion of women, Indigenous Peoples, and marginalized communities is vital for equitable governance. Traditional ecological knowledge, particularly on medicinal plants, pasture rotation, and spiritual beliefs tied to nature, should be documented and integrated into resource management. Promoting biodiversity-friendly livelihoods, such as the cultivation and processing of medicinal and aromatic plants into essential oils or teas, eco-tourism in Ruby Valley, and handicrafts in highland areas, helps link conservation with economic incentives.

Local stewardship plays a key role in sustaining the province's forests and biodiversity. Co-management is needed to conserve the critical habitats as the habitats are keys to opt as biological corridors and transboundary conservation scale. Moreover, Indigenous communities such as the Tamang, Chepang, and Sherpa have long been resided in the provinces and actively conserved the landscapes and biodiversity through traditional beliefs, customary norms and indigenous land-use practices. Sacred forests associated with religious sites continue to function as important stocks of original seed sources of the endemic and indigenous trees, safeguarding local biodiversity.

5. Conclusions and recommendations

5.1. Conclusions

Critical habitats and biodiversity hotspots are ecologically important areas that require special attention due to their rich biodiversity, unique ecosystems, and vulnerability to environmental threats. Local stakeholders have emphasized conserving several critical areas outside protected areas of the province since they boast several endemic and threatened species. Among many, Swayambhu groove of Kathmandu, Daman-Phulchoki complex of Lalitpur-Makawanpur, Panchpokhari area of Sindhupalchok, Chilime-Goljung-Gatlang area of Rasuwa, Ruby valley of Dhading, Rolwaling area of Dolakha, and lower GCA areas were considered as critical as large number of endemic, threatened and high value flora, fauna and agro-resources are found in these areas. Moreover, the associated districts of these areas are impacted by several threats including severe climate vulnerability, invasion by alien plant species and forest cover loss.

For the proper management of biodiversity, hotspots, and ecosystems in Bagmati Province, in-situ conservation, habitat management, community participation, scientific research, and policy integration is emphasized while maintaining habitat connectivity and ordering the climate change, land use change and invasion of plant species.

Conservation efforts should emphasize on conservation of threatened and endemic/high value species like Red panda, Chinese pangolin, *Taxus maieriei*, *Larix potaninii*, *Butea monosperma*, *Cyathea spinulosa*, etc. Technologies and tools such as camera traps, GPS tracking, and citizen science can be applied to enhance the species monitoring.

Ex-situ efforts must focus on strengthening institutions such as the Central Herbarium of Tribhuvan University and the National Plant Laboratory and Herbarium (KATH) in Godawari and province level herbarium can be set up. Seed banking of rare and endemic species should be expanded. Simultaneously, the spread of invasive alien plants especially *Mikania micrantha* and *Lantana camara* must be controlled through systematic mapping, removal, wise use (application of biochar) and restoration with native species.

Strengthening institutional capacity and promoting awareness at the local level are also essential to ensure long-term ecological balance and resilience. Strengthening the role of local governments and empowering communities through inclusive governance models will be essential to secure a resilient and biodiversity-rich future for Bagmati Province.

Monitoring of ecological indicators such as flowering times, animal migrations, and range shifts is necessary. Proactive measures against forest fires - like constructing fire lines, deploying early warning systems, and training local fire response teams must be institutionalized. Additionally, the province must remain vigilant about glacial lake outburst threats in mountain regions, ensuring preparedness through regular risk assessments and emergency planning. Together, these coordinated efforts can secure the ecological future of Bagmati Province while enhancing the well-being of its communities.

Strengthening research, education, and local capacity is essential to ensure science-based decision-making. Regular biodiversity assessments should be carried out using standardized methodologies, and the findings integrated into provincial biodiversity databases. In terms of

policy, planning, and intersectoral coordination, Bagmati Province must develop and implement its own Biodiversity Strategy and Action Plan aligned with national priorities. Biodiversity should be integrated into the planning frameworks of agriculture, tourism, energy, and infrastructure. Collaboration across government agencies, academic institutions (such as Tribhuvan University), I/NGOs, and cross-border partners especially in areas adjacent to the Tibetan Autonomous Region can enhance conservation effectiveness.

