System of Environmental Economic Accounting

REVIEW OF EXISTING ECOSYSTEM ACCOUNTING INTIATIVES AND LITERATURE IN INDIA:

BIOPHYSICAL ASSESSMENTS, ECONOMIC VALUE OF ECOSYTEM SERVICES, AND OVERVIEW OF AVAILABLE DATA SOURCES

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प्रगतेः मूलं प्रकृतिः

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Objectives and context

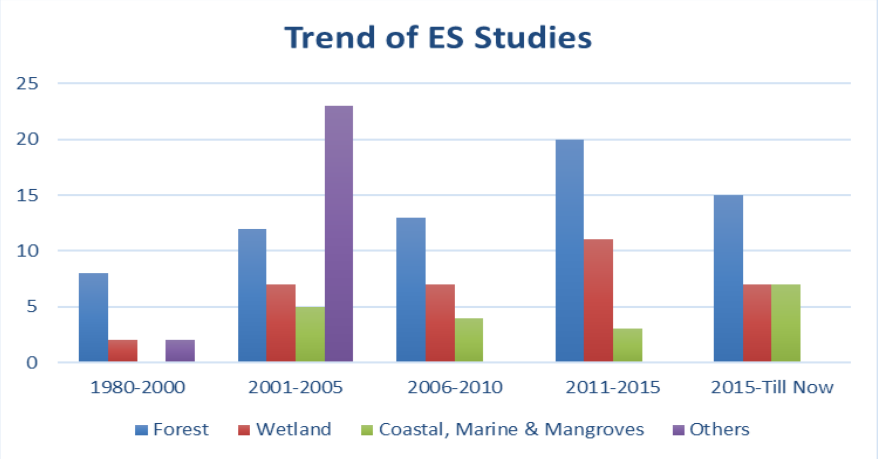
The study was conducted as part of the United Nations Statistics Division (UNSD), UN Environment, and the Secretariat of the Convention on Biological Diversity project "Natural Capital Accounting and Valuation of Ecosystem Services", a three-year partnership project funded by the European Union. Partner countries in the project are India, Brazil, China, South Africa and Mexico. Building on internationally agreed methodology (the System of Environmental – Economic Accounting, Experimental Ecosystem Accounting, in short SEEA EEA) and on the development of national competences, the project will initiate pilot testing of the SEEA EEA in partner countries to advance the knowledge agenda on natural capital accounting. The project's main objective in the partner countries is to mainstream natural capital accounting and valuation of ecosystem services in data-driven decision and policy making and is expected to influence policy-makers at the national, regional and local level. In this context, the project will review policy demands, data availability and measurement practices, in order to advance and mainstream Natural Capital Accounting in India.

The specific objectives of this report are: to review existing ecosystem accounting initiatives and literature in India; to stock-take available data sources for compiling ecosystem accounts; identify and engage institutions and agencies active in this field, understand their policy goals, map their interest in the field of ecosystem accounting, and identify their potential contributions to the SEEA EEA India project; to compile a list of potential case studies that may be undertaken and prioritize within those. The study includes possible avenues for cooperation with various stakeholders and collaboration that may be undertaken as part of SEEA-EEA India.

Review of Existing Initiatives, Literature and Data

Valuation of ecosystem services (ES) is a rapidly emerging field of study in India. There has been a surge in the number of valuation studies since 2000 (Figure 1).

Figure 1: Trend of Ecosystem Services Valuation Studies in India



This report reviews 146 ES studies conducted in India in the following categories:

i) terrestrial wetlands (34 studies);
ii) forests (68 studies);
iii) marine, coastal, mangroves, including coastal wetlands and marshlands (19 studies); and
iv) other ecosystems such as urban, agroecological ecosystems, etc. (25 studies).

Case studies

Based on the all India review of studies in the previous section, current data availability and capacity to use modelling frameworks, the report provides a comprehensive list of potential case studies that may be undertaken as part of SEEA-EEA India. The recommendations for the studies are based on the following nine selected criteria as stated below:

- Region
- Number of biomes
- Percentage of forest cover
- Unique ecosystems present in the state
- Replicability of accounts across states
- Openness of the state to this kind of work
- Presence and capacity of research institutes
- Spatial data availability
- Availability of earlier studies

All Indian states have been scored and selected based on the literature review, authors experience in previous assignments and experts' interviews. Based on a ranking matrix and literature review the a number of case studies are being proposed: A) State-Level Studies in Madhya Pradesh, Assam, Uttarakhand, Karnataka and Rajasthan; B) Primary Studies for Individual Ecosystem Services of Pollination; Gene Pool; Biological Control; and Gas Regulation; C) Study of Ecosystem Disservice of Alien Weed Invasion; and D) a Spatial Dimension Study on Urban Landscapes.

This assessment herewith provides an important input into the next stage of the NCAVES project in India.

ACKNOWLEDGEMENTS

At the very outset, the author expresses her gratitude to the United Nations Development Programme (UNDP) and United Nations Environment Programme (UNEP) for showing confidence in her by assigning such an important task to her and extending wholehearted support during the execution of the study. I am extremely grateful to Mr. Bram Edens, Senior Statistician, United Nations Statistics Division, New York for his constant guidance, literature support and valuable comments periodically which helped me immensely to refine the methodology and focus my approach on the study deliverables. I am also grateful to him for inviting me to the Forum of Experts in SEEA Experimental Ecosystem Accounting 2018 at Glen Cove, New York, USA during June 18-20, 2018 which gave me an excellent platform to understand SEEA-EEA Economic valuation and to have interaction with Environmental Accounting experts and brought me into the SEEA-EEA network from where I constantly update my knowledge.

I am deeply indebted to Ms. Kavita Sharma, Coordinator, National Studies, Sectoral Studies and Fundraising UNEP-TEEB Office Geneva, Switzerland for her constant interaction, useful inputs and organizing meetings with SEEA group members and Indian counterparts which has greatly helped me in shaping the report in a useful manner. I am also thankful to Dr. Bethana Jackson, Associate Professor and Programme Director, Geography School of Geography, Environment and Earth Sciences, Victoria University of Wellington, New Zealand for her interaction and relevant suggestions regarding data organization.

I deeply appreciate the help extended by Smt P. Bhanumati, Director, SSD, MoSPI and wish to put on record her invaluable insights facilitating study execution. I am also grateful to Shri Rakesh Kumar Maurya, Director, SSD, MoSPI for his valuable comments from time to time.

I am obliged to all the participants of the Landscape Assessment for UNSD Natural Capital Accounting and Valuation of Ecosystem Services in India work project meeting held at CSO, New Delhi on July 9, 2018 for their inputs to the midterm work presentation of this study. I am thankful to Shri Rajeev Lochan, Director-General, SSD, MoSPI for his inputs and wish to put on record the great help extended by Shri Rajesh Kumar, Joint Director, FSI, Dehradun for useful discussions and provisioning of forest related data.

Individual consultation meetings and key informant interviews were conducted with various experts to seek their advice on policy priorities and gap areas of research in ecosystem services valuation and accounting to provide us with a list of issues which need consideration in the study. In this regard, I am grateful to all those experts for taking time out from their busy schedules and accepting my request to have a discussion with them. The suggestions and policy questions provided by them are great inputs for overall recommendation of the study.

The author is extremely grateful to Shri C.K. Mishra, Secretary, Ministry of Environment, Forest and Climate Change, Government of India for his interaction, support and appreciation for undertaking such a beneficial study and his expectation that the Report will provide useful guidance to the MoEFCC for effecting SEEA-EEA in the country which would in turn help to achieve the goals of the Ministry in an effective manner.

