SUSTAINING BHUTAN'S NATURAL WEALTH

Guidelines for Natural Capital Accounting in Protected Areas

Department of Forests and Park Services
Ministry of Energy and Natural Resources
Royal Government of Bhutan

March 2025

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Editing: ICIMOD

Design and Layout: Sudip Maharjan, ICIMOD

Citation

DoFPS, 2025. Sustaining Bhutan's natural wealth. Guidelines for Natural Capital Accounting in Protected Areas. Department of Forests and Park Services, Ministry of Energy and Natural Resources, Royal Government of Bhutan

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Royal Government of Bhutan
Ministry of Energy and Natural Resources
Department of Forests and Park Services

ROYAL GOVERNMENT'S ENDORSEMENT AND APPROVAL

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Acknowledgements

The Department of Forests and Park Services extends its deepest gratitude to the International Centre for Integrated Mountain Development (ICIMOD) for its exemplary collaboration in developing the Natural Capital Accounting (NCA) guidelines for Protected Areas with pilot accounts on the Jigme Dorji National Park (JDNP). This initiative was generously supported, both technically and financially, by ICIMOD through the Himalayan Resilience Enabling Action Programme (HI-REAP), funded by the United Kingdom International Development.

We express our sincere thanks to Mr. Lobzang Dorji, former Director of Forests and Park Services, for his unwavering guidance and strategic vision. His leadership was crucial in steering this initiative and ensuring that the guidelines align with Bhutan's dedication to sustainable development and conservation.

We also acknowledge the Steering Committee for its continuous guidance and strategic direction. Special thanks also goes to the NCA Technical Working Group (TWG) members, whose expertise in this multidisciplinary assessment of Natural Capital was invaluable in shaping these guidelines. Their steadfast commitment to data collection, curation, and analysis paved the way for a comprehensive and accurate assessment. We particularly appreciate Mr. Arun Rai, Specialist, for his meticulous work in preparing and organising critical data on land use and land classification, which laid the foundation for this ecosystem assessment. The TWG members' dedication, coupled with active participation from multiple national-level stakeholders and leaders (thrizins, gups, mangmis, and tshongpas), and members of the local communities, including the Barshong community, has significantly enriched these guidelines. We also commend Mr. Dawa Zangpo, Principal Forest Officer, for his efforts in curating and analysing data on forest resource utilisation.

Our sincere gratitude goes to Mr. Wangchuk, Forest Officer at the JDNP, for his dedicated efforts in field data collection on non-timber forest products (NTFPs), sacred sites ("nyes"), and hot springs. His work has been crucial in documenting key aspects of the park's natural resources.

Our sincere thanks to Dr. Pema Wangda, Executive Director of Bhutan for Life for his critical review and Dasho Geley Norbu, Director General, National Land Commission for his guidance and encouragements. We are also thankful to the ICIMOD team of Dr. Bandana Shakya, Dr. Rajesh Kumar Rai, Dr. Tashi Dorji, Mr. Bibek Raj Sharma, Ms. Srabani Roy, and Mr. Ramesh Kathariya for their expert facilitation of various consultation sessions and their invaluable guidance throughout the NCA process. Special gratitude goes to Dr. Rajesh Rai for playing a pivotal role in introducing the concept of NCA and leading in-depth discussions on different aspects of Natural Capital accounts. The collective insights of the ICIMOD team have significantly enriched the development of the guidelines.

We also extend our sincere appreciation to Mr. Dago Retty (ICIMOD, Bhutan Desk Office) and Ms. Rekha Rasaily for their meticulous handling of all logistical arrangements for the consultation workshops and meetings. Their tireless efforts ensured the smooth coordination of these events, making it possible for all stakeholders to contribute effectively.

This collaborative effort between ICIMOD, the Steering Committee, the Technical Working Group, and consultation workshop participants, has been instrumental in the successful development of these NCA guidelines. We deeply appreciate their collective efforts and look forward to continued partnership as we work towards implementing sustainable resource management and conservation practices.

Abbreviations and acronyms

BNC	Black-Necked Crane
BFL	Bhutan for Life
CBD	Convention on Biological Diversity
DoA	Department of Agriculture
DoE	Department of Energy
DoECC	Department of Environment and Climate Change
DoFPS	Department of Forests and Park Services
DoGM	Department of Geology and Mines
DoI	Department of Immigration
DoL	Department of Livestock
DoT	Department of Tourism
DoW	Department of Water
dSPHs	degraded Service Provisioning Hotspots
EA	Ecosystem Accounting
FAO	Food and Agriculture Organization
FIRMS	Forest Information and Resources Management System
FMID	Forest Monitoring and Information Division
FMRD	Forest Resource Management Division
FMU	Forest Management Unit
FRPMD	Forest Resources Planning and Management Division
GDP	Gross Domestic Product
GIS	Geographic Information System
GNH	Gross National Happiness
ITMS	Institute for Traditional Medicinal Services
IUCN	International Union for Conservation of Nature
JDNP	Jigme Dorji National Park
JKSNR	Jigme Khesar Strict Nature Reserve
LULC	Land Use and Land Cover
NCA	Natural Capital Accounting
NCD	Nature Conservation Division
NCHM	National Centre for Hydrology and Meteorology
NFI	National Forest Inventory
NLCS	National Land Commission Secretariat
NSB	National Statistics Bureau
NSSC	National Soil Services Centre
NWFP	Non-Wood Forest Product
NTFPs	Non-Timber Forest Products
OFS	Online Forestry Services
PAs	Protected Areas
PES	Payment for Ecosystem Services
PNP	Phrumsengla National Park
RSPN	Royal Society for Protection of Nature
RUSLE	Revised Universal Soil Loss Equation
SBAs	Service Beneficiary Areas
SC	Steering Committee
SDGs	Sustainable Development Goals
SEEA	System of Environmental-Economic Accounting
SNA	System of National Accounts
SPHs	Service Provisioning Hotspots
TEEB	The Economics of Ecosystems and Biodiversity
ToR	Terms of Reference
TWG	Technical Working Group
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change
UWIFORT	Ugyen Wangchuck Institute for Forestry Research and Training
WBH	White-Bellied Heron
WCNP	Wangchuck Centennial National Park
WWF	World Wide Fund for Nature

Foreword

The Department of Forests and Park Services (DoFPS) is committed to the conservation and sustainable management of Bhutan's forest ecosystems in order to ensure that our nation continues to flourish while safeguarding its natural heritage. With a mandate to maintain a minimum of 60 per cent forest cover in perpetuity, forests currently cover 69.71 per cent of the country. This includes Protected Areas and biological corridors which occupy over 52 per cent of the total land area of the country. This commitment has earned Bhutan its global reputation as the world's only carbon-negative nation, a status we aim to uphold as a beacon of environmental leadership.

In an era when sustainable management of natural resources is more than ever essential to human well-being and planetary health, Bhutan stands out as a model of visionary environmental stewardship. This success has to do with our visionary leader – His Majesty the King of Bhutan – our stable governance model, and our enduring pro-environment policies, all rooted in the guiding philosophy of Gross National Happiness.

The DoFPS recognises the growing importance of integrating ecological values into our economic and policy frameworks through Natural Capital Accounting (NCA). By embracing environmental-economic accounting, we aim to generate science-based evidence on the true value of Bhutan's vast natural resources. In line with this vision, the DoFPS has committed to developing Natural Capital Accounts for all Protected Areas and biological corridors under the Bhutan for Life initiative, a key deliverable in the nation's 13th Five-Year Plan.

In this regard, the development of NCA guidelines for the Jigme Dorji National Park (JDNP) marks a pivotal step, representing a significant advancement in integrating ecological values into our national planning and economic systems. This initiative also aligns seamlessly with Bhutan's Sustainable Development Goals and provides a model for other nations seeking to incorporate Natural Capital into policy and planning. By accurately valuing our natural assets, we will be ensuring that future generations inherit a nation that balances economic progress with environmental preservation.

We extend our sincere gratitude to the International Centre for Integrated Mountain Development (ICIMOD) and the Himalayan Resilience Enabling Action Programme (HI-REAP), funded by the United Kingdom International Development through its Foreign, Commonwealth & Development Office (FCDO), for their instrumental support in this initiative. Special thanks are also due to the ICIMOD team members for their technical expertise and facilitation.

We deeply appreciate the contributions from all stakeholders, including local communities, government leaders, and national authorities, whose active participation in the consultative meetings was invaluable. We also owe our indebtedness to the Steering Committee members for their strategic guidance and direction, and to the Interdisciplinary Technical Working Group for their unwavering dedication and collaboration.

As Bhutan continues to chart a path of leadership in global conservation and sustainable development, this NCA guide will serve as a foundational document for protecting our invaluable natural resources. It also reaffirms our national commitment to environmental stewardship and will ensure that Bhutan's Natural Capital is recognised, valued, and preserved for generations to come.

Karma Tenzin
Director
Department of Forests and Park Services

Executive summary

The Department of Forests and Park Services (DoFPS) of the Ministry of Energy and Natural Resources (MoENR) – by engaging wider agencies and stakeholders – has developed these **National guidelines for Natural Capital Accounting in Protected Areas**. The Jigme Dorji National Park (JDNP) serves as a pilot case and is part of these guidelines. This experimental case account also serves as a learning module for developing various kinds of such accounts.

Natural Capital Accounting, or NCA, is a systematic process to measure and keep track of the natural resources and services provided by ecosystems in a specific area, such as a country or a region. It helps us see nature as an important asset that must be protected and managed responsibly – with its contributions integrated into the economy and societal well-being.

NCA is increasingly recognised in the global conservation agenda, especially in relation to climate change, biodiversity loss, and degradation of ecosystem services. NCA provides comprehensive statistics on natural resources and their conditions, thereby enabling an impetus for their sustained management. The System of Environmental-Economic Accounting (SEEA), adopted by the United Nations Statistical Commission in 2012, serves as the global framework for NCA.

The types of SEEA Ecosystem Accounts include: i) Assets Account that measures the stock of natural resources, such as forests, water bodies, and minerals in terms of their quantity, quality, and changes over time; ii) Ecosystem Extent Account that tracks changes in the size and types of ecosystems over time, such as the extent of forests, wetlands, and grasslands; iii) Ecosystem Condition Account that assesses the health and function of ecosystems using indicators such as the quality of biodiversity, soil, and water; iv) Ecosystem Services Account that quantifies the flow and economic value of ecosystem services, such as carbon sequestration, water purification, and recreation; and v) Monetary Account that converts physical measures of Natural Capital into monetary terms, highlighting the economic value of natural resources (assets) and ecosystem services.

The Protected Areas (PAs) network in Bhutan covers over 52 per cent of the country and is vital for maintaining ecological balance, supporting livelihoods, and fostering sustainable development. Bhutan's PA network comprises five national parks, four wildlife sanctuaries, one strict nature reserve, one botanical park, and nine biological corridors. The evolution of Bhutan's PA system represents a globally significant landscape conservation model.

NCA quantifies the economic contributions of Bhutan's PAs, including in terms of critical services like water regulation, carbon sequestration, and biodiversity conservation, thereby making the value of PAs visible in the System of National Accounts (SNA). By valuing Natural

Capital, NCA informs more efficient and equitable allocation of resources, thereby guiding investments in areas where ecosystem services are most vital to the economy and local livelihoods.

NCA highlights the direct economic and social benefits of PAs for local communities, thus promoting inclusive and community-based approaches to conservation; this enhances livelihoods and strengthens conservation efforts.

Importantly, NCA strengthens Bhutan's ability to meet international commitments, such as the Sustainable Development Goals (SDGs), by systematically accounting for Natural Capital contributions to economic growth, poverty reduction, and environmental sustainability.

The development of the guidelines for NCA for PAs was a participatory and inclusive process, engaging a wide range of stakeholders to ensure that the approach was meaningful, context-specific, and aligned with Bhutan's commitments to conservation and global contribution as a carbon-negative country.

A critical step in the NCA process was mapping the available data and assessing its relevance for environmental accounting. Realising that the data was scattered across different government departments and that their validation for quality would necessitate the engagement of experts from various departments, an interdisciplinary Technical Working Group (TWG) was formed comprising members from various bodies such as the DoFPS, the National Land Commission, the Department of Agriculture, the Department of Livestock, the Department of Water, the Department of Tourism, the National Soil Service Center, and the National Statistics Bureau. The TWG was responsible for driving the technical work, while a Steering Committee (SC) consisting of directors and directors general from relevant departments was established to provide strategic oversight. The national NCA guidelines outline the roles and responsibilities of these institutional mechanisms.

NCA for the PAs aligns with Bhutan's unique Gross National Happiness (GNH) vision, which integrates sustainable growth, social well-being, and environmental stewardship. It also supports the country's 13th Five-Year Plan by recognising the immense value of Bhutan's rich natural resources and integrating this value into national economic planning. The guidelines have been based on the standards set by the SEEA framework to ensure that they meet international benchmarks for environmental and economic data integration.

An experimental accounting exercise for the JDNP revealed that the total annual flow of ecosystem services was valued at Nu 1,043 million (USD 12.42 million) in 2017 and Nu 1,066 million (USD 12.70 million) in 2023. The largest contributor was non-wood forest products, which accounted for 53 per cent of the total value in 2017, and for 39 per cent in 2023. These preliminary results underscore the significant role of PAs in Bhutan's economy and highlight the value of expanding NCA to cover all 11 PAs and nine biological corridors.

1.Introduction

These guidelines on Natural Capital Accounting (NCA) for Bhutan's Protected Areas (PAs) aim to quantify the value of the country's rich landscape assets, ecosystems, and ecosystem services within its 11 PAs and nine biological corridors. By providing a structured approach to the valuation of natural resources, Bhutan reinforces the importance of conserving and sustainably managing these areas. The NCA exercise ensures that Bhutan's PAs continue to deliver critical ecological functions and economic benefits for both the country and the global community. This initiative underscores Bhutan's commitment to preserving its natural heritage in order to ensure that future generations benefit from its unparalleled biodiversity and ecosystem services.