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Annexes

Annex 1. Checklist for ecological sampling

Date: 2025/.../...	District:	RM/M:
Plot no.:	Ecosystem name:	Elevation (m):
Ecosystem type (√)	Forest/Wetland/Grassland/ Agroecosystem/Other	Lat.: Long.:
Ecosystem Condition (√)	i) Healthy ii) Vulnerable iii) Degraded	Remarks:

Healthy: Threats are minimal or highly localized; habitat structure and processes are well maintained.

Vulnerable: Noticeable degradation or disturbance in some processes; ecosystem still largely functional.

Degraded: Widespread damage or disruption of key processes; high risk of collapse without intervention.

DBH and Height only for tree species and total number of shrubs and herbs

[illegible]

Annex 2. Checklist for social survey

District:	RM/M:	Lat.: Elevation (m):	Long.: 	Date: 2025/.../....
Local Biodiversity trend: • “What changes have you noticed in the abundance or variety of plants and animals around your village over the past 10-20 years?” • “Which species (wild plants/animals) do you see less often now, and which have become more common?”				
Perceived Threats & Drivers: • “What do you think are the main causes of forest loss or degradation in this area?” • “How have farming, grazing, or development projects affected wildlife habitats here?”				
Ecosystem Services & Livelihoods: • “Which forest or wetland products (e.g., firewood, fodder, medicinal plants) are most important to your household?” • “Have you experienced any changes in water supply, soil fertility, or pollination services? How has that affected your work?”				
Cultural & Traditional Knowledge: • “Are there any sacred groves, ritual sites, or culturally important species you or your community protect? Why?” • “Can you share traditional practices or taboos that help conserve certain species or areas?”				
Community Capacity & Governance • “How effective are current community forest management rules (CFUG bylaws) at protecting biodiversity?” • “What challenges do you face in enforcing rules against illegal logging, grazing, or wildlife poaching?”				
Prioritization & Solutions • “Which areas or species do you think should be highest priority for conservation action?” • “What strategies-training, alternative livelihoods, awareness campaigns-would help your community conserve biodiversity?”				

Annex 3. Distribution of endemic plant species

Family	Taxa	Bh	Ch	Dh	Do	Kat	Kav	La	Ma	Nu	Ra	Ras	Sidh	Sindp
Acanthaceae	<i>Strobilanthes nutans</i> (Nees) T.Anderson											1		1
Apiaceae	<i>Acronema bryophilum</i> Farille & Lachard											1		
Apiaceae	<i>Acronema mukherjeeanum</i> Farille & Lachard											1		
Apiaceae	<i>Acronema phaeosciadeum</i> Farille & Lachard											1		
Apiaceae	<i>Lalldhwojia pastinacifolia</i> Pimenov & Kljuykov											1		
Apiaceae	<i>Oreocome depauperata</i> Pimenov & Kljuykov											1		
Apiaceae	<i>Oreocome involucellata</i> Pimenov & Kljuykov											1		
Apiaceae	<i>Pimpinella acronemastrum</i> Farille & Lachard											1		
Apiaceae	<i>Rohmooa kirmzii</i> Farille & Lachard											1		
Apiaceae	<i>Synclinostyles denisjordanii</i> Farille & Lachard											1		
Asteraceae	<i>Ligularia amplexicaulis</i> var. <i>nepalensis</i> S.W.Liu & T.N.Ho											1		
Balsaminaceae	<i>Impatiens harae</i> var. <i>micrantha</i> (H.Hara) H.Ohba & S.Akiyama ex S.Akiyama											1		
Berberidaceae	<i>Berberis orthobotrys</i> Bienert ex Aitch.											1		
Caryophyllaceae	<i>Silene fissicalyx</i> Bocquet & Chater											1		
Cyperaceae	<i>Carex herbacoeli</i> Jim.Mejías & Roalson											1		
Ericaceae	<i>Rhododendron cowanianum</i> Davidian											1		
Fabaceae	<i>Crotalaria kanaii</i> H.Ohashi											1		
Orchidaceae	<i>Hermidium fimbriatum</i> (Raskoti) X.H.Jin, Schuit., Raskoti & Lu Q.Huang											1		
Orchidaceae	<i>Liparis langtangensis</i> Raskoti & Ale											1		
Orobanchaceae	<i>Pedicularis oxyrhyncha</i> T.Yamaz.											1		
Papaveraceae	<i>Corydalis stipulata</i> Lidén											1		
Papaveraceae	<i>Meconopsis autumnalis</i> P.A.Egan											1		
Papaveraceae	<i>Meconopsis regia</i> G.Taylor											1		
Poaceae	<i>Elymus nepalensis</i> (Melderis) Melderis											1		
Poaceae	<i>Festuca eriobasis</i> H.Scholz											1		
Poaceae	<i>Himalayacalamus planatus</i> Stapleton											1		
Poaceae	<i>Himalayacalamus porcatus</i> Stapleton											1		
Polygonaceae	<i>Eskemukerjea megacarpum</i> (H.Hara) H.Hara											1		