I am deeply indebted to Dr. Tejinder Singh, the then Director, IIFM who encouraged me to undertake this assignment and also for his inputs for framing the policy questions. I am also thankful to the current Director, IIFM Dr. Pankaj Srivastava for his understanding and appreciation of the issues, his ideas and support.

The study would not have been accomplished in the manner in which it stands now, without the intense research carried out by Prabhakar Panda and Zuhail Thatey, Special Project Associates (SPAs) at CESM, IIFM, Bhopal. I am thankful for their enthusiasm and efforts in collation of numerous studies and their dedicated research contribution to the study. The author also wishes to put on record the assistance extended by Charu Tiwari and Sumit Anand, SPAs at CESM, IIFM in the literature review and collation of valuation studies.

To conclude, I once again extend my heartfelt thanks to all the individuals and their institutions who contributed their time and expertise to the realization of the objectives of the study.

(Madhu Verma)

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Place: Bhopal

LIST OF ABBREVIATIONS AND ACRONYMS

APU	Azim Premji University
ARIES	Artificial Intelligence for Ecosystem Services
ATREE	Ashoka Trust for Research in Ecology and the Environment
CAZRI	Central Arid Zone Research Institute
CBD	Convention on Biological Diversity
CEES	Centre for Economics, Environment and Society
CESM	Centre for Ecological Services Management
CEV	Corporate Ecosystem Valuation
CF	SEEA Central Framework
CLEV	Compensation for Loss of Ecological Value
CMDR	Centre for Multi-Disciplinary Development Research
CPCB	Central Pollution Control Board
CSO	Central Statistics Organization
CVM	Contingent Valuation Method
CWC	Central Water Commission
EERC	Environmental Economics Research Committee
EMCaB	Environmental Management Capacity Building
ENVIS	Environmental Information System
EP&L	Environmental Profit & Loss
EPM	Ecosystem Portfolio Model
ERS	Ecosystem Services Review
ES	Ecosystem Services
ESCAP	UN Economic and Social Commission for Asia and Pacific
ESR	Ecosystem Services Review
FAO	Food and Agricultural Organization
FC	Finance Commission
FRA	Forest Resource Accounting
FSC	Forest Stewardship Council
FSI	Forest Survey of India
GDP	Gross Domestic Product
GEF	Global Environmental Facility
GRI	Global Reporting Initiative
GSDP	Gross State Domestic Product
GSVA	Gross State Value Added
GTF	Global Tiger Forum
GVA	Gross Value Added
IBM	Incentive Based Mechanisms
IEG	Institute of Economic Growth
IIT	Indian Institute of Technology
InVEST	Integrated Valuation of Ecosystem Services and Tradeoffs
IPBES	Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services
IPCC	Intergovernmental Panel for Climate Change
ISEC	Institute for Social and Economic Change
ISFR	Indian State Forest Report
ISI	Indian Statistical Institute
ISRO	Indian Space Research Organization
ITTO	International Timber Trade Organization
JFMC	Joint Forest Management Committees
LEAD	Leadership for Environment and Development
LUCI	Land Utilization and Capability Indicator
MA	Millennium Assessment
MAI	Mean Annual Increment
MDF	Medium Density Forest
MEB	Multiple Evidence Based
MIMS	Multiscale Integrated Models of Ecosystem Services
MOEFCC	Ministry of Environment, Forest & Climate Change
NBT	National Biodiversity Targets
NCA	Natural Capital Accounting
NCC	National Capital Coalition
NCP	Nature's Contributions to People
NCR	National Capital Region
NCT	National Capital Territory
NGO	Non-Governmental Organization
NIPFP	National Institute of Public Finance & Policy
NPV	Net Present Value
NR5	Fifth National Report (NBT)
NSSO	National Sample Survey Office
NTCA	National Tiger Conservation Authority
NWFP	Non-Wood Forest Products
OF	Open Forests
PA	Protected Area
PES	Payment for Ecosystem Services
REDD+	Reduced Emissions from Deforestation and Forest Degradation
RSPM	Respirable Suspended Particulate Matter
SANDEE	South Asian Network for Development & Environmental Economics
SDG	Sustainable Development Goals

IGIDR	Indira Gandhi Institute of Development Research
IIASA	International Institute for Applied Systems Analysis
IIFM	Indian Institute of Forest Management
IIM-B	Indian Institute of Management-Bangalore
IIRC	The International Integrated Reporting Council
IISS	Indian Institute of Soil Science
SPM	Suspended Particulate Matter
TCM	Travel Cost Method
TEEB	The Economics of Ecosystem and Biodiversity
TEV	Total Economic Value
TIFAC	Technology Information Forecasting and Assessment Council
SEEA EEA	System of Environmental-Economic Accounting - Experimental Ecosystem Accounting
SNA	System of National Accounts
SolVES	Social Values for Ecosystem Services
SPCB	State Pollution Control Board
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNSD	United Nations Statistics Division
VDF	Very Dense Forest
WBCSD	World Business Council on Sustainable Development
WRI	World Resources Institute

UNITS

ha	Area in Hectares
kg	Weight in Kilograms
m^3	Volume in Cubic Metres
km^2	Area in Square Kilometres

Background of the Technical Review

The United Nations Statistics Division (UNSD), UN Environment, and the Secretariat of the Convention on Biological Diversity have launched the project "Natural Capital Accounting and Valuation of Ecosystem Services", a three-year partnership project funded by the European Union. Partner countries in the project are India, Brazil, China, South Africa and Mexico. Building on internationally agreed methodology (the System of Environmental – Economic Accounting, Experimental Ecosystem Accounting, in short SEEA EEA) and on the development of national competences, the project will initiate pilot testing of the SEEA EEA in partner countries to advance the knowledge agenda on natural capital accounting.

The project's main objective in the partner countries is to mainstream natural capital accounting and valuation of ecosystem services in data-driven decision and policy making and is expected to influence policy-makers at the national, regional and local level. In this context, the project will review policy demands, data availability and measurement practices, in order to advance and mainstream Natural Capital Accounting in India. It is expected that the following work streams will be carried out during the project implementation period:

- Pilot ecosystem accounts in India, which include the development of a national plan and the compilation of selected ecosystem accounts in physical and monetary terms based on policy priorities and its policy mainstreaming.
- Develop guidelines and methodology that contribute to the in-country implementation and global research agenda of the SEEA EEA.
- Develop an indicator set based on SEEA EEA in India in the context of the 2030 Sustainable Development Agenda, Aichi Targets or other international indicator initiatives.
- Develop a national communication and outreach strategy to raise awareness and value added SEEA EEA in India.
- Organize a national training workshop to enhance capacity and enlarge the community of practitioners on SEEA EEA.

To this end, UNSD and UN Environment are partnering with the Central Statistical Office (CSO), Ministry of Statistics and Programme Implementation, Government of India. A national inception mission was held in October 2017 in New Delhi to launch the project. As a first step, a landscape assessment will be conducted to develop a work plan, given the state of existing research on ecosystem accounting in India, and in line with priorities of CSO India.

To execute the landscape assessment work in India, the author was hired as a consultant to perform the following activities:

Activity 1: Review of existing ecosystem accounting initiatives and literature in India. This will include, but not be limited to, initiatives and research related to ecosystem services modelling in biophysical terms, ecosystem services valuation.