1.1 Purpose and scope

These guidelines offer a standardised methodology to assess and integrate the value of Bhutan's natural assets, ecosystems, and ecosystem services from its PAs into its System of National Accounts (SNA). They provide a framework for understanding the contribution of Natural Capital from the PAs to the economy and can guide sustainable management decisions. The aim is to:

- Identify and classify natural assets within the PAs and assess their ecological and socio-economic importance at local, national, and international levels.
- Integrate environmental and economic data to evaluate the value of the PAs, thereby enhancing their mandate for conservation and sustainable development.
- Monitor and track the stocks of natural resources within the PAs, thereby enabling better resource management, sustainable use, and early detection of changes – depletion or growth.
- Quantify and value the ecosystem services provided by the PAs such as by way of carbon sequestration, water regulation, biodiversity conservation, and recreation, and determine their direct and indirect economic contributions.
- Assess and account for the costs associated with environmental degradation, pollution, and loss of ecosystem services within the PAs.

Scope of the guidelines

These guidelines apply to the PA network in Bhutan, which comprises PAs and biological corridors, represents diverse land-use patterns and ecosystems, delivers on a range of ecosystem services, and plays a critical role in biodiversity conservation and ecosystem services provisions. The guidelines cater to both annual and long-term monitoring of natural assets and ecosystem services within the PAs. In terms of their application and use, the data generated by applying the guidelines will inform national decisions on conservation, climate change adaptation and mitigation, and sustainable development, thus supporting strategic planning and programme development for the PAs.

1.2 Alignment with Bhutan's national priorities and international commitments

Bhutan is a global leader in redefining the concept of development by prioritising well-being and happiness of its citizens over conventional economic measures.

Unique approach to development: Instead of focusing solely on Gross Domestic Product (GDP), Bhutan introduced Gross National Happiness, a concept pioneered by His Majesty the Fourth King of Bhutan, Jigme Singye Wangchuck. Enshrined in the Constitution of the Kingdom of Bhutan in 2008, GNH emphasises holistic development that integrates social, cultural, and environmental well-being. Environmental conservation, one of the four pillars of GNH (the others being sustainable development, cultural preservation, and good governance), highlights the central role of NCA in integrating environmental sustainability into Bhutan's holistic vision. Globally, the United Nations reinforced this vision in 2011 through Resolution 65/309 (see: UN, 2013) which advocates for happiness and well-being as integral to development.

Bhutan's national commitments: Bhutan's 13th Five-Year Plan (2024–2029) aims to transform the country into a high-income GNH economy by 2034 by focusing on the interconnected pillars of people, progress, and prosperity. Central to this vision is the integration of NCA into national planning. The NCA exercise for the PAs ensures that Bhutan's natural resources and cultural heritage are conserved to secure long-term sustainability and prosperity for current and future generations.

Global framing for NCA: The System of Environmental-Economic Accounting (SEEA) is the international standard for environmental-economic accounting that broadens the traditional SNA by including the contributions of ecosystems and the environment to overall well-being. In 2012, Bhutan adopted the SEEA as its official national accounting framework to quantify the links between the environment and economy. Building on this, Bhutan's National Implementation Plan for SEEA (2024–2029) prioritises NCA for nine thematic areas, including water, forest, land, and biological resources. Following a phased approach, the plan allows for evidence-based decision-making, strategic resource allocation, and sustainable management practices related to the country's vital natural assets.

Bhutan for Life project: NCA aligns with Bhutan for Life's milestone 13, which aims to incorporate NCA and ecosystem service valuation for all the PAs and biological corridors in its management plans as well as in the national Five-Year Plan. This ensures that NCA can guide investments in conservation, thereby facilitating ecological compensation mechanisms, Payment for Ecosystem Services (PES), and green financing.

Innovating for a holistic economy: Bhutan has created a special administrative zone, the Gelephu Mindfulness City, as envisioned by His Majesty the Fourth King, to integrate economic growth with mindfulness, holistic living, and sustainability. The NCA exercise provides a crucial set of metrics to measure this city's ecological health, thereby enabling planners and policymakers to balance conservation and development effectively. Notably, the Gelephu Mindfulness City spans two PAs – the Royal Manas National Park and the Phibsoo Wildlife Sanctuary – where these guidelines can be applied to conduct NCA, maintain ecological integrity, and align Bhutan's broader well-being goals with the SDGs.

International commitments: NCA strengthens Bhutan's ability to meet international commitments such as the SDGs by systematically accounting for Natural Capital contributions to economic growth, poverty reduction, and environmental sustainability. It can provide robust data to track progress on targets around conservation and sustainable use, such as the targets of the Kunming-Montreal Global Biodiversity Framework. Likewise, NCA can delineate the role of the PAs in climate regulation and thus enhance Bhutan's credibility in global climate negotiations.

1.3 Relevance to the PA network

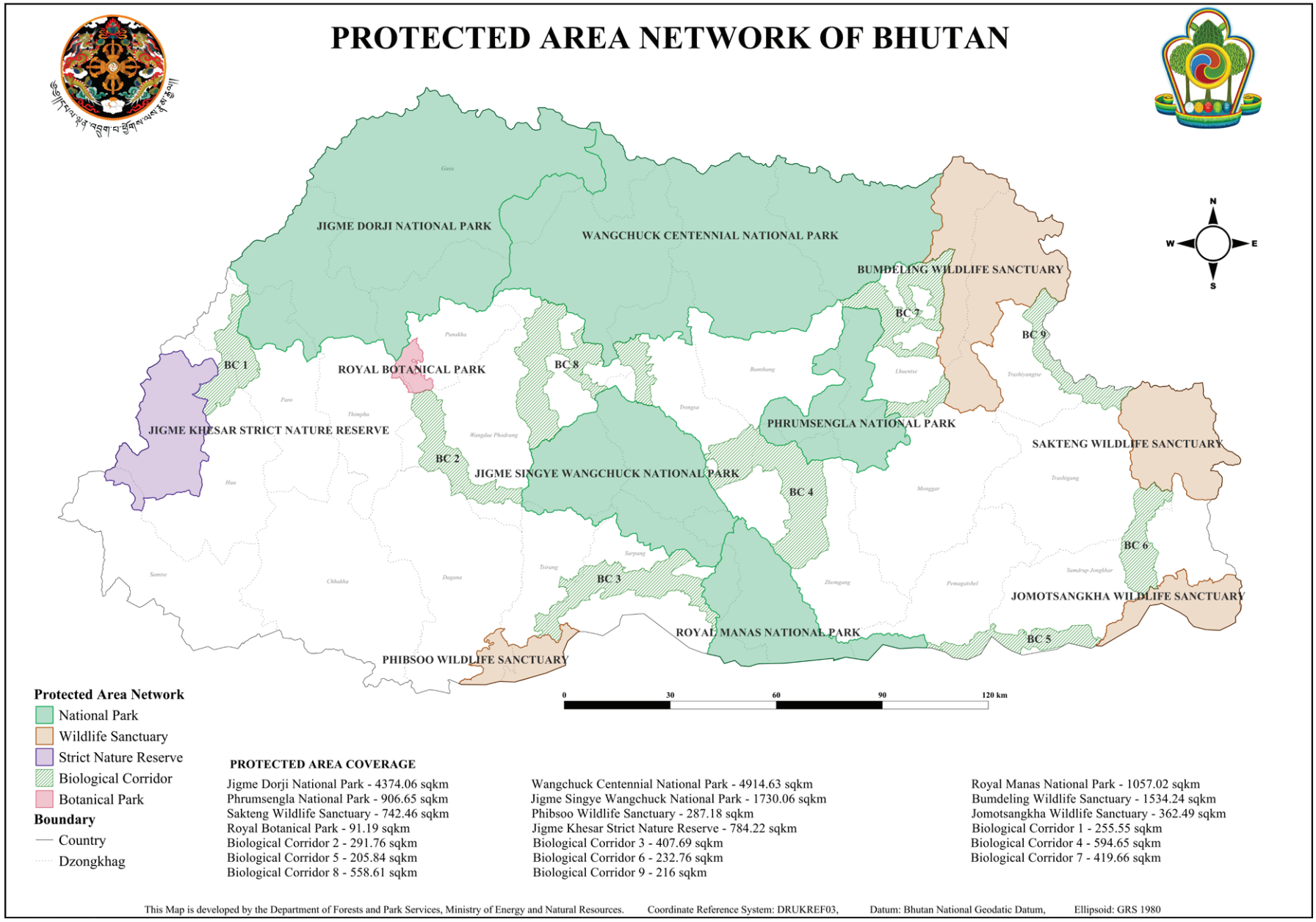
Bhutan's PAs and biological corridors (Figure 1) are globally acknowledged for their rich biodiversity and for the crucial ecosystems services they provide. However, despite half of the county's area of natural resources being protected, with the PAs contributing to a wide range of social and economic benefits, their true potential to support Bhutan in terms of its economy, climate resilience, and social well-being remain under-recognised.

Historical evolution

- **Humble beginnings:** Long before the formal PAs were established, small sacred groves and restricted spaces had been created to encourage environmental stewardship.
- **Formalising conservation (1974):** The year saw the Royal Government establishing PAs, including wildlife sanctuaries, national parks, forests, and game reserves.
- **Merging and redesigning (1983–1993):** During this period, the PAs were remapped wherein smaller regions were merged to create a more ecologically representative system.
- **Ideation for biological corridors (1996–1998):** The first nationwide survey of tigers spurred the creation of biological corridors and the expansion of the Bumdeling Wildlife Sanctuary and the Phrumsengla National Park.
- **Gift to the Earth (1999):** During the celebration of His Majesty the Fourth King's Silver Jubilee year in 1999, an additional 9 per cent of the country's land was declared as biological corridors, which also came to be known as Bhutan's Gift to the Earth.
- **Centenary celebrations (2008):** Bhutan honoured the centenary of the Wangchuck dynasty's reign by establishing the largest PA in the country – the Wangchuck Centennial National Park.
- **Strengthening the conservation network (2023):** During this year, Bhutan further expanded its conservation network with the creation of Biological Corridor 9 (BC9), which connects the Bomdeling Wildlife Sanctuary with the Sakteng Wildlife Sanctuary.

In the context of Bhutan's forward-looking conservation acts and policies, such as the Forest and Nature Conservation Act 2023, the country's PAs are now recognised as not just a national asset but a global one. By adopting the NCA system, Bhutan will be able to estimate the true value of its PAs and outline the country's contribution to global environmental well-being. Currently, ecosystem services valuation is being conducted in the PAs and biological corridors through the Bhutan for Life initiative which could form a part of the NCA assessment later.

Figure 1. The Protected Areas and biological corridors of Bhutan.



2. Natural Capital Accounting

2.1 What is Natural Capital?

Natural Capital refers to the world's stock of natural resources, including soil, air, water, and all living organisms. It provides a wide range of ecosystem services (flows) that are essential for human survival and well-being, such as clean air, water, food, and materials, as well as regulating services like climate regulation, carbon sequestration, and flood control. Natural Capital (stock) underpins economic activity, and its proper management ensures the sustainability of ecosystems and the flow of benefits for current and future generations.

2.2 What is Natural Capital Accounting?

Natural Capital Accounting is a systematic approach to measure and keep track of the natural resources and services provided by ecosystems in a specific area, such as a country or a region. It helps us to see nature as an important asset that must be protected and managed responsibly – with its contributions integrated into the economy and societal well-being. NCA bridges the gap between traditional economic indicators and the value of natural resources, thereby fostering a new way of thinking that recognises the environment as a critical component of national wealth.

The key features of NCA (Figure 2) focus on the need for a comprehensive approach to assessing Natural Capital, both in terms of its current stocks and flows of ecosystem services while also highlighting their integration into decision-making processes. The key terminologies around NCA excerpted from the global SEEA is given in Annexe I, and definitions of NCA are listed in Annexe II.

Figure 2. Key features of Natural Capital Accounting.

Focuses on quality and quantity of **stocks** of natural capital (both biotic and abiotic) and **flows** of benefits.	Assesses and compares how stocks and flows are **likely to change** in future.	Considers the **dependencies** of economic activities and their **impacts** on natural capital.
Uses qualitative, quantitative and monetary approaches to **estimate the value**, usefulness or worth.	Creates a series of interconnected physical and monetary **accounts.**	Makes links of the accounts to support **system-based thinking** and decision making.
Signals businesses and decision-makers on the **value** of natural assets.	Strengthens intersectoral innovations and impact **partnerships**.	**Monitors** losses and gains, pressure of economic actions on natural capital and investment requirement.

2.3 What are the different types of accounts?

In the System of Environmental-Economic Accounting, adopted by the United Nations Statistical Commission in 2012, there are two types of accounts (Figure 3). Among them, the account types are:

Assets Account: This measures the stock of natural resources, such as forests, water bodies, and minerals in terms of their quantity, quality, and changes over time.

Ecosystem Extent Account: This tracks changes in the size and types of ecosystems over time, such as the extent of forests, wetlands, and grasslands.