Ranunculaceae	Thalictrum alpinum var. minutissimum H.Hara											1		
Rosaceae	Griffitharia sharmae (M.F.Watson, V.Manandhar & Rushforth) Rushforth											1		
Saxifragaceae	Saxifraga excellens Harry Sm.											1		
Saxifragaceae	Saxifraga roylei Harry Sm.											1		
Urticaceae	Pilea kanaii H.Hara											1		
Orobanchaceae	Pedicularis pseudoregeliana P.C.Tsoong										1	1		
Apiaceae	Cortia staintonianiana Farille & S.B.Malla										1			
Balsaminaceae	Impatiens harae H.Ohba & S.Akiyama var. harae										1			
Cyperaceae	Carex esbirajbhandarii (Rajbh. & H.Ohba) O.Yano										1			
Orobanchaceae	Pedicularis chamissonoides T.Yamaz.										1			
Ranunculaceae	Ranunculus pegaeus var. curvistylis Y.Kadota										1			
Saxifragaceae	Saxifraga mallae H.Ohba & Wakab.										1			
Begoniaceae	Begonia nuwakotensis S.Rajbh.									1				
Primulaceae	Primula buryana var. purpurea Fletcher									1				
Orchidaceae	Habenaria wallichii (Kolan., Kras & Szlach.) J.M.H. Shaw								1					
Acanthaceae	Strobilanthes saccata J.R.I.Wood							1						1
Plantaginaceae	Wulfeniopsis nepalensis (T.Yamaz.) D.Y.Hong							1				1		
Caryophyllaceae	Stellaria rajbhandaryi Kafle & G.Parmar							1						
Elaeagnaceae	Elaeagnus tricholepis Momiy.							1						
Musaceae	Ensete nepalensis (Wall.) G.Parmar							1						
Hypericaceae	Hypericum cordifolium Choisy					1						1		
Lamiaceae	Isodon phulchokiensis (Murata) H.Hara					1		1						
Asteraceae	Cirsium phulchokiense Kitam.					1		1						
Asteraceae	Synotis triligulata (Buch.-Ham. ex D.Don) C.Jeffrey & Y.L.Chen					1								
Campanulaceae	Lobelia chinensis var. pilosa Kitam.					1								
Celastraceae	Parnassia chinensis var. ganeshii S.Akiyama & H.Ohba					1								
Orchidaceae	Bulbophyllum nepalense Raskoti & Ale					1								
Orchidaceae	Herminium hongdeyuanii Raskoti					1								