Activity 2: Stocktaking of data sources for compiling ecosystem accounts. This stocktaking exercise should cover i) traditional data sources (e.g. agriculture, environment and nature/biodiversity statistics), ii) maps (e.g. on land use/cover, hydrology, soil, digital elevation, roads and infrastructure etc.) as well as iii) the potential of remote sensing data sources (e.g. on characteristics such as land use/cover, carbon, precipitation, evapotranspiration, etc.) that may be useful for biophysical modelling on ecosystem services. The results of this stocktaking should be presented by the type of ecosystem service that could be informed (e.g. provisioning services of crops, non-timber forest resources, regulating services such as carbon sequestration and storage, coastal protection, water flow regulation, as well as cultural series such as recreation, amenity services, etc.). In addition, the list of data sources should also be organized by the type of ecosystem account (e.g. extent account, condition account, ecosystem service supply account, biodiversity account, water account, carbon account) as distinguished in the Technical Recommendations in support of Ecosystem Accounting.

Activity 3: Identify and engage institutions and agencies active in this field, understand their policy goals, map their interest in the field of ecosystem accounting, and identify their respective contributions to the SEEA EEA India project. In cooperation with CSO India, meet agencies and institutions active in this space. This may include, but not be limited to, the Ministry of Environment, GIZ India, ISRO, Dept. of Land Resources, Ministry of Agriculture & Farmers Welfare, and relevant universities/ academic institutions.

Activity 4: Under the leadership of CSO India draft the National Plan for Advancing Environmental-Economic and Ecosystem Accounting broadly covering the objectives, main initiatives, stakeholders and priorities. Specifically

1. Compile a comprehensive list of potential case studies (indication around 15 - 20) that may be undertaken in the context of the SEEA EEA in India, with a short description of area, type of service(s) being assessed, biophysical model used, policy issue that may be addressed
2. From this long list, prioritize two to three case studies for SEEA EEA India, taking into account factors such as data availability, policy relevance and clearly articulating the thematic and geographical scope of each of the case studies.
3. For each of the prioritized case studies, identify relevant stakeholders, partners, and data sources.
4. For each of these prioritized case studies, detail the policy questions being responded to by the compilation of ecosystem accounts, and map the relevant government agencies and departments with these policy questions.
5. For each of these case studies, identify the scope of ecosystem asset and flow accounts to be part of the physical and monetary accounts for India.
6. Develop a work programme to develop these accounts, including deliverables and timelines.

The undersigned in consultation with relevant experts at UNDP, UNSD, UNEP and CSO was expected to produce the following deliverables:

1. **Pursuant to Activity 1:** Review of existing ecosystem accounting initiatives and literature in India, including biophysical assessments, and economic valuation of ecosystem services
    a. Electronic submission of draft document providing a review of the above
2. **Pursuant to Activity 2:** Stocktaking of data sources for compiling ecosystem accounts
    a. Electronic submission of draft document presenting an overview of available data sources, organized by ecosystem service and type of account
3. **Pursuant to Activity 3:** Identify and engage institutions and agencies active in this field, understand their policy goals, map their interest in the field of ecosystem accounting, and identify their respective contributions to the SEEA EEA India project.
    a. Electronic submission of draft document presenting findings from meetings; names of people and institutions met; minutes of meetings; mapping of policy priorities, and possible avenues for their cooperation and contribution to SEEA EEA India project.
4. **Deliverable 4.** Under the leadership of CSO India draft the National Plan for Advancing Environmental-Economic and Ecosystem Accounting broadly covering the objectives, main initiatives, stakeholders and priorities.
    a. Electronic submission of final document including –
        i. Comprehensive list of potential case studies that may be undertaken as part of SEEA EEA India
        ii. Priority two-three case studies for SEEA EEA India, taking into account factors such as data availability and policy relevance, and clearly articulating the thematic and geographical scope of each of the case studies
        iii. For each of these case studies, identify relevant stakeholders, partners, and data sources
        iv. For each of these case studies, detail the policy questions being responded to by the compilation of ecosystem accounts, and map the relevant government agencies and departments with these policy questions
        v. For each of these case studies, identify the scope of ecosystem asset and flow accounts to be part of the physical and monetary accounts for India
        vi. Develop a work programme to develop these accounts, including deliverables and timelines

Table of Contents

List of Tables

List of Figures

REVIEW OF EXISTING INITIATIVES, LITERATURE AND DATA

- **Deliverable 1: Review of Existing Ecosystem Accounting Initiatives and Literature in India, Including Biophysical Assessments, and Economic Valuation of Ecosystem Services**
- **Deliverable 2: Overview of Available Data Sources, Organized by Ecosystem Service and Type of Account**

Introduction

Valuation of ecosystem services is an emerging field and a trending topic for ongoing studies in India. One of the first attempts of quantifying the worth of natural resources in India was done by T.M. Das with his study named "Value of a Tree" in 1979. The study determined the intrinsic value of a tree based on various environmental benefits and services derived from a tree during its lifespan of 50 years. The outcomes of the study were astronomical: a single tree's worth was determined as Rs. 15.7 lakhs (Das, 1979). This revelation captured the attention and interest of many researchers. Since then, many valuation studies have been done in India using different techniques of valuation and highlighting the range of values.

In India the ecosystem services (ES) research has evolved for the past 25 years from theoretical concepts to its practical applications and internalization of study outcomes into policies. Figure 2 shows that there has been a surge in the number of valuation studies after 2000.

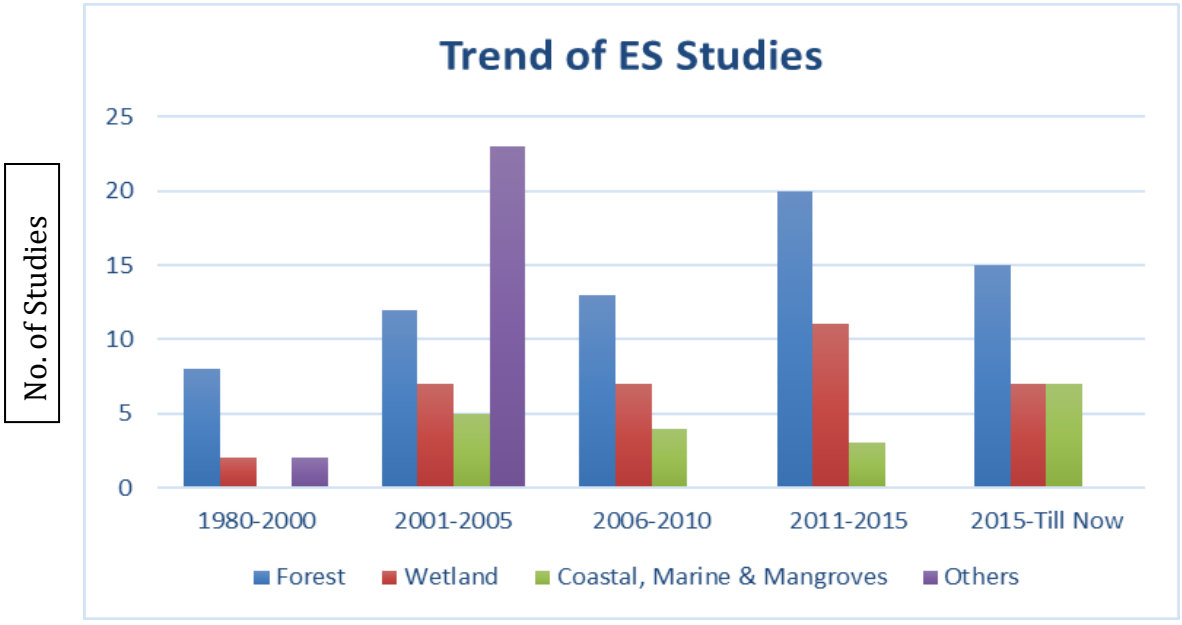

Figure 2: Trend of Ecosystem Services Valuation Studies in India

After the Rio Earth Summit in 1992, the Convention on Biological Diversity (CBD) provided opportunities to undertake studies in conservation and sustainable use of

biodiversity into the national programmes and policies. Work was also undertaken to quantify intangible benefits of forests and other ecosystems by individual researchers, for example:

- Water supply benefits from Almora forests by indirect methods (Chaturvedi, 1992).
- The value of recreation and ecotourism using Travel Cost Method to assess the consumer surplus to measure the recreational benefits by Chopra (1997) in Keoladeo National Park, Bharatpur.