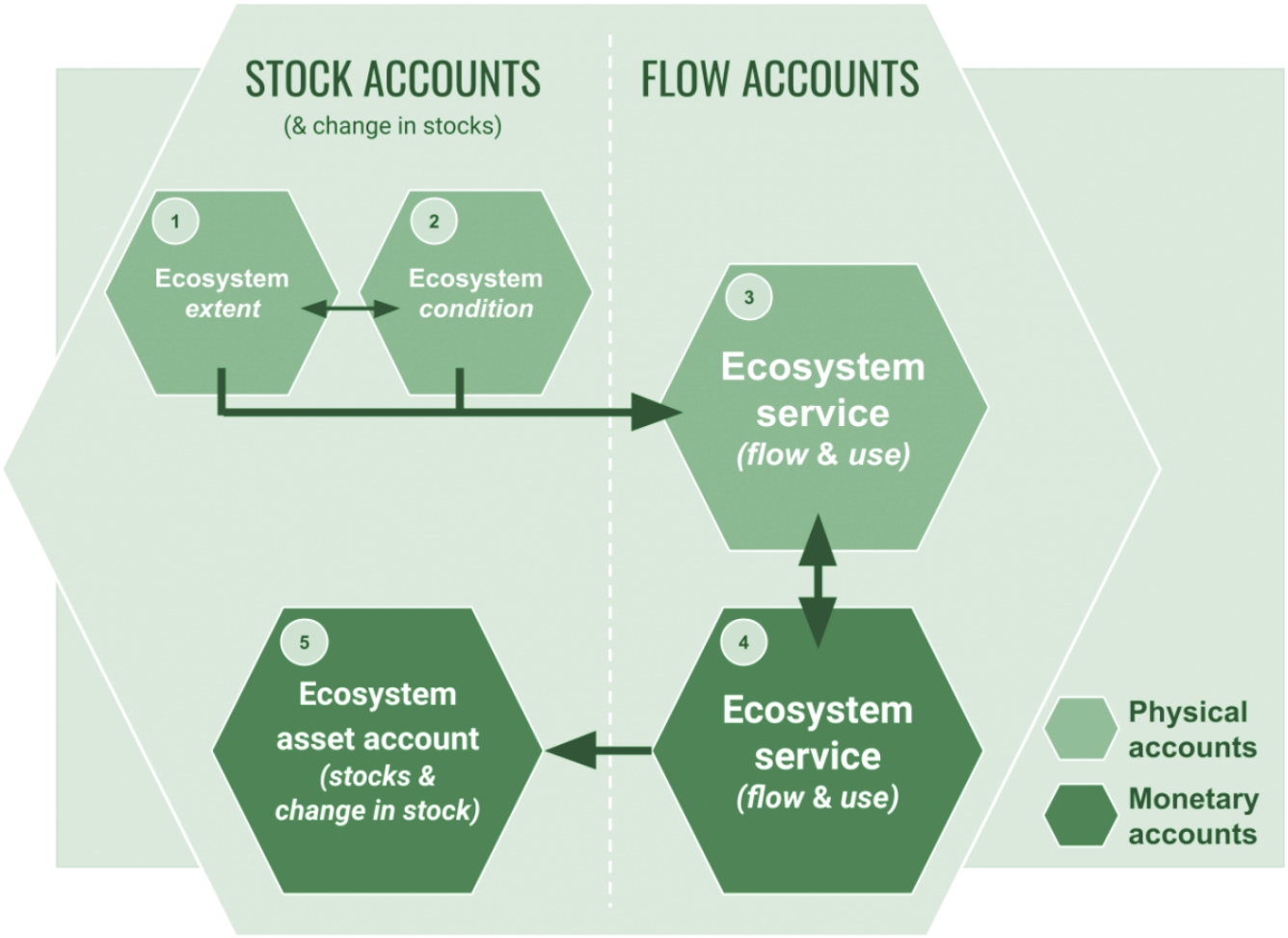
Ecosystem Condition Account: This assesses the health and function of ecosystems using indicators such as biodiversity and soil and water quality.

Ecosystem Services Account: This quantifies the flow and economic value of ecosystem services, such as carbon sequestration, water purification, and recreation.

Monetary Account: This converts physical measures of Natural Capital into monetary terms, highlighting the economic value of natural resources (assets) and ecosystem services.

(See Annexe III for an overview of the SEEA Framework.)

Figure 3. SEEA ecosystem accounts consist of stocks (assets) and flows (services). Both accounts may be recorded in either physical or monetary terms.



3. Methodology for conducting NCA

A structured methodology based on the UN's SEEA is adopted to assess and monitor the Natural Capital of PAs. This involves integrating biophysical data, ecosystem services valuation, and spatial mapping to generate a comprehensive view of ecosystem assets and service flows. Both primary data – such as from field surveys and remote sensing – and secondary data – including from national statistics and ecological models – should be combined to quantify the economic values of these assets and services in a consistent, reliable manner.

3.1 Defining the accounts

This involves classifying the ecosystems, identifying the indicators related to their condition and services, and quantifying the annual flow of these services. A participatory two-tier process is recommended to ensure inclusivity and robustness when establishing ecosystem service accounts:

- First, village-level consultations to capture local community insights into existing ecosystems, their services, observed trends, and dependencies.
- Second, landscape or PA-level consultations to build on the community insights to prioritise key assets, ecosystem services, and associated benefits.

Annexe IV elaborates on the different participatory tools that may be used during the consultative process.

Preparing the Ecosystem Extent Account

- Identify land-cover types and delineate boundaries of ecosystems (e.g. forests, wetlands, grasslands, agricultural land, built-up area) based on ecological and geographical criteria. It is not mandatory for ecosystems to be identical, as they may vary across different PAs.
- Apply nationally recognised classification systems, such as the IPCC (Intergovernmental Panel on Climate Change) land-use classification mechanism, for consistency,
- The extent of the area of an ecosystem is reported more than once; and this provides information on changes over time.
- Define ecosystem boundaries and classification (e.g. forests, grasslands, wetlands).

Preparing the Ecosystem Condition Account

- Identify the relevant indicators to measure the ecosystem's condition. These should align with social, economic, and ecological objectives.
- The state of the ecosystem condition could involve biodiversity metrics (species richness, abundance), carbon stocks, forest condition (crown cover, growing stock, regeneration), and soil and water quality parameters (see Annexe V).

Preparing the Ecosystem Services Account

- Physical Account: Measure the annual flow of the ecosystem services in physical units, such as cubic metres of timber and fuelwood harvested, tons of carbon sequestered, cubic metres of water purified, or hectares of habitat restored (see Annexe VI).
- Monetary Account: Assign monetary values to the ecosystem services by applying ecosystem service valuation methods.

3.2 Data collection

Mapping of data types and sources

- Conduct a national-level workshop with representatives from various agencies and departments responsible for managing data related to the identified ecosystems and ecosystem services (see Annexe VII).
- Prepare a list of the available data by linking it to the identified ecosystem components, services, and indicators. Mainly six types of data are required for NCA (see Annexe VIII).
- Identify primary data sources, such as government departments, research institutions, satellite imagery, field surveys, and community-based monitoring systems.
- Analyse the existing datasets to detect missing or incomplete information; in doing so, prioritise critical areas where data is needed for better understanding of ecosystem conditions and services.

Identification of tools and methods

- Use satellite imagery, Geographic Information System (GIS) tools, and remote sensing data to create spatially explicit maps of ecosystems and relevant ecosystem condition indicators.
- Carry out a survey to collect data on the quantification of ecosystem services used for domestic purposes.
- Use ecosystem valuation methods to monetise the identified ecosystem services, such as direct market valuation for provisioning services, travel cost method for recreational and cultural services, and cost-based approaches for regulatory services.

Standards for data quality, validation, and consistency checks

- Consolidate data from diverse sources into a unified database to ensure consistency and use it for ecosystem assessment.
- Employ triangulation by comparing data with secondary sources, expert reviews, and field observations to verify accuracy and reliability.
- Ensure that the data aligns with national standards like System for National Accounting and national SEEA.

3.3 Data analysis and reporting

Trends of change

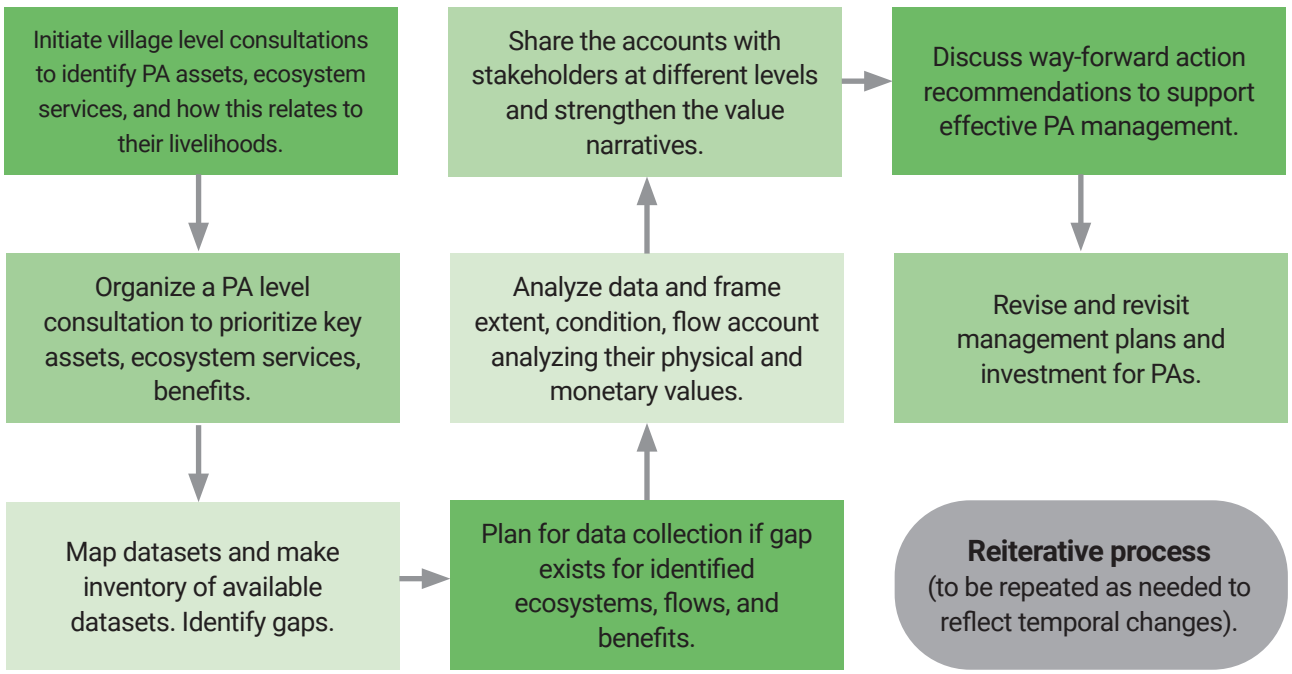
- Document and integrate trends in ecosystem extent and transitions over time, including on deforestation, urbanisation, and wetland degradation.
- Analyse and quantify the impacts of these changes on the availability and value of ecosystem services using historical and current data.
- Assess and examine the influence of socio-economic drivers, such as population growth, agricultural shifts, and industrialisation, on the ecosystem dynamics.
- Identify and evaluate the relationships between ecosystem changes and Natural Capital service delivery.
- Compare and correlate changes in ecosystem services with shifts in land use, resource utilisation, and demographic trends.
- Quantify and highlight the annual flow and economic value of ecosystem services to provide evidence for policymakers.

Informing the decision-makers

- Visualise and present data through graphs, maps, and trends to highlight changes and their implications for Natural Capital.
- Generate and report actionable insights to inform policies and management practices related to investments in conserving high-value ecosystems or restoring degraded ones, as well as explore incentive opportunities such as PES and fair compensation mechanisms to encourage conservation efforts.

A stepwise summary of the NCA process for PAs is given below:

Figure 4. The process of conducting NCA for PAs.



4. Institutional arrangements

Data sharing among agencies is the most important task in developing NCA. The National SEEA Implementation Plan recommended a SEEA Technical Group with clear terms of reference (ToR) to guide the compilation of the accounts. The guidelines emphasise on two tiers of institutional mechanisms: Steering/Advisory Committee (SC); and Technical Working Group (TWG).

4.1 Steering Committee (SC)

Composition

- Head of relevant departments and agencies.

Functions

- Ensuring interdepartmental coordination.
- Ensuring strategic alignment with national policies.
- Ensuring resource mobilisation for NCA.
- Providing oversight to the TWG.

The prospective ToR for SC members are presented in Annexe IX.

4.2 Technical Working Group (TWG)

Composition

- A multisectoral team involving governmental bodies related to forestry, environment, land, agriculture, water, finance, tourism, and statistics.

Functions

- Facilitating participatory stakeholder engagement.
- Facilitating PA officials' discussions on data validation.
- Collecting relevant data and facilitating data analysis and interpretation.
- Coordinating field research for new data if need be.

The prospective ToR for the Technical Working Group members are presented in Annexe X.

5. Foundations for effective NCA

Given below are basic requirements for ensuring the efficacy of the NCA exercise:

Formalisation of institutional arrangements: Hold regular meetings between the SC and the TWG to ensure coordinated and sustained efforts in conducting NCA. This may enable interdepartmental collaboration and contribution.

Mobilisation of resources to conduct NCA: Provide financial, technical, and human resources to support data collection, analysis, and reporting of environmental accounts.

Strengthening the capacity of the TWG and park officials: Provide targeted training and knowledge-sharing opportunities to enhance technical and operational skills. Provide mentorship and support to technical staff and partners in implementing NCA methodologies. Academic institutions can be engaged to transfer knowledge to university students and researchers.

Creation of awareness among local governments and communities: Conduct outreach and educational campaigns to help local governments and communities understand the importance and benefits of NCA, thereby triggering their proactive engagement.

Strengthening on-site data-recording systems for all PAs and biological corridors: Develop robust data-recording systems for consistent data collection. This will enhance the credibility of NCA data. Besides, comprehensive zone-wise data will help in developing an efficient park management strategy.

Creation of a national data repository and information system: Build a standardised database aligned with the SEEA implementation plan to facilitate data sharing and analysis across sectors and departments. Carry out data validation, particularly on the changes in ecosystem conditions. Prepare NCA briefs for each PA and present key findings and recommendations.

Integration of findings into the SNA: Ensure that insights from NCA are systematically incorporated into the SNA for policy relevance and impact.

Updating accounts on a regular basis: Establish a consistent schedule for revising and updating NCA datasets and reports to reflect changing conditions, and maintain their usefulness for decision-making.