Orchidaceae	Pinalia baniae (Bajrach., L.R.Shakya & Chettri) Schuit, Y.P.Ng & H.A.Pedersen				1									
Poaceae	Bambusa nepalensis Stapleton				1									
Poaceae	Dendrocalamus hamiltonii var. undulatus Stapleton				1									
Poaceae	Himalayacalamus fimbriatus Stapleton				1									
Rhamnaceae	Rhamnus virgata var. flavida (Momi.) Momi.				1									
Rosaceae	Rubus dorcheei M.B.Rokaya & S.Subedi				1									
Apiaceae	Tetrataenium lallii (C.Norman) Cauwet, Carb. & M.Farille		1								1			
Apiaceae	Acronema pneumatophobium Farille & Lachard				1									
Apiaceae	Chamaesium shrestaeum Farille & S.B.Malla				1									
Araliaceae	Hydrocotyle himalaica subsp. mukherjeeana Farille & Lachard				1									
Balsaminaceae	Impatiens kharensis S.Akiyama, H.Ohba & Wakab.				1									
Begoniaceae	Begonia leptoptera H.Hara				1									
Fabaceae	Indigofera trifoliata var. nepalensis H.Ohashi				1									
Fabaceae	Oxytropis morenarum Vassilcz.				1									
Gentianaceae	Swertia acaulis Harry Sm.				1									
Orobanchaceae	Pedicularis yalungensis T.Yamaz.				1									
Saxifragaceae	Saxifraga amabilis H.Ohba & Wakab.				1									
Saxifragaceae	Saxifraga hookeri var. rolwalingensis (H.Ohba) Kozhev.				1									
Asteraceae	Leontopodium montisganesii S.Akiyama		1								1			
Orobanchaceae	Pedicularis annapurnensis T.Yamaz.		1								1			
Saxifragaceae	Saxifraga hypostoma Harry Sm.		1							1				
Ranunculaceae	Aconitum bhedingense Lauener		1	1										
Apiaceae	Sinocarum normanianum (Cauwet & Farille) Farille		1	1	1						1			
Apiaceae	Lalldhwojia staintonii Farille		1											
Apiaceae	Synclinostyles exadversum Farille & Lachard		1											
Fabaceae	Hedysarum manaslense (Kitam.) H.Ohashi		1											
Iridaceae	Iris staintonii H.Hara		1											

Orchidaceae	Pleione coronaria P.J.Cribb & C.Z.Tang			1										
Papaveraceae	Corydalis megacalyx Ludlow & Stearn			1										
Papaveraceae	Meconopsis ganeshensis Grey-Wilson			1										
Poaceae	Poa hideaki-ohbae Rajbh.			1										
Poaceae	Thamnocalamus chigar (Stapleton) Stapleton			1										
Polygonaceae	Bistorta millettioides H.Ohba & S.Akiyama			1										
Saxifragaceae	Saxifraga ganeshii H.Ohba & S.Akiyama			1										
Zingiberaceae	Roscoea ganeshensis Cowley & W.J.Baker			1										
Zingiberaceae	Roscoea purpurea f. rubra Cowley			1										
Begoniaceae	Begonia tribenensis C.R.Rao		1											
Orchidaceae	Eria nepalensis Bajrach. & K.K.Shrestha		1											
Orchidaceae	Habenaria plantaginea var. nepalensis (Kolan.) Rajbh. & R.Chhetri		1											
Acanthaceae	Thunbergia kasajuana Bh.Adhikari & J.R.I.Wood	1												