Numerous studies were done on ecotourism in forest areas, followed by carbon assessment and timber valuation of forest areas. A similar trend was also observed in other ecosystems. Capacity 21 programme[1] (1992-97) followed by Environmental Management Capacity Building (EMCaB) (1998-2003) project[2] funded by the World Bank were a few initiatives in India which boosted initiatives from economists to conduct studies on biophysical assessment, monetary valuation and green accounting of different ecosystems.

Simultaneously at the international level, the UN Economic and Social Commission for the Asia and Pacific (ESCAP) Project launched in 1992, emphasized inclusive, sustainable economic and social development. The London group on Environmental Accounting was formed in 1993 which facilitated linking environmental accounts with the System of National Accounts.

The economic valuation work in India also received support from parallel international programmes such as the Millennium Ecosystem Assessment (MEA), The Economics of Ecosystems and Biodiversity (TEEB) and the ongoing Intergovernmental Platform for Biodiversity and Ecosystem Services (IPBES). These international initiatives gave good visibility to Indian case studies in their documentation process. Some of the major stages in the execution of ecosystem service valuation and accounting studies in India are highlighted in Figure 3.

[1] Project funded by the UNDP to build capacities of local institutions to undertake work in the domain of ES valuation and accounting process. The Capacity 21 project in India was implemented by the Indira Gandhi Institute for Development Research (IGIDR), Mumbai through the Ministry of Environment & Forests (1993-97). The main objective of the project is to build capacity at various levels of government, national institutes and the community at large through NGOs by introducing concepts of environmental economics into their resource use and planning decisions. Specific interventions of natural resource accounting through practical applications at policy and field levels include – Air Quality, Water Quality, Biodiversity and Common Property Resources.

[2] The Environmental Economics component of the Environmental Management Capacity Building (EMCaB)Technical Assistance Project that focused on enhancing environmental management capacity to ensure effective implementation of Environment Action Programme India priorities by developing curriculum, overseas exchange and capacity building of personnel was implemented by the Madras School of Economics for the Ministry of Environment & Forests (1993-97). The research component of the programme was executed by the Environmental Economics Research Committee (EERC) anchored at IGIDR, Mumbai.

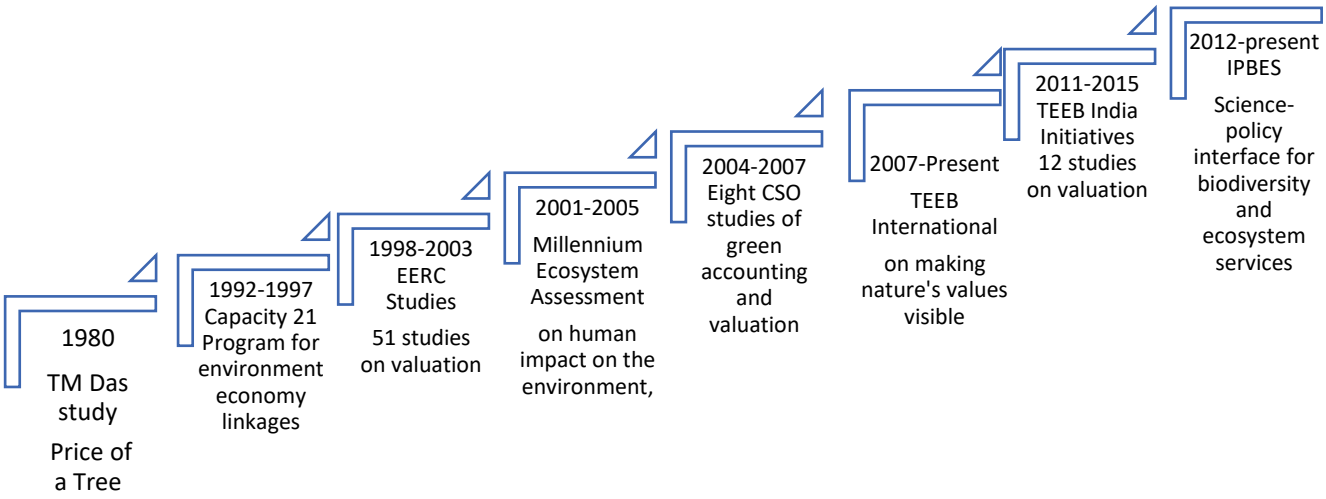

Figure 3: Major Stages: Initiatives by India and International Institutions for Ecosystem Services Valuation and Accounting Studies in the Past Four Decades

A significant number of studies were carried out in 1998-2003 under the aegis of Environmental Economics Research Committee (EERC) of EMCaB Programme. The committee funded nearly 57 research projects out of which 52 studies focused on valuation from over 30 universities, 23 research institutions and NGOs. The studies were conducted by reputed institutions like Indian Statistical Institute (ISI) Kolkata, Indian Institute of Forest Management (IIFM) Bhopal, Madras School of Economics (MSE) Chennai, Institute of Economic Growth (IEG) Delhi, Indira Gandhi Institute of Development Research (IGIDR) Mumbai, and other organizations. The programme focused on enhancing the capacity for application of economic principles and tools to environmental management in India across the full range of issues such as priority setting, cost-benefit analysis of alternative policies for pollution control, modelling, resources management and biodiversity conservation.

MEA was initiated in 2001, with an objective to assess the consequences of ecosystem change for human well-being and the scientific basis for action needed to enhance the conservation and sustainable use of those systems and their contribution to human well-being. The MEA Reports provided a state-of-the-art scientific appraisal of the condition and trends in the world's ecosystems and the services they provide (such as clean water, food, forest products, flood control, and natural resources) and the options to restore, conserve or enhance the sustainable use of ecosystems.

During 2004-2007 the Central Statistical Organization (CSO), Ministry of Statistics and Programme Implementation, Government of India commissioned 8 major state-level studies on natural resource accounting focused on specific ecosystems all over India to quantify the resourcefulness of the country.

The Economics of Ecosystems and Biodiversity (TEEB) is an ongoing global initiative (2007-present) focused on "making nature's values visible". Its principal objective is to mainstream the values of biodiversity and ecosystem services into decision-making at all

levels. The TEEB launched its interim report in 2008 which collated various examples of valuation and accounting studies with policy implications.

In 2011, Government of India launched the TEEB-India Initiative (TII) to highlight the economic consequences of the loss of biological diversity and the associated decline in ecosystem services in India. The Initiative focussed on three ecosystems, namely forests, inland wetlands and coastal and marine ecosystems. A series of 12 studies were conducted under this initiative.