Global outreach: Present the findings at the Conference of the Parties of the United Nations Framework Convention on Climate Change (UNFCCC) and at the Convention on Biological Diversity (CBD) to link up with global climate and biodiversity commitments.

6. An experimental account: Jigme Dorji National Park

JDNP, established in 1993, is Bhutan's second largest national park, encompassing a range of ecosystems from alpine meadows to subtropical forests. The JDNP stretches over 4,374 square kilometres and is one of the richest PAs in terms of cultural and biological diversity. The park is unique in terms of habitat overlap between the Royal Bengal tiger (*Panthera tigris tigris*) and the snow leopard (*Uncia uncia*). It is also the only park that is the habitat for all four of Bhutan's national symbols: tree – cypress (*Cupressus corneyana*); bird – raven (*Corvus corax*); flower – blue poppy (*Meconopsis grandis*); and animal – Bhutan takin (*Budorcas taxicolor whitei*). The park has the largest number of hot springs and medicinal baths, and also houses several spiritual sites like monasteries, dzongs, and nyes. The JDNP is divided into zones: Core; Buffer; Multiple Use; and Transition. Each of them has specific roles in conservation and resource management.

Objectives

The key objectives of this NCA were as follows:

- To assess the identified ecosystems within the JDNP, such as forests, cropland, grassland, settlements, wetland, and other types of land.
- To evaluate the condition of the ecosystems within the JDNP to detect any signs of degradation.
- To identify, quantify, and evaluate the flow of ecosystem services from this particular ecosystem that contributes to the economy and human well-being.
- To inform polices related to land use, biodiversity conservation, and sustainable resource management in the JDNP.
- To raise awareness among the stakeholders, including policymakers and local communities, on the value and potential of the JDNP in terms of biodiversity conservation and sustainable development, and generate adequate revenue for its management.
- To create opportunity for future research to update Natural Capital data and information from the JDNP.

Methodology

The NCA exercise for the JDNP involved consultations with villagers and local leaders, as well as national-level consultations. A village-level consultation was held at Barshong in Naro block. The objective was to engage with the local communities (women, men, youth, and the elderly) and the local administrative heads (gups and tshogpas) and co-understand the value of the JDNP. Participatory and appreciative inquiry methods were used to bring out valuable insights, voices, experiences, and aspirations of the local communities. The consultation threw light on the community perceptions of the JDNP's value in terms of geophysical, ecological, and cultural assets, as well as diverse services and benefits from these assets and ecosystems. During the discussions, residents of three chewogs (electoral precincts) shared their opinions on the diverse values of the park and explained how these values were intricately linked to their daily lives and livelihoods.

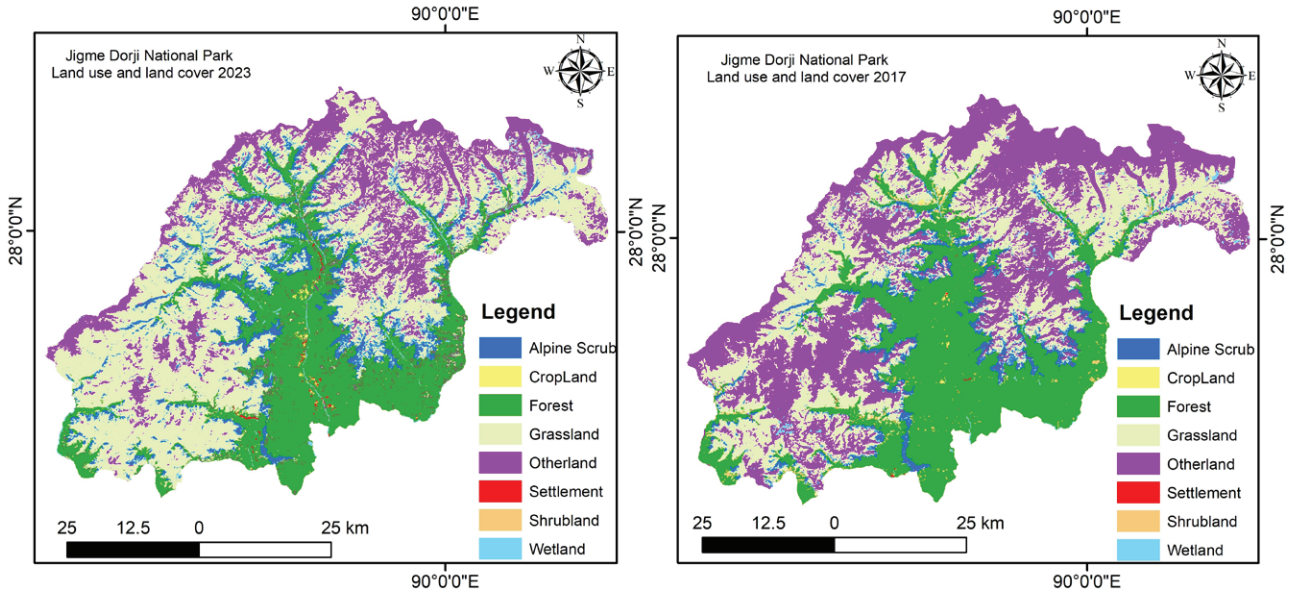
The local leaders' consultation was held in Paro. The objective was to facilitate sharing of knowledge and experience among the local leaders and garner collective insights, perspectives, and priorities for the JDNP's NCA. It was also to collectively identify the geophysical assets, ecosystems, ecosystem services, and flow of services, as well as beneficiaries.

The national-level consultation was held in Haa. The objective was to develop a collective understanding about NCA and its relevance for the PAs in the country. The consultation also dwelt on mapping datasets and the institutions that could contribute to the NCA exercise.

6.1 Ecosystem Extent Account

We focused on six primary ecosystem types – cropland, forest land, grassland, wetland, settlement, and other land – with each representing distinct ecological and land-use characteristics within the JDNP; this was based on the land-use and land-cover classification of the IPCC. These ecosystem types were chosen for analysis because of their ecological significance, the need for their sustainable management, and their role in supporting both biodiversity and livelihoods. We chose data from 2017 and 2023 (Figure 5) to understand the changes; this was essential for identifying the trends and potential threats to the integrity of the park's ecosystems.

Figure 5. Ecosystem Extent Account of the JDNP.



The Ecosystem Extent Account has reported on the changes in the ecosystem from 2017 to 2023 (Table 1).

Table 1: Extent of the JDNP's ecosystems in 2017 and 2023

Ecosystem	2017 (hectares)	2023 (hectares)	Change (hectares)
Cropland	668.90	1,090.65	+421.76
Forest land	111,644.51	110,531.90	-1,112.62
Grassland	138,021.45	195,047.67	+57,026.67
Settlement	128.26	218.59	+90.33
Wetland	3,247.72	2,575.40	-672.32
Other land	183,695.11	127,941.74	-55,753.37

Inference

- The cropland expanded at an annual rate of 70.29 hectares (ha). There is 965.40 ha of registered land in the park. Therefore, this increment is mainly due to the expansion of farming practice in the registered land.
- There was an increase in the settlement area at an annual rate of 15.05 ha during the reporting period.
- A substantial increase in grassland by 41 per cent, with an annual increment of 9,504.44 ha.
- Decrease in the extent of wetland (112 ha annually) and other types of land (9,292.23 ha annually).
- Forest land decreased by 0.99 per cent at an annual rate of 185.43 ha. This may have been due to forests being cleared for development activities. In 2023, 28 forest clearance permits were issued for infrastructure development in the form of roads and transmission lines.
- There are 11 monasteries, two dzongs, and five hot springs in the park. These sacred sites are important assets of the park (Figure 6).
- There are a number of tsamdros (rangelands) in the park. In 2023, they occupied 25,046 ha. Almost 50 per cent (12,007 ha) of them are in the multiple-use zone (Figure 7).

Figure 6. Location map of the cultural heritage sites in the JDNP.

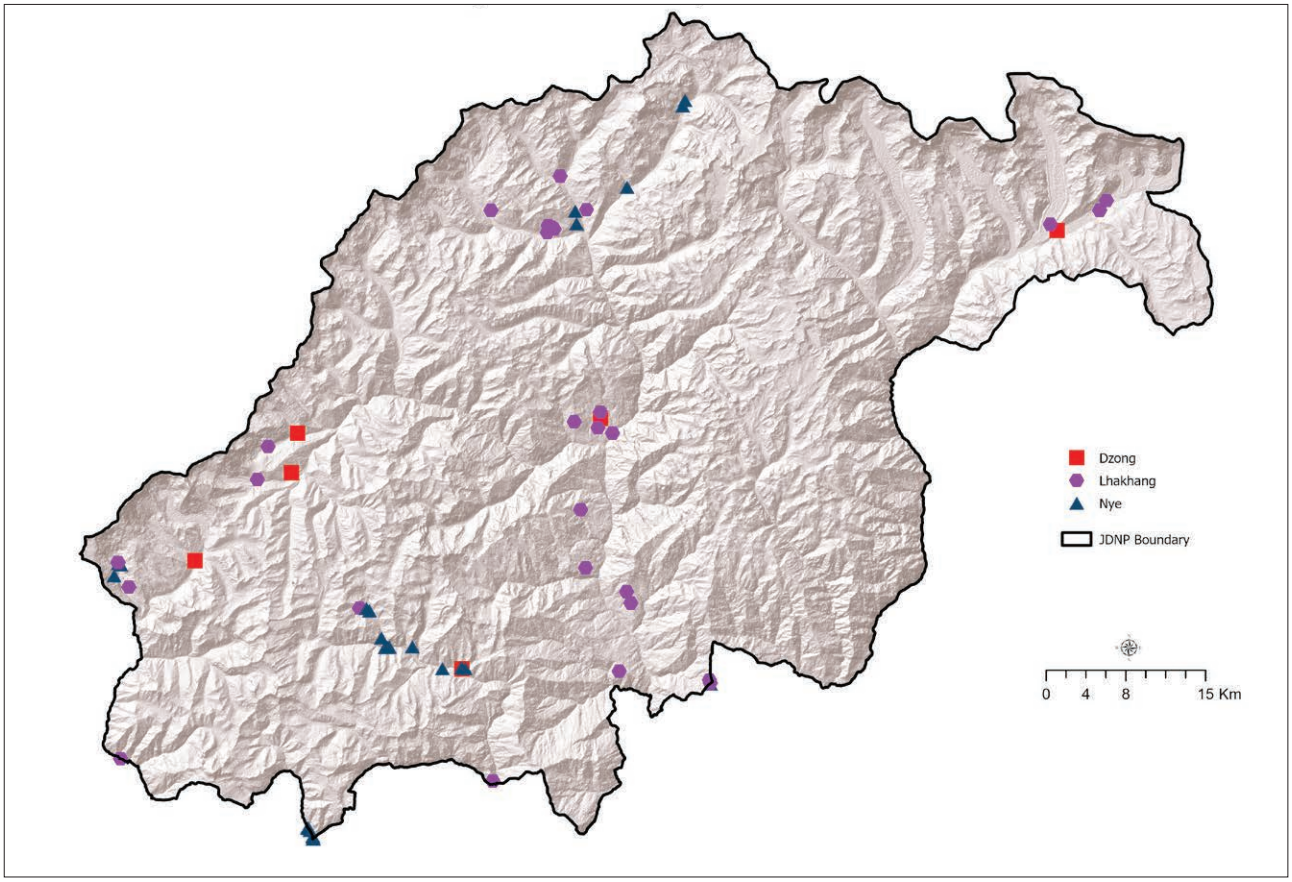
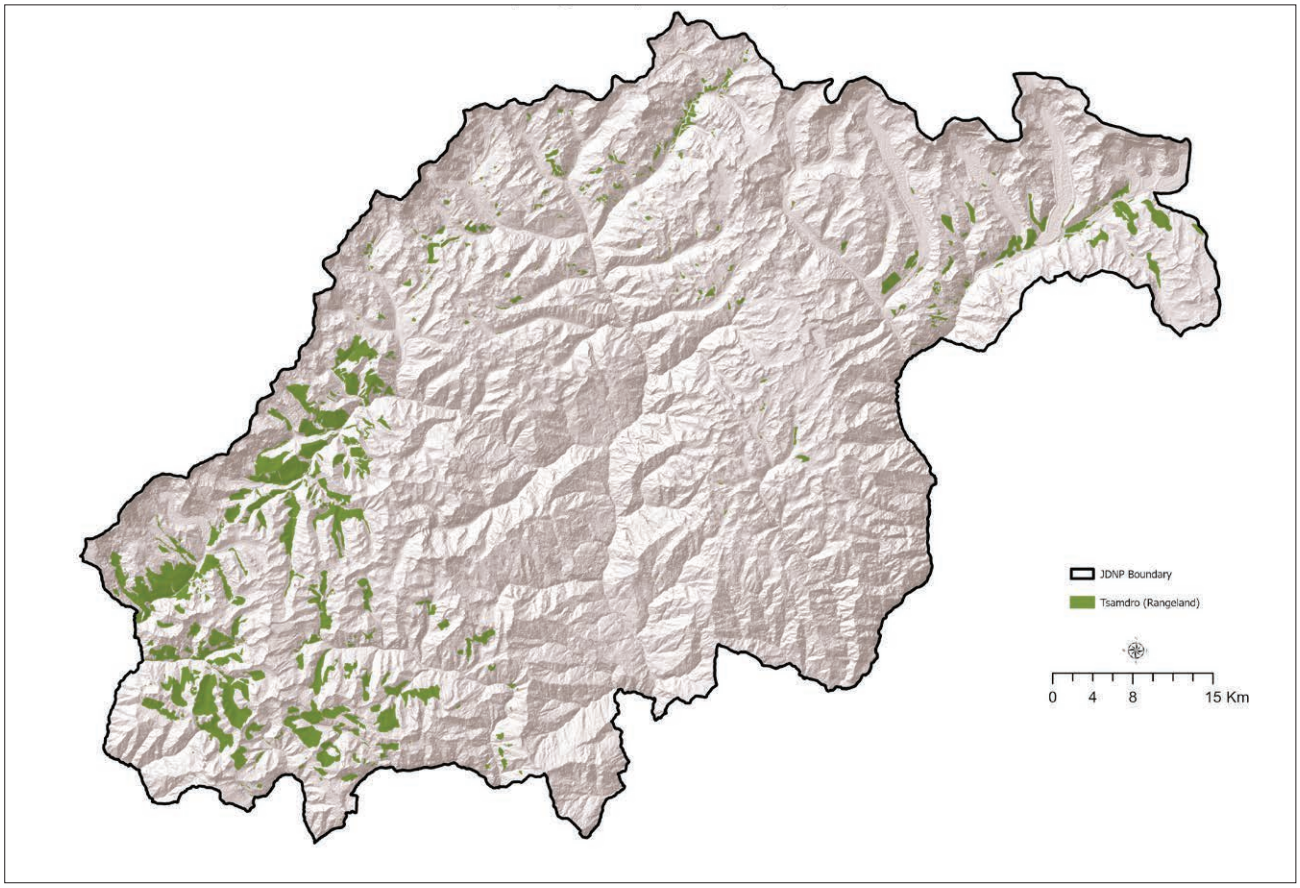


Figure 7. Distribution of tsamdros in the JDNP.