Annex 4. Distribution of threatened plant species

Species	Go N	CITE S	CAM P	IUC N	Bh	Ch	Dh	Do	Kat	Kav	La	Ma	Nu	Ra	Ras	Sidh	Sindp
1. <i>Michelia champaca</i> L.			CR				1		1								
2. <i>Valeriana jatamansi</i> Jones	***		V				1							1	1		
3. <i>Tinospora sinensis</i> (Lour.) Merr.			V				1	1									
4. <i>Eulophia obtusa</i>		II		CR		1											
5. <i>Gnetum montanum</i>		III				1						1					
6. <i>Operculina turpethum</i> (L.) Silva Manso			EN			1											
7. <i>Euphorbia royaleana</i>		II			1												
8. <i>Juglans regia</i> L.	*								1						1		
9. <i>Paris polyphylla</i> Sm.			V	VU					1						1		
10. <i>Swertia angustifolia</i> Buch.-Ham. ex D. Don			EN						1						1		
11. <i>Taxus wallichiana</i> Zucc.	***	II	EN	EN					1						1		
12. <i>Podocarpus neriifolius</i>		III							1			1					
13. <i>Magnolia hodgsonii</i>		III							1								
14. <i>Taxus mairei</i>		II		EN					1	1		1				1	
15. <i>Lilium nepalense</i> D. Don			DD						1								
16. <i>Pectelis triflora</i>		II		CR					1								
17. <i>Quercus lamellosa</i>				NT					1								
18. <i>Quercus oblongata</i>				NT					1								
19. <i>Maharanga emodi</i> (Wall.) A. DC.			DD	K			1								1		
20. <i>Nardostachys grandiflora</i> DC.	***	II	V	CR			1								1		
21. <i>Rhodiola species</i>		II					1								1		
22. <i>Litsea doshia</i>				NT			1		1						1		
23. <i>Panax pseudo-ginseng</i> Wall.			V				1		1						1		
24. <i>Neopicrorhiza scrophulariiflora</i> (Pennell) D.Y. Hong	*		V											1	1		
25. <i>Fritillaria cirrhosa</i> D. Don			V	VU											1		
26. <i>Gloriosa superba</i> L.			EN												1		
27. <i>Oroxylum indicum</i> (L.) Kurz			EN			1	1		1			1			1		
28. <i>Shorea robusta</i>	**					1						1			1		
29. <i>Maharanga bicolor</i> (Wall. ex G. Don) A. DC.			DD												1		
30. <i>Meconopsis dhwojii</i> G. Taylor ex Hay			NT												1		
31. <i>Meconopsis regia</i>		III													1		
32. <i>Podophyllum hexandrum</i> Royle		II	V												1		
33. <i>Rheum australe</i> D. Don			V	V											1		
34. <i>Rheum moorcroftianum</i> Royle			NT												1		
35. <i>Sloanea tomentosa</i>				EN											1		

Species	Go N	CITE S	CAM P	IUC N	Bh	Ch	Dh	Do	Kat	Kav	La	Ma	Nu	Ra	Ras	Sidh	Sindp
36. <i>Trillium govanianum</i>				EN											1		
37. <i>Rubia manjith</i> Roxb. ex Fleming			V						1						1		1
38. <i>Swertia chirayita</i> (Roxb. ex Fleming) Karsten			V	V					1					1	1		
39. <i>Abies spectabilis</i>	*			NY			1								1		1
40. <i>Aconitum heterophyllum</i> Wall. ex Royle			V	EN			1										
41. <i>Aconitum spicatum</i> (Bruhl) Stapf			V	T											1		
42. <i>Alstonia neriifolia</i> D. Don			EN	R		1	1		1								
43. <i>Alstonia scholaris</i> (L.) R. Br.			V	R		1						1					
44. <i>Actinodaphne longipes</i>				VU					1								
45. <i>Aegle marmelos</i>				NT					1								
46. <i>Asparagus racemosus</i> Willd.			V						1						1		
47. <i>Butea monosperma</i> (Lam.) Kuntze			V	EN													
48. <i>Corydalis megacalyx</i> Ludlow			EN				1										
49. <i>Crateva unilocularis</i> Buch.-Ham.			EN	R					1					1			
50. <i>Cycas pectinata</i>		II		VU								1					
51. <i>Cyathea species</i>		II			1			1		1	1		1				
52. <i>Curculigo orchioides</i> Gaertn.			V						1								
53. <i>Cyperipedium conrdigerum</i>		II		VU							1						
54. <i>Dioscorea deltoidea</i> Wall. ex Griseb		II	EN	T					1						1		
55. <i>Ephedra gerardiana</i> chrenk & Meyer			EN	VU			1	1						1	1		
56.					2	7	14		24	2	2	7	1	5	30	1	2