The following Figure 4 summarizes the timeline in which various country and regional level programmes, networks and institutions took the initiative to conduct economic valuation and accounting studies in the Indian landscape.

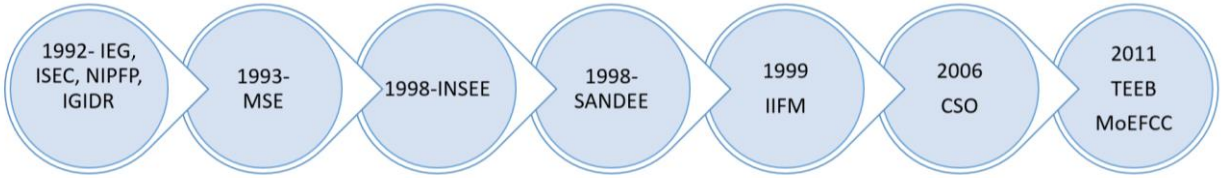

Figure 4: Valuation and Accounting Initiatives by Programmes, Institutions and Networks - Timeline

Institute of Economic Growth (IEG)	Institute for Social & Economic Change (ISEC)
National Institute of Public Finance & Policy (NIPFP)	Madras School of Economics (MSE)
Indira Gandhi Institute of Development Research (IGIDR)	Indian Society for Ecological Economics (INSEE)
South Asian Network for Development & Environmental Economics (SANDEE)	The Economics, Ecosystems and Biodiversity (TEEB)
Indian Institute of Forest Management (IIFM)	Central Statistics Organization (CSO)
Ministry of Environment, Forests & Climate Change (MoEFCC)	

The Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) is an independent intergovernmental body, established by member states in 2012. It provides policymakers with objective scientific assessments about the state of knowledge regarding the planet's biodiversity, ecosystems and the benefits they provide to people, as well as the tools and methods to protect and sustainably use these vital natural assets.

The deliverables of IPBES can be broadly grouped into four complementary areas: (a) Assessments: On specific themes (e.g. "Pollinators, Pollination and Food Production"); methodological issues (e.g. "Scenarios and Modelling); and at both the regional and global levels (e.g. "Global Assessment of Biodiversity and Ecosystem Services"); (b) Policy Support: Identifying policy-relevant tools and methodologies, facilitating their use, and catalysing their further development; (c) Building Capacity and Knowledge: Identifying and meeting the priority capacity, knowledge and data needs of our member states, experts and stakeholders and (d) Communications and Outreach: Ensuring the widest reach and impact of IPBES work. There has been extensive involvement of Indian scientists in IPBES which besides their contribution to the process also provides them with an opportunity to further accomplish their skills in the domain of diverse

conceptualization of values, new valuation techniques, modelling frameworks, scenarios, accounting and instruments and global assessments which will further help enriching valuation and accounting research in India and bridge the gap areas.

Ecosystem-wise Analysis of Valuation/Accounting/Biophysical Assessment Studies – An Overview

Four broad categories of ecosystems are considered to analyse the status of ES studies in this report, viz. wetlands, forests, marine, coastal and mangroves and others (urban, agroecological ecosystems, etc.). The category "wetland" refers to terrestrial wetlands and the category "marine" refers to coastal and mangroves includes coastal wetlands and marshlands.

The current report considers 146 Ecosystem Services studies conducted in India for the purpose of landscape assessment which comprise 34 studies for wetlands, 68 studies for forests, 19 studies for coastal, marine and mangroves and 25 studies for other ecosystems (Figure 4).

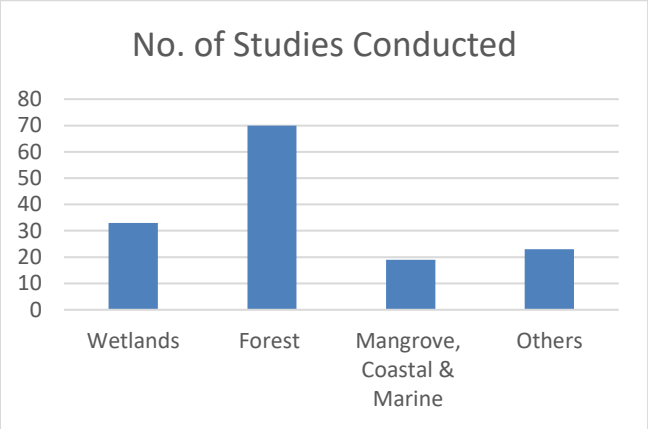

Figure 5: Studies Conducted in Different Ecosystems

Table 1 illustrates the number of studies accomplished across various ecosystems in India.

Table 1: Number of Studies in Various Ecosystems in India

Ecosystems	**No. of Studies**
Wetland	
• Ramsar Site	11
• Other	30
Coastal, Marine and Mangroves	
• Ramsar Site	3
• Other	16
Forest	
• National Parks / Wildlife Sanctuaries	19
• Other	49
Other	
• Agricultural	8
• Water Institutions and Sustainable Use	8
• Environment, Health and Economics	3
• Solid Waste Management	2

• National and International Policy Issues	5
• Industrial Pollution and Policy	10

The following section provides a detailed analysis of studies across various ecosystems of India and highlights the extent, condition, variety of ecosystem services and their spatial location.

Wetlands

Wetlands are highly productive ecosystems that encompass diverse and heterogeneous assemblage of habitats and provide several "life-supporting" services of significant value to mankind (Figure 5). A total of 34 studies have been carried out as an attempt to know the actual worth of these wetlands and to make policy interventions at the state and national level.

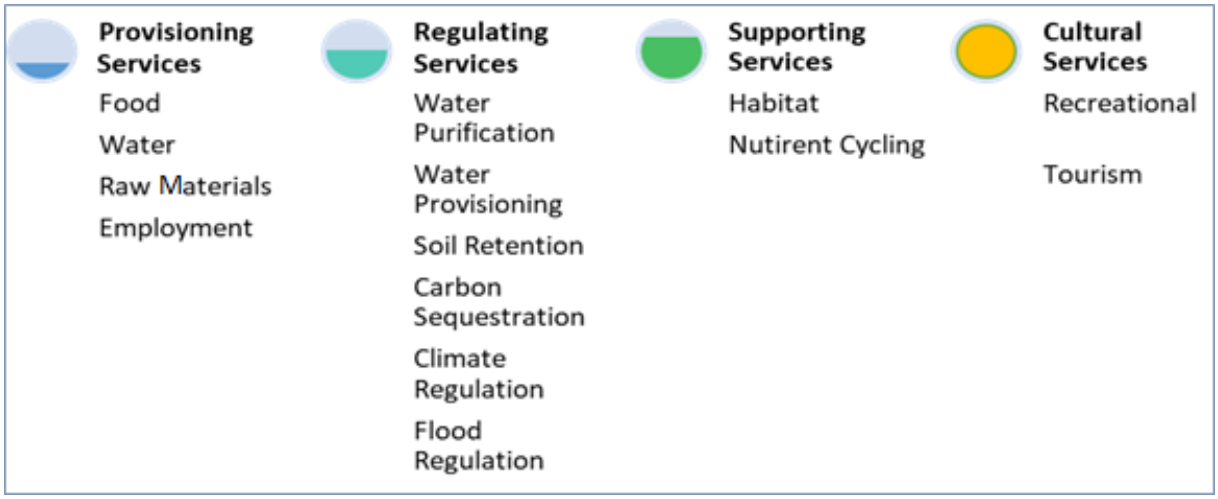

Figure 6: Major Ecosystem Services from Wetlands

Wetlands being one of the important natural resources have received major attention for research in the more recent decades. One such policy-relevant study ''Economic Valuation of Bhoj Wetland for Sustainable Use" (Verma, 2001) attempted to capture the value of ecosystem services provided by wetlands and suggested a framework and set of instruments for sustainable management of Bhoj Wetland. Figure 6 shows the percentage of composition of studies focused on the various wetland ecosystem services.