- A change analysis between the different ecosystems indicates that 73 per cent cropland, 94 per cent forest land, 87 per cent grassland, 15 per cent settlements, 27 per cent wetland, and 57 per cent other types of land remained intact (Table 2).
- Of the total land converted to cropland (602 ha), forest land comprises 46 per cent, followed by other types of land (33 per cent) and grassland (91 per cent).
- A total of 5,665 other ecosystems were converted to forest land. This was mainly other types of land (81 per cent) and grassland (18.5 per cent).
- Out of the 74,957 ha of new grassland, 98 per cent was converted from other land types. Similarly, the new land area has been dominated by conversion from grassland (71 per cent) and forest land (22 per cent).
- The converted wetland area (1,690 ha) has been dominated by other land types (63 per cent) and forest land (32 per cent). Similarly, out of the 199 ha of new settlement areas, 60 per cent was converted from forest land, followed by cropland (20 per cent) and other land types (12 per cent).

Zone-based analysis

- A zone-wise analysis of changes in the ecosystem extent between 2017 and 2023 shows that cropland was present only in the multiple-use zones, while there were no settlements in the transition zone (Table 3). The expansion of cropland from 2017–2023 was confined to the transition zone. All of this reflects the impact of conservation efforts to carry out activities as per the zonation.
- Deforestation occurred in the buffer and core zones. This indicates that infrastructure, particularly transmission lines, were being installed in these zones. However, forest land did expand in the multiple-use and transition zones. This may have to do with the conversion of cropland and grassland into forest land.
- Grassland was converted into forest land and cropland in the multiple-use zones, while other zones gained grassland during the reporting period. The settlements decreased in the core zone, while it expanded in the multiple-use and buffer zones. There were no settlements in the transition zone.
- Except for the transition zone, all the other zones gained in wetland, while the multiple-use zones gained by way of other types of land.

Table 2: Change in the extent of the ecosystems

		Ecosystem Extent 2023 (hectares)						
Ecosystem Extent 2017		**Cropland**	**Forests**	**Grassland**	**Settlement**	**Wetland**	**Other land**	**Total**
	Cropland	487.78	44.92	77.63	39.13	1.70	17.73	668.90
	Forests	277.41	104,866	581.88	119.65	536.00	5,263.09	111,644.5
	Grassland	91.62	739.87	120,089.8	5.53	80.79	17,013.74	13,8021.4
	Settlement	30.55	36.96	7.31	19.36	2.41	31.67	128.26
	Wetland	3.65	227.58	474.15	11.07	885.37	1,645.89	3,247.72
	Other land	199.64	4,616	73,816.81	23.84	1,069.13	103,969.61	183,695.
	Total	**1,090.65**	**110,532**	**195,048**	**218.59**	**2,575**	**127,942**	**437,406**

Table 3: Zone-wise extent of the JDNP's ecosystems in 2017 and 2023

Zone	**Land Use and Land Cover (LULC) 2017 (hectares)**					
	Forests	Cropland	Grassland	Settlement	Wetland	Other land
Buffer zone	13,165.42	0	25,739.21	7.85	272.50	11,940.13
Core zone	60,537.49	0	5,588.72	5.22	470.10	56,488.60
Multiple-use zone	37,433.78	668.90	32,215.84	115.19	871.85	13,959.45
Transition zone	507.82	0	74,477.68	0	1,633.28	101,306.93
Total	**111,644.5**	**668.9**	**138,021.4**	**128.26**	**3,247.7**	**183,695.1**
	LULC 2023					
Buffer zone	13,137.69	0	28,625.77	8.12	290.27	9,063.23
Core zone	59,213.50	0	14,338.43	3.60	659.60	48,875.00
Multiple-use zone	37,617.97	1,090.65	31,054.79	206.87	938.64	14,356.09
Transition zone	562.74	0	121,028.67	0	686.88	55,647.42
Total	**110,531.9**	**1,090.65**	**195,047.6**	**218.59**	**2,575.4**	**127,941.7**

6.2 Ecosystem Assets Account

The Ecosystem Assets Account for the JDNP provides a structured method for measuring and monitoring changes in the park's ecosystems over time. This process involves evaluating the extent of various ecosystem types – forest land, grassland, wetland, cropland, other types of land, and settlements – at two critical points: 2017 and 2023.

By establishing the opening stock for each ecosystem, tracking any additions or reductions in their areas, and calculating the closing stock for 2023, the accounts offer a detailed view of how these ecosystems have evolved (Table 4). This analysis reveals the impacts of natural processes and human activities, thereby aiding in the identification of trends and guiding future management strategies.

The primary goals of calculating the ecosystem assets of the JDNP were to accurately capture the park's ecological changes over time, evaluate the effects of management practices and external pressures, and guide future conservation efforts.

By documenting the opening stock, monitoring additions and reductions, and determining the closing stock for each ecosystem type, the accounts provide insights into how different ecosystems respond to various influences. This information is crucial for identifying areas needing immediate intervention, assessing the success of conservation actions, and making informed decisions to enhance the park's ecological resilience.

Opening stock

Forest land is the most extensive ecosystem type within the JDNP, and covered 26 per cent of the total park area in 2017. In the same year, the zone-wise proportions of this vast forest area were: 54 per cent – core zone; 12 per cent – buffer zone; 33.5 per cent – multiple-use zone; and 0.5 per cent – transition zone . The forest land of the park is characterised by diverse types – subtropical forest, warm temperate forest, cool temperate forest, subarctic/cold temperate forest, and rhododendron scrub.

The *grassland* ecosystem covered about 138,021 ha (32 per cent) of the park in 2017. These grasslands are vital for supporting herbivorous wildlife and domestic livestock, including yaks. Their zone-wise proportions in 2017 were: 54 per cent – transition zone; 23 per cent – multiple-use zone; 19 per cent – buffer zone; and 4 per cent – core zone.

Wetland areas, crucial for hydrological regulation and aquatic biodiversity, covered around 3,248 ha (1 per cent) of the park in 2017. Their zone-wise proportions were: 50 per cent – transition zone; 27 per cent – multiple-use zone; 14 per cent – core zone; and 8 per cent – buffer zone .

Cropland accounted for around 668 ha in 2017. It was predominantly located in the transition zone.

Other types of land, including barren areas and rocky outcrops, covered 42 per cent of the park area in 2017. In the same year, their zone-wise proportions were: 55 per cent – transition zone; 31 per cent – core zone; 8 per cent – multiple-use zone; and 6 per cent – buffer zone .

Settlements, comprising human habitations and administrative zones, have been minimal in the park, and these are primarily concentrated in the multiple-use zone where infrastructure development and community activities are prevalent.

Additions to stock (2017–2023) in ecosystem assets

Between 2017 and 2023, significant additions to ecosystem assets were observed across various types within the JDNP, reflecting the impact of targeted management practices and conservation initiatives.

Cropland experienced a significant addition during this period. It increased by 63 per cent in the multiple-use zone. The partition of land among families and governmental interventions to reduce human–wildlife conflict may have led to this increase in cropland.

Grassland areas saw an increase by 41 per cent. This may have been due to forest degradation wherein forests became grassland; the increase could be attributed to a classification issue between grassland and shrubland. Forest fires and fir dieback could also have triggered the change.

Settlement areas increased by 70 per cent during this period. This may have been due to the expansion of the road network and the division of family units.

Table 4: Assets and changes in different ecosystems

	Ecosystem Assets (hectares)					
	Cropland	Forests	Grassland	Settlement	Wetland	Other land
Opening stock of resources in 2017	689	111,644	138,021	128	3,247	183,695
Addition of stock to ecosystem assets (+)	421		57,026	90		
Reduction in stock (-)		1,112			672	55,753
Closing stock of resources in 2023	1,090	110,532	195,047	218	2,575	127,942

Reductions in stock (2017–2023) in ecosystem assets

Between 2017 and 2023, the JDNP experienced notable reductions in its ecosystem stock across several categories, reflecting the impacts of human activities and natural processes.

Forest land saw a reduction by around 1 per cent primarily due to deforestation caused by agricultural expansion, forest fires, and construction of infrastructure. In 2023, around 229.39 ha of forest area was cleared for several purposes, such as for transmission lines which saw the clearance of around 228.41 ha of forest area. It is important to note that while agriculture expansion into forest land is considered as encroachment, recultivation in registered drylands may not be considered as a factor behind forest degradation. This is an area that needs careful assessments.

Wetlands experienced a substantial decrease by about 21 per cent. This, again, could have been due to a classification issue – for instance, when wetlands are covered by snow in winter, they come under the category of other types of land.

Other types of land, which include barren land and rocky outcrops, decreased by 31 per cent. This reduction could be linked to natural changes and minor human interventions altering the extent of these non-vegetated areas. Again, a classification issue needs to be considered here.

Closing stock (2023) in ecosystem assets

By the end of 2023, the closing stock of the ecosystems in the JDNP revealed notable changes in the extent of various ecosystem types, reflecting the cumulative effects of conservation efforts, natural processes, and human activities during the period of 2017 to 2023. Grassland became the dominant ecosystem type, covering 45 per cent of the total park area, followed by other types of land (29 per cent), and forest land (25 per cent). The changes in the composition of cropland and settlements were minimal.

The closing stock shows a decrease in major ecosystem types such as forest land and wetland. This would mean that the park authorities have to develop an appropriate strategy and strictly implement it to maintain the JDNP's ecological integrity.

6.3 Ecosystem Condition Account

An Ecosystem Condition Account systematically documents and assesses the state of ecosystems within a defined area. It involves compiling data on various indicators/metrics that reflect the health, integrity, and functioning of ecosystems over time to detect changes in their condition (Table 5.). The indicators are ecosystem specific, with five practical criteria, such as validity, reliability, availability, simplicity, and compatibility (Czúcz et al., 2021).

Table 5: Ecosystem condition account of the JDNP in 2017 and 2023

Ecosystem	Condition indicators	Unit	Year 2017 (baseline)	Year 2023 (current)	Change
Forests	Forest patches	Number	1,199	1,269	+70
	Average patch size	ha	93.11	87.1	-6.01
	Forest patches <100 ha	Number	1,180	1,247	+67
	Proportion of area <100 ha patches	%	2.70%	2.80%	+0.10%
	Growing stock	m^3/ha	346	283.65	-62.35
	Regeneration	Number/ha	2,660	1,981	-679
	Crown cover (0–9%)	ha	979.74	1,348.68	+368.94
	Crown cover (10–39%)	ha	4,685.55	6,122.07	+1,436.52
	Crown cover (40–59%)	ha	7,906.15	9,916.88	+2,010.73
	Crown cover (60–69%)	ha	17,695.44	18,835.96	+1,140.52
	Crown cover (> 70%)	ha	79,262.73	72,473.83	-6,788.90
	Annual forest carbon stock growth rate	ton/ha	1.14	1.14	0
Agriculture**	Total cropped area	ha	249.88	269.34	+19.46
	Area sown more than once	ha	245.19	151.95	-93.24
	Total irrigated area	ha	102.26	95.12	-7.14
	Cropping intensity	Ratio	42.26	39.21	-3.06
	Crop diversity	Number	40	40	0

*** Total cropped area is the total area sown once or more than once in a particular year; the area is counted as many times as there are sowings in a year. Areas sown more than once are the areas on which crops are cultivated more than once during an agricultural year. The total area irrigated is the total area of crops irrigated once or more than once a year. It is counted as many times as the number of times the areas are cropped and irrigated in a year. Crop intensity is the ratio of the Gross Cropped Area to the Net Area Sown.*

Interpretation

- There were five events of fire from 2017 to 2024. Around 216.87 ha area was burnt, with a loss of 1,351.47 m^3 of timber. There was one event in 2018 in the Juniper-Rhododendron Scrub; two events in 2020 in the Chir Pine Forests; and two events in 2022 in Spruce Forest and Cool-Broadleaf Forest.
- Grassland was affected by the expansion of *Rumex* spp.*, Rhododendron* spp., *Berberis* spp., and *Pinus wallichiana*, as well of several bamboo species, due to a decrease in grazing activities and inadequate management interventions. There is a data gap regarding the area of grassland encroached by bushes.
- In 2021, there were 219 water sources used by 975 households, while 30 water sources dried up.
- According to the National Center for Hydrology and Meteorology (NCHM), there are 223 glacial lakes in the park, covering an area of around 25.23 km^2 (CSD/NCHM, 2021).
- The park has 1,434 species of vascular plants (with more than 200 species of medicinal plants), 50 mammals, 407 birds, 184 butterflies, 15 amphibians, 22 reptiles, 17 dragonflies and damselflies, and four wild bees (Dendhup et al., 2021).
- As per the park's management plan, there are 14 threatened species in the JDNP, including snow leopards, which number 31, and tigers, which number six (Dendhup et al., 2021).