Annex 5. BSO, Mother tree stands and in-situ sites in Bagmati province

Common name	Scientific name	In-situ site	Breeding Seed Orchards	Seed stands
Khayer	<i>Acacia catechu</i>		Mirchaiya 3, Siraha	Benighat 9 Dhading Chaturmukhi, Chitwan
Siris Kalo	<i>Albizia lebbek</i>		Jutpani 9, Chitwan	
Uttis	<i>Alnus nepalensis</i>			Sitapaila, Kathmandu; Goldhunga 4, Kathmandu; Phulchoki, Lalitpur; Majhuwa, Sindhuli;
Badahar	<i>Artocarpus lacucha</i>		Jutpani 9, Chitwan	
Koiralo	<i>Bauhinia purpurea</i>		Majhimtar 3, Dhading	
Tanki	<i>Bauhinia variegata</i>		Jutpani 9, Chitwan	Majimtar 3, Dhading;
Saur	<i>Betula nitida</i>			Daman 3, Makawanpur
Simal	<i>Bombax ceiba</i>			Kumroj 1, Chitwan
Katus dhalne	<i>Castanopsis indica</i>			Bisankhunarayan, Lalitpur
Debdar	<i>Cedrus deodara</i>		Suspa 1, Dolakha	
Lapsi	<i>Choerospondias axillaris</i>		Kakani 3, Nuwakot; Thankot, Kathmandu	Syaule 9, Sindhupalchok
Satisal	<i>Dalbergia latifolia</i>		Jutpani 9, Chitwan	
Sissoo wild	<i>Dalbergia sissoo</i>		Jutpani 9, Chitwan; Sauraha, Chitwan;	
Chiuri	<i>Diloknema butyracea</i>		Gadhi 1, Makawanpur	Nuwakot
Nimaro	<i>Ficus roxburghii</i>			Haibung, Sindhupalchok
Okhar	<i>Juglans regia</i>		Markhu 8, Makawanpur	Wiksimle 9, Kavre; Lisankhu 5, Sindhupalchok
Ipil ipil	<i>Leucaena leucocephala</i>		Sauraha, Chitwan; Jutpani 9, Chitwan	
Champ	<i>Magnolia spp</i>	Timkanya, Sindhuli	Thankot, Kathmandu	
Amala	<i>Phyllanthus emblica</i>		Jutpani 9, Chitwan	
Salla Pate	<i>Pinis patula</i>			Lakurisana 4, Dolakha; Chautara, Sindhupalchok; Daksinkali, Kathmandu; Chaubas, Kavre
Salla Gobre	<i>Pinus roxburghii</i>			Jiri 9, Dolakha; Gokarna, Kathmandu; Paldada, Makawanpur
Salla Khote	<i>Pinus wallichiana</i>			Hokse 2, Kavre; Bidur, Nuwakot; Gerku, Nuwakot; Nagarkot, Bhaktapur; Jyamrung, Dhading; Bhimeswor, Dolakha; Fasku, Dolakha; Goldhunga 4, Kathmandu; Mitinkot, Kavre; Lamidada, Makawanpur; Baluwajor, Ramechap; Sunarpani, Ramechap; Thumpakhar, Sindhupalchok
Banjh	<i>Quercus lanata</i>			Godawari 5, Lalitpur;

<i>Common name</i>	<i>Scientific name</i>	<i>In-situ site</i>	<i>Breeding Seed Orchards</i>	<i>Seed stands</i>
Khasru	<i>Quercus semecarpifolia</i>			Daman, Makawanpur; Jiri, Dolakha; Godawari 5, Lalitpur
Chilaune	<i>Shima walichii</i>			Goldhunga 4, Kathmandu; Madanpur 8, Nuwakot
Salla Loth	<i>Taxus mairei</i>	Daman, Makawanpur		
Bodhichitta	<i>Ziziphus budhanesis</i>		Namobuddha, Kavre	