The reviewed studies highlight various issues and challenges faced by wetlands and estimate the economic value of both conservation and degradation and give many policy signals for their sustainable management. With increasing dependency on natural resources wetlands are facing serious problems of siltation, unsustainable fishing activities (Prasher R.S., Negi Y.S, and Vijay 2006). The intrinsic ecological value

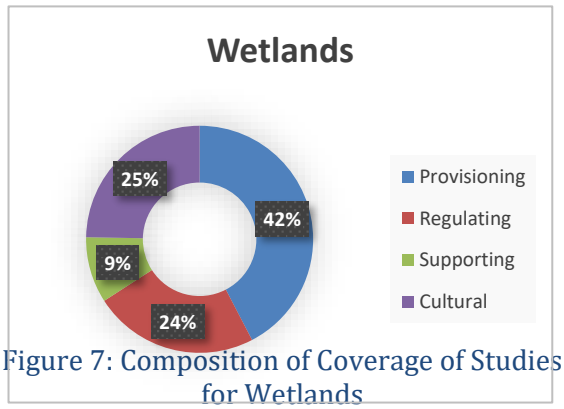

Figure 7: Composition of Coverage of Studies for Wetlands

that wetlands provide to local populations, as well as people living outside the periphery of the wetlands is yet to be fully recognized. Biswas et al. 2010 highlights the stakeholders role in the protection and preservation of wetlands and its ecological importance in the wetland system.

A number of studies conducted at different landscapes for valuation of ecosystem services shows that wetlands provides a range of ecosystems services (Sacchidananda 2009)(World Bank, 2013) like provisioning services, e.g. livelihood/employment generation (B. Roy et al. 2012), fishing drinking water, ecotourism, fuelwood (M Verma, Bakshi, and Nair 2001), (Das et al. 2011), (Leima, Pebam, and Hussain 2008); regulating services, e.g. climate regulation, water purification, pollination (Sreeja, Gilna, and Khaleel 2009) and cultural services (Bhatt and Abdullah 2011). Figure 7 shows the Ramsar sites for which economic valuation has been done.

Wetlands of northeastern India fall amongst the global hotspots of biodiversity. Though they have received very little attention, they are critical for the sustenance of the tribal communities (Jain et al. 2011). A case study of the Maguri-Motapung Beel wetlands of Assam showed a total of 29 ecosystem services, and high dependency on livelihood strategies sourced from ecosystem services (Bhatta et al. 2016).

These studies use a number of frameworks for valuation of ecosystem sources in the form of MA classification, Total Economic Value framework, tangible and intangible, stock and flow to identify numerous ecosystem services and different methodologies have been adopted for valuation of ecosystem services. Like for example contingent valuation approach (Venkatachalam and Jayanthi 2016), hedonic pricing method, market-based pricing etc. (Madhu Verma and Negandhi 2011).

Figure 8: Economic Valuation of Ramsar Sites

In order to assess the feasibility of application of economic valuation approaches for addressing policy issues related to management of three ecosystems such as forests, wetlands and coastal and marine ecosystems a study "Natural Capital of Wetlands Synthesis of the Wetlands Thematic Area of TII" was conducted by TEEB India Initiative project for 14 sites in India. Nine of the 14 study sites addressed policy dimensions related to wetland conservation and wise use which will eventually help India in its policy decision (Kumar, Bhatt, and Goel 2017). Wetland valuation and modelling exercises are quiet complex and require varied data sets. Table 2 provides an overview of such datasets, data sources, types of data and its resolution.

Table 2: Data Requirements for Wetland Studies

Wetland				
No.	**Dataset**	**Data Source**	**Type of Data**	**Data Resolution**
1	River flow and water level	Central Water Commission, Local Studies	Statistical data, shapefiles	Basin, sub-basin, watershed
2	Flow direction and streamline	Satellite DEM, Space Applications Centre (SAC) - ISRO	Statistical data, shapefiles	Basin, sub-basin, watershed
3	Wetland boundary	Satellite DEM, Space Applications Centre (SAC) - ISRO	Spatial, shapefiles	Regional, sub-regional, local level
4	Dam, reservoir and hydro-power locations	National Portal of India, Open Government Data Platform of India, ENVIS, WWF Studies, TEEB India	Statistical data	Regional, sub-regional, local level
5	Catchment areas	Space Applications Centre (SAC) - ISRO	Maps, shapefiles	Basin, sub-basin, watershed
6	Command area	Irrigation Department	Statistical data, Maps	Regional, local level
7	Land use land cover	USGS and ISRO, FSI	Spatial, statistical data	National, regional, sub-regional, local level
8	Administrative boundary	Survey of India	Spatial, statistical data	National to local level
9	Meteorological data	Indian Meteorological Department	Maps, statistical data	Regional, sub-regional, local level
10	Demographic and water usage data	Census Report of India, National Statistical Office, Central Water Commission, Ministry of Drinking Water and Sanitation	Statistical data	Block level

The following section provides detailed documentation of wetland valuation studies in India across locations, ecosystem services, methods of valuation, year of publication and year for which the data has been used.

Wetland Economic Valuation Studies in India

Author(s)	Study Title	Location	Type of Ecosystem Service Studies	Ecosystem Service Mapped	Method	Year of Publication	Biophysical Assessment	Economic Valuation	Year(s) of Data Sourcing	Biophysical Model
Malabika Biswas, Nihar R. Samal, Pankaj K. Roy, Asis Mazumdar	Human wetland dependency and socio-economic evaluation of wetland functions through participatory approach in rural India	West Bengal	Provisioning service	Biophysical Assessment	Socio-economic survey	2010	*	*	2002-2007	-
A Jain, M Sundriyal, S Roshnibala, R. Kotoky, P.B. Kanjilal, H.B. Singh, and R.C. Sundriyal	Dietary use and conservation concern of edible wetland plants at Indo-Burma hotspot: a case study from northeast India	Manipur	Provisioning service		Market price, contingent valuation	2011	*	*	2003-2006	-
Ramachandra et al. - 2011	Ecological and socio-economic assessment of Varthur wetland, Bengaluru (India)	Bengaluru	Provisioning		Market price, contingent valuation	2011	*	*	2009	-
Bhatt and Abdullah - 2011	Valuing Biodiversity of Hokera Wetland Reserve: A Contingent Valuation Approach	Jammu and Kashmir (Hokera Wetland; Ramsar site)	Cultural service		Contingent valuation Approach	2011		*	-	-
Madhu Verma and Dhaval Negandhi	Assessment of Bhoj Wetland	Madhya Pradesh (Bhoj Wetland; Ramsar site)	Provisioning, regulating, cultural services		Contingent valuation, Hedonic pricing	2011	*	*	-	-
Piyashi Deb Roy and R. Jayaraman	Economic Valuation of Mangroves for Assessing the Livelihood of Fisherfolk: A Case Study in India	Tamil Nadu	Provisioning and regulating services	Fisheries/recreational services	Market price, contingent valuation	2012	*	*	Not mentioned	-