6.4 Ecosystem Service Flow (Physical) Account

This account records the annual flow of ecosystem services from the relevant PAs (Table 6). In the case of the JDNP, the following considerations were made to calculate the flow and present the data:

- There are seven types of components in surface collection – aggregates, granular sub-base material, gravel, river bed materials, sand, stone, and stone chip. As their units are the same, the sum of their quantity is presented here.
- Non-wood plant-based forest products include incense, juniper leaf, large bamboo, pine needle, *Primula sikkimensis*, *Sarcococca hookeriana*, small bamboo, *Aconitum* spp., and wood burr. They are presented in lumpsum.
- In 2017, there were 826 international visitors to the park, while this number was 567 in 2023 (source: Nature Conservation Division). On an average, tourists spent 6.6 nights in Bhutan (Tourism Council of Bhutan, 2018).
- The production of forage in the park, including for horse riding services, was estimated from the livestock products (milk and meat). The data on the livestock population of the JDNP were compiled from *Livestock Statistics 2017* (12th Series) and the Integrated Agriculture and Livestock Census of Bhutan, 2023 (National Statistics Bureau, 2024).
- In terms of household drinking water, what was taken into account was the time spent daily to collect water, which was found to be 30 minutes during the period of 2017–2023 (*National Health Survey Report*, 2023).
- The agriculture production data was derived from the Integrated Agriculture and Livestock Census of Bhutan, 2023. Here, the value of four major crops (irrigated paddy, potato, garlic bulb, and barley) were reported individually. The remaining 36 crops were reported collectively as "other crops".
- Among the horse population, during the period of 2017–2023, 20 per cent of them were used as packhorses, while 5 per cent were used for riding. Only 1 per cent of cattle, including yak, were used for meat production during 2017–2023.
- There were 17,105 yaks – including 3,776 milch yaks – in 2017, and 13,598 yaks – including 3,475 milch yaks – in 2023. During the period of 2017–2023, the average annual milk production was 153 litres, while the average annual meat production from yak was 180 kg.
- In 2017, the average lactation yield of cattle was 584 kg, while it was 660 kg in 2023. The average annual meat production from cattle was 180 kg during 2017–2023.
- There were 3,851 horses in the park in 2017 and 5,227 in 2023. Horses are used for carrying goods and for riding. On an average, during 2017–2023, horses were used to carry goods for 30 days annually, and for riding, they were used for five days annually.
- There are negligible number of sheep and goats in the park. There were around 10 of them (seven sheep and three goats) in 2017, while there was only one goat in 2023.
- In 2023, the total area of paddy cultivation was 95.12 ha; for potato, it was 36.75 ha; for garlic bulb, it was 5.82 ha; and for barley, it was 39.27 ha. In 2022, paddy was cultivated in 102.26 ha, potato in 39.18 ha, barley in 47.68 ha, and garlic bulb in 2.87 ha.
- Two hydropower projects are under way in Punatsangchhu: PHPA I (of a capacity of 1,200 MW); and PHPA II (of a capacity of 1,020 MW). Respectively, they are estimated to consume 353.90 m^3/sec and 311.18 m^3/sec of water. But since they have not yet produced hydropower, their flow has not been accounted for in this NCA. These two projects are expected to generate 9,560 million units of electricity annually (Rai et. al. 2024).

Table 6: Annual physical flow of the ecosystem services in the JDNP

SN	Ecosystem services	Unit	2017	2023
1	**Timber**	m^3	2,182.20	4,806.80
2	**Non-wood forest products (NWFPs)**			
2.1	Fuelwood	m^3	3,284.00	9,758.91
2.2	*Ophiocordyceps*	kg	242.60	55.01
2.3	*Nardostachys* sp. (pangpoe)	kg	9,097	8,806
2.4	*Rhododendron* spp.	kg	12,710	20,885
2.5	Leaf mound	Truckload	17	7
2.6	*Neopicrorhiza* spp.	kg	100	1,285
2.7	Shilajit	kg	No data	73
2.8	Other plant-based NWFPs	Lumpsum	1,460	1,851
2.9	Carbon sequestration	tCO_2/year	127,274.74	126,006.37
2.10	Surface collection	Truckload	756.27	1,417
3	**Recreation (international tourists)**	Days spent	5,476.38	3,759.21
4	**Cultural services**			
4.1	Monasteries	Number of pilgrims	No data	36,792
4.2	Dzongs	Number of pilgrims	No data	3,024
4.3	Hot springs	Number of visitors	No data	146,000
5	**Water**			
5.1	Drinking water	Collection day	No data	22,242
6	**Agriculture**			
6.1	Irrigated paddy	kg	No data	354,750
6.2	Potato	kg	No data	312,390
6.3	Garlic bulb	kg	No data	13,579
6.4	Barley	kg	No data	33,033
6.5	Other crops	Kg	No data	191,468
7	**Livestock**			
7.1	Yak milk	Kg	577,728	531,675
7.2	Yak meat	Kg	30,789	24,300
7.3	Packhorses	Days	23,106	31,362
7.4	Horses for riding	Days	962	1,306
7.5	Cattle milk	Kg	1,226,984	985,380
7.6	Cattle meat	kg	3,782	2,687

Trends in ecosystem services flow

- The JDNP has applied the scientific thinning process to remove mature trees for the purpose of regeneration and improvement of overall forest health. This may have increased the production of timber and fuelwood during the reporting period. However, there was a decrease in the annual increment of carbon, probably due to forest fires.
- There was a sharp decrease in *Ophiocordyceps* collection. The collected quantity of 2023 was just 23 per cent of the 2017 collection. Local stakeholders relate the change to either market influence or decrease in the rate of collection.
- A clear picture could not emerge regarding the trend related to NWFPs. However, many of them reflected an increase. For a definitive assessment of the NWFPs, systematic data keeping and proper provision in the management plan are immediate requirements.
- Livestock number and production, too, showed a decreasing trend. Local stakeholders relate this change to factors like encroachment by unpalatable bushes affecting the rangeland ecosystem.
- The data from the year 2022 suggests a sharp decline in agricultural production and cropping intensity despite expansion in agricultural land. Local stakeholders relate the change to human–wildlife conflicts and labour shortages.

Data limitations

- The account of the flow of ecosystem services in this NCA was at the lower bound due to limitations in the availability of data. In addition, there was absence of data from 2017 for several services; this compromised a comparative study.
- Limited data, particularly on the flow of ecosystem services, could have led to an underestimation of the value of the ecosystem services provided by the JDNP. Especially because there were no data on the following: the number of domestic trekkers in the park; the actual expenses of international visitors, including airfare; and water consumption.
- The flow of ecosystem services of the different ecosystems could not be segregated as data were not kept accordingly. Therefore, the data presented here about the flow of ecosystem services do not reflect on individual ecosystems – they relate to the national park's entire ecosystem.
- The ecosystem services of the park were divided into seven broad categories: timber; NWFPs; recreation (international tourists); cultural services; water; agriculture; and livestock.

6.5 Ecosystem Services Flow (Monetary) Account

Considerations in the valuation

- For a few services, data from 2017 were not available. So, the annual Consumer Price Index (of the National Statistics Bureau) was used to estimate the value. The assumption was that there was no change in the flow of ecosystem services.
- The minimum wage rate of unskilled labour (Category V) was Nu 400 per day for the year 2023; earlier, it was Nu 215 per day (Ministry of Finance, notification of 22/11/2023).
- In 2017, the average daily expenditure of a tourist was USD 225. In 2023, it was USD 325 per day (USD 100 as Sustainable Development Fee plus USD 225 per person, apart from the package tour cost). In 2023, each international visitor had to also pay USD 40 as visa fee.
- Since the market price of timber and *Ophiocordyceps* vary according to the species and grade respectively, the average price was calculated based on the quantity and price of each species and grade.
- The water value of PHPA I and PHPA II was estimated from Rai et al. (2024). The total net annual benefit came to USD 152.2 million.
- According to Rai et al. (2024), these two hydropower projects generate a net benefit of USD 152.2 million annually. If we assume that only 50 per cent of the net benefits is attributable to water, then the annual value of water used for electricity generation amounts to Nu 6,316 million. This means a value of Nu 0.66 for per unit of electricity that is produced.

See table 7 provides estimated value of the annual flow of ecosystem services.

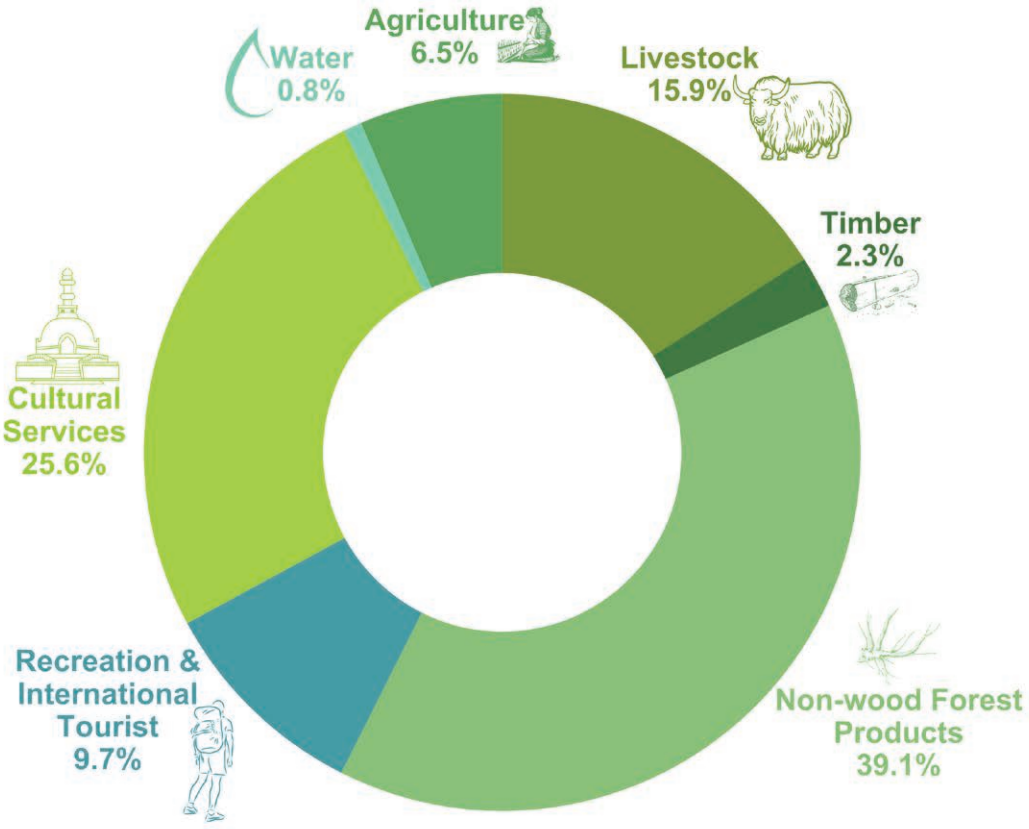
Table 7: Value of the annual flow of ecosystem services in the JDNP

SN	Ecosystem services	Value in 2017 (Nu)		Value in 2023 (Nu)	
		Price/Unit	Total Value	Price	Total Value
1	**Timber**	5,325.45	11,621,206	5,183.51	24,916,086
2	**NWFPs**				
2.1	Fuelwood	750	2,463,000	1,620.00	15,809,434
2.2	*Ophiocordyceps*	1,618,000	392,526,800	3,550,000	195,285,500
2.3	Nardostachys sp. (pangpoe)	498	4,530,306	498	4,385,388
2.4	*Rhododendron* spp.	22.85	290,423.50	22.85	477,222.25
2.5	Leaf mound	9,499	161,483	9,499	66,493
2.6	*Neopicrorhiza* spp.	1,203	120,300	1,203	1,545,855
2.7	Shilajit	2,000	0	2,000	146,000
2.8	Other plant-based NWFPs	23.63	34,500	7.28	13,477
2.9	Carbon sequestration	325	151,806,948	425	196,538,429
2.10	Surface collection	163.64	123,754	2,323.54	3,292,450
3	**Recreation (international tourists)**				
3.1	Daily expenses	14,625	80,092,058	26,975	101,404,690
3.2	Visa	2,600	2,147,600	3,320	1,882,440
4	**Cultural services**				
4.1	Monasteries		21,537,749	771.22	28,374,985
4.2	Dzongs		8,054,678	3,509.18	10,611,665
4.3	Hot springs		177,904,018	1,605.34	234,380,293
5	**Water**				
5.1	Drinking water	215	4,782,070	400	8,896,875
6	**Agriculture**				
6.1	Irrigated paddy		22,887,938	85	30,153,797
6.2	Potato		9,484,678	40	12,495,623
6.3	Garlic bulb		3,607,513	350	4,752,731
6.4	Barley		3,008,857	120	3,964,029
6.5	Other crops		13,208,820	90.88	17,402,008
7	**Livestock**				
7.1	Yak milk	75	43,329,600	100	53,167,500
7.2	Yak meat	500	15,394,500	800	19,440,000
7.3	Packhorses	500	11,553,000	1,000	31,362,000
7.4	Horses for riding	300	288,825	500	653,375
7.5	Cattle milk	50	61,349,200	65	64,049,700
7.6	Cattle meat	250	945,450	500	1,343,700
Total (Nu)			**1,043,225,275**		**1,066,811,745**

Value of the annual flow of ecosystem services

- In 2017, the value of the annual flow of ecosystem services from the park was Nu 1,043 million, while it was Nu 1,066 million in 2023. The value of the ecosystem services in 2023 was 28 times the budget (Nu 37.87 million) allocated for the park in the fiscal year 2023/24.
- NWFPs were the biggest contributor to the total value of the annual flow of ecosystem services; they contributed 53 per cent (Nu 552 million) in 2017 and 39 per cent (Nu 417 million) in 2023. Among the NWFPs, *Ophiocordyceps* contributed 71 per cent (Nu 392 million) in 2017 and 47 per cent (Nu 195 million) in 2023. As for the value of carbon sequestration, it accounted for 27 per cent (Nu 151 million) in 2017 and 47 per cent (Nu 196 million) in 2023 (Figure 8).
- Sacred places and hot springs were the second biggest contributors to the total value of the annual flow of ecosystem services. Collectively, they contributed 20 per cent (Nu 207 million) in 2017 and 26 per cent (Nu 273 million) in 2013.
- The value of forage production from the grasslands and forests in terms of livestock production contributed 13 per cent (Nu 132 million) in 2017 and 16 per cent (Nu 170 million) in 2023.
- Recreational value (international tourists) contributed 8 per cent (Nu 82 million) in 2017 and 10 per cent (Nu 103 million) in 2023 to the total value. This estimate included only visa fee, Sustainable Development Fee, and minimum daily expenditure.
- Agriculture contributed 5 per cent (Nu 52 million) to the total value in 2017 and 6 per cent (Nu 68 million) in 2023.
- The share of timber was 1 per cent in 2017 and 2 per cent in 2023. The value of drinking water, too, was minimal, with a contribution of 0.5 per cent in 2017 and 0.8 per cent in 2023.
- There was a decline, by 25 per cent, in the value of NWFPs; this was mainly due to a reduction, by 50 per cent, in *Ophiocordyceps* collection in 2023.

Figure 8. The distribution of the value of the annual flow of ecosystem services in 2023 (%).



6.6 Key messages

- The JDNP is witnessing gradual changes in land use, with slight shifts observed in forest, wetlands, croplands, and settlements. While these changes are not highly significant, the areas within the buffer and core zones are experiencing some pressure from infrastructure development. This calls for careful monitoring and adaptive management practices.
- Alongside deforestation, forest fragmentation is presenting challenges for biodiversity conservation. For instance, an increased number of forest patches, particularly of those with less than 100 ha area, and reduction in the average size of patches reflect habitat fragmentation.
- The trend of growing stock and regeneration of forests suggests that the scientific thinning programme has to be continued to improve forest production and productivity.
- Grasslands have been degrading over time, although there has been an extension of its area. This may be one of the causes behind reduction in the availability of *Ophiocordyceps*. Grassland degradation can also lead to reduction in livestock numbers.
- Despite cropland expanding, cropping intensity has decreased over time. This may be due to the excessive practice of monocropping; there is also labour shortage in agriculture.
- Despite the gradual decrease in budget allocation for the JDNP, there has been an increase in the value of the flow of ecosystem services. However, this is just a nominal value; therefore, there is a need to develop appropriate strategies to maintain the ecological integrity of the park, while balancing social needs and market demands.

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Annexes

Annexe I: Glossary of terms: Definitions of key terms and concepts

Ecosystems: Ecosystems are dynamic complexes consisting of plant, animal, and micro-organism communities interacting with their non-living environment as a functional unit. This interaction forms the foundation of ecosystem services that benefit people.

Ecosystem assets: Ecosystem assets refer to specific spatial areas that contain a combination of living (biotic) and non-living (abiotic) components working together as a functional whole. These assets are critical to maintaining the flow of ecosystem services.

Ecosystem condition: Ecosystem condition reflects the overall quality and health of an ecosystem asset. It encompasses various characteristics, such as biodiversity, productivity, and resilience, which determine the ability of an ecosystem to continue providing services.

Ecosystem extent: Ecosystem extent refers to the total area covered by each type of ecosystem within a specified geographic boundary. It is a key metric for ecosystem accounting, helping to assess changes in the size and distribution of ecosystems over time.

Ecosystem services: Ecosystem services are the benefits that people derive from ecosystems. According to the Millennium Ecosystem Assessment (2005), these services are categorised into four types:

- Supporting services: Services that are necessary for the production of all other ecosystem services, such as nutrient cycling and soil formation.
- Regulating services: Benefits obtained from the regulation of ecosystem processes, such as climate regulation, water purification, and pollination.
- Provisioning services: Products obtained from ecosystems, such as food, freshwater, and raw materials.
- Cultural services: Non-material benefits obtained from ecosystems, such as spiritual enrichment, recreation, and aesthetic experiences.

Ecosystem service flow: Ecosystem service flow refers to the annual provision of benefits that people receive from ecosystems. These flows capture both the quantity and quality of the services provided, reflecting the ongoing contribution of ecosystems to human well-being.

Ecosystem valuation: Ecosystem valuation is the economic process of assigning a value to an ecosystem or its services. This value can be expressed in monetary, biophysical, or other terms and helps in understanding the importance of ecosystems in economic and policy contexts.

Travel cost method: This is a technique used in ecosystem valuation, particularly for estimating the value of recreational benefits provided by ecosystems. It is based on the revealed preference approach, where the cost of travel to a site is used to infer the value that individuals place on the recreational experience.

Source: CBD, 2003; MA, 2005; UNSD, 2024

Annexe II: Natural Capital as defined by several institutions

Natural Capital is the value of everything that comes from nature –soil, air, water, and all living creatures. (**European Investment Bank**)

Natural Capital is an economic metaphor for the limited stocks of physical and biological resources found on earth, and for the limited capacity of ecosystems to provide ecosystem services. (**The Economics of Ecosystem and Biodiversity – TEEB)**

Natural Capital is another term for the stock of renewable and non-renewable resources (e.g. plants, animals, air, water, soils, minerals) that yield a flow of benefits to people. (**International Union for Conservation of Nature – IUCN**)

Natural Capital comprises Earth's natural assets (soil, air, water, flora, and fauna), and the ecosystem services resulting from them, which make human life possible. Ecosystem goods and services from Natural Capital underpin productivity and the global economy. (**United Nations Environment Program – UNEP)**

Natural Capital is the world's stock of natural assets on which human well-being ultimately depends. (**World Bank**)

Natural Capital is the world's stocks of natural assets, which include geology, soil, air, water and all living things. (**World Forum on Natural Capital)**

Natural Capital is a stock of resources, both biotic (i.e. communities of living organisms such as plants, animals, and micro-organisms) and abiotic (the non-living environment), some of which are renewable and others which are not (fossil fuels, minerals, and ores). (**World Wide Fund for Nature – WWF)**

Annexe III: Brief overview of the SEEA Framework

The System of Environmental-Economic Accounting is a framework that integrates environmental data with the System of National Accounts, ensuring that environmental and economic statistics are compatible and comparable. Adopted by the United Nations Statistical Commission in 2012, SEEA serves as the official framework for Natural Capital Accounting. The SEEA central framework focuses on three main areas:

- Environmental flows: These are the flows of natural resources, products, and waste between the environment and the economy, as well as within the economy. These flows are measured in both physical and monetary terms. Examples include timber and non-timber forest products, water usage for tourism and local communities, wildlife for ecotourism, waste from tourism and recreational activities, nutrient run-off from agriculture, and soil erosion and sediment deposition.
- Stocks of environmental assets: This refers to the measurement of individual environmental assets and how they change over time due to economic activities and natural processes. These assets, measured in physical and monetary terms, include forests, water resources, soil, rangelands, agricultural land, mountains, biodiversity, and more within Protected Areas.
- Economic activity related to the environment: This area focuses on the monetary flows associated with economic activities related to the environment. It includes spending on PA management and the production of environmental goods and services.

Meanwhile, SEEA-EA is composed of several accounts, including the Ecosystem Extent Account, Ecosystem Condition Account, Ecosystem Services Flow Account (in both physical and monetary terms), and supply and use tables. These accounts are integrated into a single, coherent system to provide a comprehensive view of the environment's role in the economy.

Annexe IV: Participatory tools to capture community and stakeholder perceptions

Tool 1. Creating a sense of value for a landscape

Ask communities to list different landscape elements, ecosystems, ecosystems services, challenges, opportunities, and policy priorities for a given PA.

Table 1: Sense of value of a landscape

Criteria		List (For example)	Add qualifier (For example)
Landscape assets Features such as mountains, rivers, cultural areas, sacred forests, ancient trade routes, and heritage areas that give a unique essence to a landscape		• Mountains, snow peaks	Name of the peak
Ecosystems Structural and functional units of biodiversity		Forests, pastures, woodlands, agricultural systems, wetlands, peatlands, marshes, rivers	
Ecosystem services	**Provisioning**	• Water, medicinal plants	
	Regulating	• Pollination, water filtration	
	Cultural	• Education, spiritual experience, recreation	
	Supporting	• Soil and nutrient recycling	
Challenges		• Biodiversity loss	
Opportunities		• Species conservation	
Policy priority		• Sustainable resource harvesting	

Alternatively, facilitators can also do participatory resource mapping. This will require drawing materials such as paper, crayons, and markers.

Tool 2. Linkage to local lives and livelihoods

Ask communities to identify the most important ecosystems that cater to them and then get them to describe how these landscape assets, ecosystems, ecosystem services, challenges, opportunities, and policy priorities are linked to environmental conservation, economic growth, and sociocultural objectives.

Table 2: Linkage to local lives and livelihoods

Score (2 = direct relevance; 1 = indirect relevance; and 0 = no relevance)

List of identified assets and services	Environmental value (EN) (Integral to nature)	Economic value (EC) (Integral to livelihoods)	Sociocultural value (SC) (Integral to culture)	Remarks	Total score
Example: Stupa	1	2	2	Very revered monastery; visitors come – requires entry fee, hence source of income	5
Landscape assets (lists)					
Ecosystem types (list)					
Ecosystem services					
Challenges					
Opportunities					
Policy priorities					

Tool 3. Identify drivers of change and their impact on landscape assets

Ask communities to identify the most critical ecosystems and services with regard to the impact of different drivers of change or challenges in the landscape.

Table 3: Drivers of change and their impact on landscape assets

Score (2 = high impact; 1 = weak impact; and 0 = no impact)

List of identified assets and services	Challenge 1	Challenge 2	Challenge 3	Remarks	Total score
Example: Stupa	Migration of local community	Heavy rainfall	Deforestation	Stupas are closely linked to people and their traditions and cultural practices	3
	2	1	0		
Landscape assets					
Ecosystem types (list)					
Ecosystem services					

Tool 4. Identify the most important ecosystems in terms of delivery of ecosystem services

Ask communities to identify the most important ecosystems in terms of the different services they are able to generate and deliver to the communities.

Table 4: Most important ecosystems

Score (1 = delivers the services; 0 = does not deliver the services)

List of identified ecosystem services	Ecosystem 1	Ecosystem 2	Ecosystem 3	Remarks	Total score
Example: medicinal plants	Rangeland 1	Forests 0	Marshes 1	Cordyceps and many other medicinal plants are found in rangelands and marshes, less in forest	2
Landscape assets					
Ecosystem types					
Ecosystem services					

Tool 5. Prioritise the most important ecosystems and ecosystem services using dependency and impact analysis

Ask communities to list all the ecosystems and ecosystem services and then in each column list the key actions that are being undertaken in the PAs.

Table 5: Prioritisation of the most important ecosystem services

Dependency scores (D): 2 = highly dependent; 1 = low dependence; 0 = not dependent
Impact score (I): 2 = direct or high impact; 1 = indirect or weak impact; 0 = no impact

	Forest management		Rangeland restoration		Ecotourism development		NTWP-based enterprise development		Culture preservation		Total score
	D	I	D	I	D	I	D	I	D	I	
Forests	2	2	1	1	2	1	2	1	1	1	14
Rangelands	0	1	2	2	2	1	2	1	2	2	15
Lakes	1	2	2	1	2	2	0	0	2	2	14
Medicinal plants, NWFPs	0	2	2	2	1	1	2	2	2	2	16
Water provisions	1	2	2	1	2	1	1	2	2	1	15

Tool 6. Prioritising by analysing supply and demand

Ecosystems directly or indirectly supply many services, and human society capitalises on them as per need and demand. A variety of provisioning, regulating, cultural, and supporting services serves as essential material basis for human society development. The value of a service increases as demand increases, and if the supply of services in high demand is insufficient, interventions are required on how to sustain the services to meet the demand. A high score for an ecosystem service indicates how that particular service relates to its current and future supply and demand, and also indicates how its values could be measured and quantified. It would make sense to assign greater value to those ecosystem services which will be in high demand in the future but whose supply in the future is expected to deteriorate. Also, we can correlate this with findings from Tool 5 to understand what decisions are likely to influence the supply and demand of a given ecosystem service.

Ask the PA managers to use the following scoring reference and fill in the table to prioritise the most important ecosystem services.

Table 6.1: Scoring to prioritise ecosystem services

Current supply	Future supply	Current demand	Future demand
2 = if supply is excellent 1 = if supply is deteriorating 0 = difficult to assess	2 = if supply will be high 1 = if supply will deteriorate 0= difficult to predict	2 = If demand is high 1 = if demand is low 0 = difficult to assess	2 = if demand will rise 1 = if demand will lessen 0 = difficult to assess

Table 6.2: Prioritisation of the most important ecosystem services

Ecosystem services	Supply (S)		Demand (D)		Remarks (in what way or for what purpose)	Total score
	Current	Future	Current	Future		
Example: Ecosystem service 1: Medicinal plant provisioning services	2	1	2	2	Good repository of medicinal plant provisioning services; however, since some of them are in high demand, they are unsustainably harvested, thereby compromising their supply in the future. Medicinal plants will continue to be a part of traditional medicines, so the demand will go up.	7
Ecosystem service 2						
Ecosystem service 3						
Ecosystem service 4						
Add other services						

Tool 7. Understanding the flow of services

Ask communities to identify the most important ecosystem services from the above list and using three pins of different colours, place them on a PA map:

- Service Provisioning Hotspots (SPHs) or the source of services (green pin)
- Service Beneficiary Areas (SBAs) or the sinks (yellow pin)
- Areas of degraded Service Provisioning Hotspots (dSPHs) (red pin)

The aim is to help PA officials realise the overlap between the source sink and the flow of services from source to sink. The inferences that could be drawn from the exercise are:

- Beneficiaries from several services are located beyond the boundaries of the JDNP.
- One area can be an SPH for many services and needs careful management attention.
- Several SPHs, SBAs, and dSPHs overlap, which calls for careful measures.
- Most SBAs are in the transition and multiple-use zones in the JDNP.