Khaleel K. M.	Study on the Socio-economic Influence of the Mangrove Wetlands of North Malabar (Kerala), India	Kerala	Provisioning, regulating	23 Ecosystem Services	Income estimation method, market price, contingent valuation	2012	*	*	Not mentioned	-
Malabika B. Roy, Pankaj K. Roy, Nihar R. Samal, Asis Mazumdar	Socio-economic Valuations of Wetland Based Occupations of Lower Gangetic Basin Through Participatory Approach	West Bengal	Provisioning service	Fisheries and Farming	Socio-economic survey	2012	*	*	2002-2007	-
Sacchidananda Mukherjee and M. Dinesh Kumar	Economic Valuation of a Multiple Use Wetland Water System: A Case Study from India	West Bengal	Provisioning service		Productivity difference, alternate cost and opportunity cost	2012	*	*	2008	-
L. Venkatachalam* and M. Jayanthi(2015)	Estimating the Economic Value of Ecosystem Services of Pallikaranai Marsh in Chennai City: A Contingent Valuation Approach*	Tamil Nadu	Provisioning, regulating, supporting and cultural services	7 Services	Contingent valuation	2015		*	Not mentioned	-
Kiran Rajashekariah, Nilanjan Ghosh, G. Areendran, Suresh Babu	Valuation of Ecosystem Services of Kunigal Lake in Tumkur District, Karnataka	Karnataka, Kunigal Lake, Tumkur District	Provisioning, regulating	Recreational Value	Market price, productivity function, contingent valuation	2015		*	Not mentioned	-
Jala, L.Nandagiri	Evaluation of Economic Value of Pilikula Lake Using Travel Cost and Contingent Valuation Methods	Karnataka	Cultural services	10 Ecosystem Services	Market price, travel cost and contingent valuation	2015	*	*	2012-2013	-
Bhatta et al. 2016	Ecosystem Service Changes and Livelihood Impacts in the Maguri-Motapung Wetlands of Assam, India	Assam	Provisioning, regulating, supporting and cultural services	29 Ecosystem services	Socio-economic survey	2016		*	2014-2015	-
Gopal, B. and Marothia, D.K. (2016)	Economics of Biodiversity and	Ken River	Provisioning, regulating	4 Ecosystem Services	Benefit-transfer,	2016	*	*	2014-2015	-

	Ecosystem Services of Rivers for Sustainable Management of Water Resources		and cultural services		contingent valuation and travel cost					
Venkatachalam, L. and Zareena Begam, I.	Economic Valuation of Ecosystem Services: A Case Study of Ousteri Wetland, Puducherry	Puducherry	Provisioning, regulating and cultural services	4 Ecosystem Services	Market price, travel cost and contingent valuation	2016	*	*	2014-2015	-
Dixit, A.M., Bandyopadhyaya, S., Kumar, L., and Bedamatta, S.	Economic Valuation of Landscape Level Wetland Ecosystem and its Services in Little Rann of Kachchh, Gujarat	Gujarat	Provisioning and Cultural services	Biophysical Assessment	Travel cost and contingent valuation	2016	*	*	2014-2015	-
Kaul, R., Masoodi, A., Rasool, A., Murty, M.N. and Kishwan, J.	Economic Feasibility of Willow Removal from Wular Lake, Jammu and Kashmir	Wular Lake (Ramsar site), Jammu and Kashmir	Provisioning service	Recreational Value	Cost-benefit	2016	*	*	2013-2014	-
C. Sulakshana Rao and R. Balasubramanian(2017)	Recreational Value of Wetlands: The Case of Kuttanad Coastal Wetland Ecosystem of Kerala, India	Kerala	Cultural service	Recreational Value		2017		*	2016-2017	-
Ritesh Kumar, J.R. Bhatt, S. Goel	Natural Capital of Wetlands Synthesis of the Wetlands Thematic Area of TII	Ashtamudi Lake,	Regulating service		Market price, travel cost and contingent valuation	2017		*		-
		Kanwar Jheel	Provisioning, regulating		Market price, travel cost and contingent valuation	2017		*		-
		Ken River	Provisioning, cultural		Market price, travel cost and contingent valuation	2017		*		-
		Lake Chilika	Provisioning, supporting, cultural		Market price, travel cost and contingent valuation	2017		*		-

		Little Rann of Kachchh	Provisioning, cultural		Market price, travel cost and contingent valuation	2017		*		-
		Loktak Lake	Provisioning, regulating		Market price, travel cost and contingent valuation	2017		*		-
		Ousteri Lake	Provisioning, supporting, cultural		Market price, travel cost and contingent valuation	2017		*		-
		Wular Lake	Provisioning, regulating		Market price, travel cost and contingent valuation	2017		*		-
		Mangroves of Gujarat	Provisioning		Market price, travel cost and contingent valuation	2017		*		-
R.B.Lal, Dr. Madhu Verma, Dr. Advait Edgankar, Mr. Chandan Khanna	Estimating Economic Values and Analysing Institutional and Legal Frameworks for Claiming REDD+ and Ecotourism Benefits for Protected Area-Ramsar Wetlands: Exploration Through Loktak and Hokersar Wetlands	Loktak and Hokersar Wetlands	Provisioning, regulating	Framework	Market price, benefit transfer	2012		*		

Forests

Even though forests provide a vast number of ecosystem services, these benefits are not reflected in the country's National Accounting System for the reason that many non-tangible services often do not have a price-tag attached to them. Forests also play a major role in providing direct and indirect benefits and contribute significantly to poverty alleviation (MoEFCC, India). In contrast, the National Forest Policy (1988) and recent orders by the Hon'ble Supreme Court of India have put a regulation on green felling, thereby decreased the revenue from forests to states. Further, States also incur an immense opportunity cost for keeping their land under forests which needs to be compensated (Verma et al. 2014). Forest ecosystem functions provide a number of ecosystem services to humans. Hence it is important to realize the actual worth of the forest assets in India. Currently the National Accounting System of India, Forests contribution is reflected as only 1.7 per cent of the total GDP of India.

Many studies have been carried out for valuation of forest ecosystem through various capacity building programmes, networks on Ecological Economics and institutions like INSEE, EMCAB, World Bank, TEEB, IEG, IGIDR, NIPFP, DU, MSE, IIFM, etc. These studies demonstrate the existence of strong interlinkage between the forest and biodiversity and how the sustainable extraction of benefits from the forest area with traditional knowledge of the local people can alleviate poverty from the grassroots level. A range of ecosystem services provided by forests mapped in studies conducted in different landscapes are demonstrated in Figure 9. The percentage of composition of studies along with their indicators used for their estimates across major categories of ecosystem functions is shown in Figure 9.