Annexe V: An example of ecosystem condition indicators

Ecosystem	Condition indicators	Unit	Base year	Current year	Change
Forests	Forest patches	Number			
	Average patch size	ha			
	Forest patches < 100 ha	Number			
	Proportion of area < 100 ha patches	%			
	Growing stock	m^3/ha			
	Regeneration	Number/ha			
	Crown cover (0–9%)	ha			
	Crown cover (10–39%)	ha			
	Crown cover (40–59%)	ha			
	Crown cover (60–69%)	ha			
	Crown cover (> 70%)	ha			
	Annual forest carbon stock growth rate	ton/ha			
Agriculture	Total cropped area	ha			
	Area sown more than once	ha			
	Total irrigated area	ha			
	Cropping intensity	Ratio			
	Crop diversity	Number			

Annexe VI: An example of ecosystem services (physical) account

SN	Ecosystem services	Unit	Base year	Current year
1	**Timber**	**m^3**		
2	**Non-wood forest products**			
2.1	Fuelwood	m^3		
2.2	Ophiocordyceps	kg		
2.3	Nardostachys sp. (pangpoe)	kg		
2.4	Rhododendron spp.	kg		
2.5	Leaf mound	Truckload		
2.6	Neopicrorhiza spp.	kg		
2.7	Shilajit	kg		
2.8	Other plant-based NWFPs	Lumpsum		
2.9	Carbon sequestration	tCO_2/year		
2.10	Surface collection	Truck-load		
3	**Recreation – international tourists**	**Day/s spent**		
4	**Cultural services**			
4.1	Monasteries	Number of pilgrims		
4.2	Dzongs	Number of pilgrims		
4.3	Hot springs	Number of visitors		
5	**Water**			
5.1	Drinking water	Collection time (day)		
6	**Agriculture**			
6.1	Irrigated paddy	kg		
6.2	Potato	kg		
6.3	Garlic bulb	kg		
6.4	Barley	kg		
6.5	Other crops	kg		

SN	Ecosystem services	Unit	Base year	Current year
7	Livestock			
7.1	Yak milk	kg		
7.2	Yak meat	kg		
7.3	Packhorse	Days		
7.4	Horse riding	Days		
7.5	Cattle milk	kg		
7.6	Cattle meat	Kg		

Annexe VII: Mapping of datasets and their sources

Objective

To identify the extent and types of dataset available in different institutions and sources. And to identify biophysical, socio-economic, spatial, and temporal variables, as well as data gaps.

Methodology

Organise multi-stakeholder consultations.

Key stakeholders

Technical experts from different government departments and representatives from academic and research institutions. Ensure equitable representation of women, youth, and interdisciplinary participation.

Key outputs

- Identification of data requirements
- Data availability, data sources, and gaps
- Data collection strategies and methods

NCA requires various types of datasets. It is efficient to use existing data rather than collecting new ones. The datasets of PAs for NCA, since PAs constitute a special thematic account, can be housed in different agencies.

Annexe VIII: Data sources

Natural Capital Accounting deals mainly with six types of data, focusing on the status of ecosystems, the flow of services they provide, their changes over time, and their monetary value.

Table 1: Data requirements for NCA

Type	Examples
Biophysical data	• Land-cover and land-use data • Soil quality and types • Biodiversity indices • Water quality and quantity
Ecosystem services data	• Provisioning services (e.g. timber, fuelwood, non-timber forest products) • Regulating services (e.g. carbon sequestration, flood protection) • Cultural services (e.g. recreational values, aesthetic benefits) • Supporting services (e.g. nutrient cycling)
Economic data	• Market prices of the natural resources • Values of the ecosystem services (market and non-market valuation)
Socio-demographic data	• Population distribution and density • Community dependence on the natural resources • Social and cultural values associated with the natural resources
Temporal data	• Time series data on resource extraction • Historical land-use changes • Trends in the ecosystem service provision
Spatial data	• GIS layers • Spatial distribution of the natural resources • Habitat and species distribution maps

Data collection methods

The data collection methods for NCA should align with national standards and best practices.

Table 2: Commonly used data collection methods

Data	Methods
Spatial data	Satellite imaging, GIS analysis, remote sensing, ground truthing
Biophysical data	Field inventories, soil and water sampling, flow measurements
Climate, air, hydrology, soil	Environmental monitoring stations, remote sensing, citizen science
Ecosystem services	Personal interviews, GIS, remote sensing
Ecosystem services valuation	Visitor interviews, travel cost method, opportunity cost, market prices

Data sources

Government agencies are the primary custodians of the essential data for NCA, but other valuable resources come from various sources, including:

- International organisations (e.g. UNEP, Food and Agriculture Organization – FAO)
- Universities and research institutes
- Scientific journals and NGO reports
- Corporate environmental reports
- Online data repositories and platforms

Any missing data can be collected through recognised methods to ensure comprehensive coverage. The existing data owners and their status are given in the table below:

Table 3 : Data availability and sources in Bhutan

Ecosystem type	Ecosystem services	Data source/document/ web portal	Agency	Data form	Remarks
Provisioning services	Commercial timber	Forest Information Reporting and Monitoring System (FIRMS)	DoFPS	Complete	Forest Management Unit (FMU) falling outside the PA boundary
	Rural timber	FIRMS	DoFPS	Complete	
	Timber (community forest)	Community Forest Management Plan	DoFPS		Missing data can be acquired from the respective offices
	Timber from private registered land	FIRMS	DoFPS	Complete	
	Commercial fuelwood	FIRMS	DoFPS	Complete	
	Rural fuelwood	FIRMS	DoFPS	Complete	
	Drinking water		Department of Public Health		
	Irrigation water		Engineering Division, Department of Agriculture		
	NWFPs	NWFPs Management Plan			
	Cordyceps	Certificate of Origin (CoO)	Marketing Department, DoFPS	Quantity	

Ecosystem type	Ecosystem services	Data source/document/ web portal	Agency	Data form	Remarks
	Medicines and aromatics	FIRMS – survey data on *Nardostacys* sp.; Jigme Khesar Strict Nature Reserve (JKSNR) JDNP, Wangchuck Centennial National Park (WCNP), Phrumsengla National Park (PNP)	DoFPS, Institute of Traditional Medicinal Services (ITSM)	Incomplete	List based on region (north and south)
	Food and vegetables			Incomplete	Edible wild vegetables
	Natural dyes	FIRMS	DoFPS	Incomplete	
	Fruits and nuts	FIRMS	DoFPS	Incomplete	Walnut
	Tubers	FIRMS	DoFPS	Incomplete	
	Insects	FIRMS	DoFPS		
	Ornamentals	FIRMS	DoFPS		
	Wood burs	FIRMS	DoFPS	Incomplete	
	Bamboo	FIRMS	DoFPS		
	Cane	FIRMS	DoFPS		
	Leaf litter	FIRMS	DoFPS		
	Leaf mould	FIRMS	DoFPS		
	Lemon grass	FIRMS	DoFPS		
	Pipla	FIRMS	DoFPS		
	Shilajit	FIRMS	DoFPS		
	Handicraft	FIRMS	DoFPS		
	Firewood	FIRMS	DoFPS		
	Daphne	FIRMS	DoFPS		
	Resins and extracted materials				
	Energy:	Energy master plan			
	Solar	Remote sensing data			
	Wind				
	Thermal				
	Hydrogen				
	Grazing	Tsamdro	Department of Livestock, National Land Commission		Area
	Mines and minerals		Department of Geology and Mines		
	Surface collection	FIRMS	DoFPS, Department of Geology and Mines		
	Apiculture				

Ecosystem type	Ecosystem services	Data source/document/ web portal	Agency	Data form	Remarks
Regulating services	Biodiversity				
	Carbon sequestration				
	Air quality				
	Niche species				
	Pollination				
	Disease/pest regulation				
	Soil erosion control regulation				
	Land management/ enrichment				
	Bioremediation				
	Climate refugia				
Cultural benefits	Ecotourism	Park permits (Online Forestry Services), respective division	DoFPS, Department of Immigration (DoI)		Park permit data available from 2023
	Eco trails	Respective division, route permit		Incomplete	Users will be difficult to track
	Spiritual/sacred sites	Singye dzong, Aja Ney (gewog data), Nub Tshonapata (3 years data, JKSNR)			
	Traditional healing				Tsachu, Menchu, Drupchu
	Recreational fishing	Fishing permit (OFS)	DoFPS		
	Birdwatching	Route permit, OFS (through permit)	Department of Tourism (DoT), DoI, DoFPS		
	Symbolic species	Nature Conservation Division (NCD), Royal Society for Protection of Nature (RSPN), White-bellied Heron (WBH), Black- necked Crane (BNC)	DoFPS		Survey of tiger, snow leopard, red panda, and elephant
	Camping sites		DoT		DoT has to identify and designate the area
	Rafting	Private companies, communities	DoT, private companies		
Supporting services	Soil formation				
	Nutrient recycling				
	Nutrient retention				
	Photosynthesis				
	Provisioning of habitats				

Ecosystem type	Ecosystem services	Data source/document/ web portal	Agency	Data form	Remarks
Ecosystem asset	Forests	National Forest Inventory (NFI)	DoFPS		
	Tree				
	Shrubs	LULC			
	Herbs	LULC			
	Grassland	NFI			
	Open meadows/Alpine scrub	LULC			
	Wetland	LULC			
	Biomass	NFI			
	Agriculture				
Other Natural Capital	Rainfall		NCHM		
	Festivals	International tourist's (Park permits)			
			Mushroom Festival (in Ura and Genekha), Royal Highland Festival, Bhutan Bird Festival, Rhododendron Flower Week, Black-necked Crane Festival (in Phobjikha Valley), Jomolhari Mountain Festival, Spring Festival, SnowmanRace, Winter Festival, Black Mountain Festival		
	Species diversity				
	Incense factory				
	Butterfly watching				
	Plantation	FIRMS			Afforestation, enrichment plantation, avenue plantation

Annexe IX: Prospective ToR for SC members

- Provide strategic direction and supervision for the NCA process.
- Ensure alignment with national and international policies and frameworks.
- Approve the scope, objectives, and deliverables of the NCA project.
- Suggest way-forward actions.
- Ensure intersectoral collaboration and support for the TWG.
- Make high-level decisions regarding the NCA process, including on resource allocation, timeline, and key methodologies.
- Approve major project milestones and deliverables, and new research for updating the accounts.
- Review and endorse final outputs and reports.
- Secure the necessary resources (financial, technical, and human) to support the NCA process.
- Identify and leverage funding opportunities from national and international sources.

Members of the Steering Committee (as of 2025)

Name	Designation	Office
Karma Tenzin	Director	Department of Forests and Park Services
Sonam Tenzin	Director General	National Statistics Bureau
Geley Norbu	Director General	National Land Commission Secretariat
Yonten Jamtsho	Director	Department of Agriculture
Lobzang Dorji	Director	Bhutan Standards Bureau
Sonam Tashi	Director	Department of Environment and Climate Change
Phuntsho Namgyal	Director	Department of Geology and Mines
Tashi Yangzom	Director	Department of Livestock
Dechen Yangdon	Director	Department of Water

Annexe X: Prospective ToR for TWG members

- Develop and refine methodologies for NCA and for new research to strengthen the accounts.
- Ensure that the methodologies are aligned with international standards and best practices.
- Address technical challenges and adjust methods to fit local contexts.
- Define data requirements and sources for NCA.
- Supervise the collection, validation, and management of data.
- Ensure data quality, consistency, and reliability.
- Provide technical guidance and support to the stakeholders involved in the NCA process.
- Conduct training and capacity-building workshops on NCA methodologies and tools.
- Analyse and interpret data to produce meaningful insights and results.
- Develop models and tools for scenario analysis and forecasting.
- Ensure the integration of physical and monetary accounts.
- Prepare technical reports, datasets, and documentation of methodologies.
- Ensure transparency and reproducibility of NCA results.
- Maintain comprehensive records of technical activities and findings.
- Implement quality assurance and control procedures for data and methodologies.
- Review and validate all technical outputs and deliverables.
- Conduct peer reviews and seek external validation as needed.

Members of the Technical Working Group (as of 2025)

Name	Designation	Office
Jigme Wangdi	Senior Specialist	Department of Livestock
Arun Rai	Specialist	FMID, DoFPS
Dawa Zangpo	Principal Forestry Officer	FMID, DoFPS
Rinchen Wangchuck	Deputy Chief Forestry Officer	UWIFoRT, DoFPS
Prakash Rai	Forestry Officer	UWIFoRT, DoFPS
Karma Chorten	Forestry Officer	Forest Resource Management Division (FRMD), DoFPS
Tshering Dorji	Forestry Officer	FRPMD, DoFPS
Phub Dorji	Forestry Officer	NCD, DOFPS
Sonam Lhaki	Forest Ranger	Thimphu Division, DoFPS
Chencho Tshering	Survey Engineer	National Land Commission
Kinzang Namgay	Deputy Chief Forestry Officer	Department of Water
Sangay Wangmo	Senior Livestock Health Supervisor	Department of Livestock
Dechen Pelzom	Statistical Investigator Assistant	National Statistics Bureau
Sangay	Principal Forestry Officer	UWIFoRT, DoFPS

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