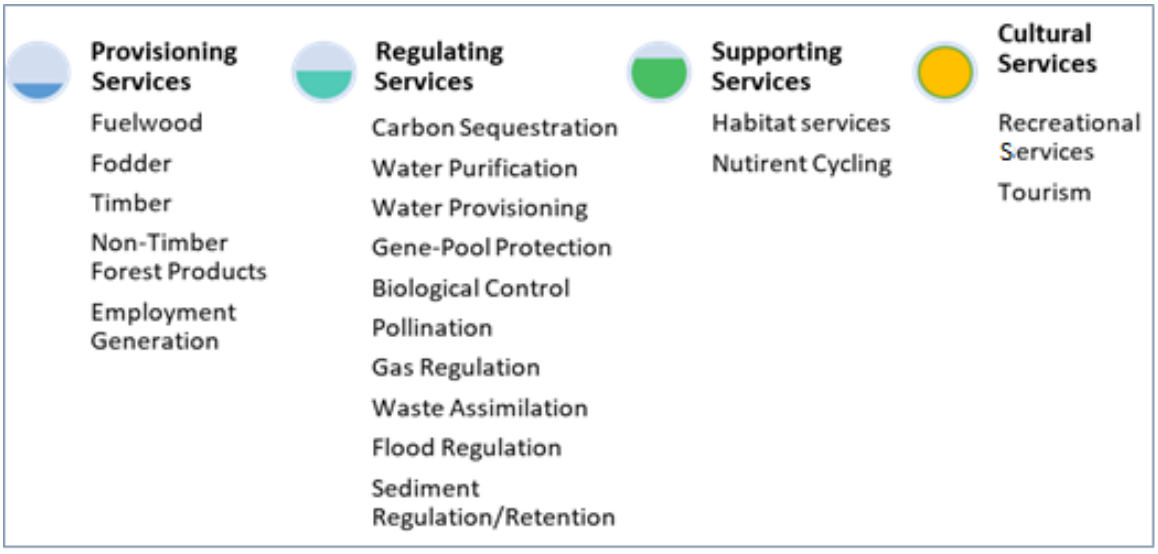

Figure 9: Major Ecosystem Services from Forests

Since the first study (Das, 1979), economic valuation of forests has received major attention as a research area. One of the attempts was to calculate water supply benefits from Almora forests by indirect methods (Chaturvedi, 1992). Chopra (1993) estimates the value of non-timber forest products: An estimation for tropical deciduous forests of India. In another study, the value was calculated using biomass extraction at 1.2 lakhs per

hectare (Kadekodi and Ravindranath, 1997). Chopra and Kadekodi (1997) estimated the value of watershed for soil conservation at Rs. 2.0 lakh/ha metre of soil in the Yamuna Basin

In another study, carbon storage value from Indian forests was calculated as Rs. 20,125 lakhs per hectare using species-wise forest inventory data (Haripriya, 1999) and in a similar kind of study value of soil conservation was also calculated in the Doon valley by replacement cost by Kumar (2005). In another study by Paul, Kathleen, Lawlor, Mullan and Pattanayak (2007), ecosystem services valuation and policy evaluation in developing countries was done.

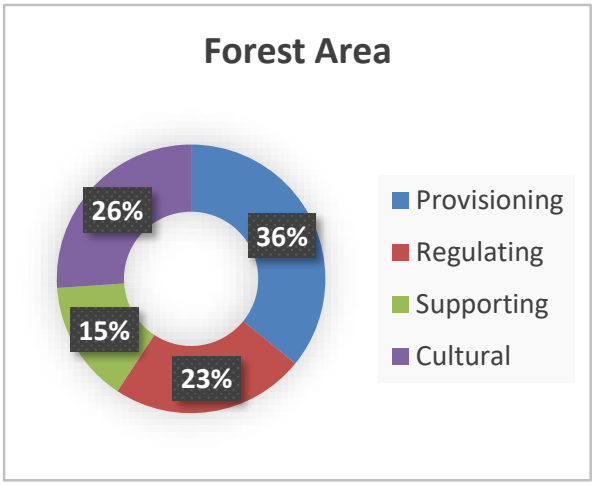

Figure 10: Composition of Coverage of Studies for Forests

An early example of application of economic valuation techniques to find the value of recreation and ecotourism was the use of the Contingent Valuation Method. Murty and Menkhuas (1994) estimated the values at Keoladeo National Park and later in the same site Chopra (1997) used the Travel Cost Method to assess the consumer surplus to estimate recreational benefits. Contingent valuation method for calculating recreational or ecotourism benefits has also been used by Haldar et al. (1995) for Boriveli National Park, Mumbai; by Manoharan (1996) for Periyar Tiger Reserve, Kerala; by Chopra and Kadekodi (1997) for Ecological functions (Use Value) for local residence in the Yamuna Basin; Manoharan and Dutt (1999) for Kalakadu Mundanthurai Tiger Reserve, Tamil Nadu.

Willingness to pay for managing the site was calculated using the contingent valuation method by Maharana et al. (2000) for recreational value of a sacred lake in Sikkim Himalaya (Khecheopalri Lake) and Khangchendzong National Park, Sikkim. Between 1999-2000, Verma et al. (2000) conducted a study in Himachal Pradesh where the Total Economic Value (TEV) of forests was calculated for the first time. Sinha and Mishra, 2015 also calculated willingness to pay for ecosystem service valuation for enhancing conservation and livelihoods in a sacred village in the landscape of Indian Himalayas. Recreationalists' willingness to pay for conservation of a forest ecosystem in Basavana Betta State Forest in Karnataka was estimated by Yashoda and Reddy (2012).

Many of the recent studies like the World Bank (2013) use economic valuation for biodiversity at the national level, Vandermeulen et al. (2011) use economic valuation to create public support for green infrastructure investments in urban areas, and Bahuguna and Bisht (2013) estimate the value of ecosystem goods and services for the Indian

forests. Nilanjan Ghosh, Dipankar Ghose, G. Areendran, Divya Mehra, Ambica Paliwal, Krishna Raj, Kiran Rajasekariah, Ambika Sharma, Anil Kumar Singh (2017) have calculated the value of ecosystem services at landscape level from Terai Arc landscape in Uttarakhand.

The related study on economic valuation such as "Revision of Rates of Net Present Value applicable for different Class/Category of Forests" by Verma et al., (2014) was conducted to estimate the value of loss of ecosystem services due to forest diversion for non-forestry purposes.

Figure 11: Economic Valuation of National Parks in India

Other studies like economic valuation of tiger reserves in India Verma et al. (2015) takes into account six tiger reserves from six different landscapes to calculate the value of 25 ecosystem services emanating from them. Forests of Himachal Pradesh, Uttarakhand and Arunachal Pradesh have been valued for their ecosystem services in the studies Madhu Verma (2000) and Madhu Verma et al. (2016), Madhu Verma (2007) and Kumar, and Chaudhry, (2015) respectively. Natural resource accounting for land and forestry sector in the states of Madhya Pradesh and Himachal Pradesh was also done by Verma and Kumar (2006). Ninan and Kontoleon (2015) value forest ecosystem services from Nagarhole National Park in Karnataka and Chaudhry, Kumar, and Yogesh (2016) calculate the same for Pakke Tiger Reserve in Arunachal Pradesh. Badola et al. (2010) assess the ecosystem services from Corbett Tiger Reserve. Figure 10 shows the economic valuation done in national parks and tiger reserves.

Western Ghats is a popular area for research in the field of ecosystem service. Anitha and Muraleedharan (2006) estimate the economic value of ecotourism development of a recreational site in the natural forests of southern Western Ghats. Another study by Blicharska, Mikusinski, Godbole and Sarnaik (2013) made an attempt to safeguard biodiversity and ecosystem services of sacred groves in the northern Western Ghats. Both the studies focus on cultural services. The data sources shown in Table 3 provides the information required and their sources for forest ecosystem studies.

Table 3: Data Requirements for Forest Ecosystem Studies

Forests				
No.	**Dataset**	**Data Source**	**Type of Data**	**Data Resolution**
1	Natural Capital (Timber, NTFP, etc.)	FSI and FRI National Level Studies, Local Studies	Statistical data	Local level
2	Carbon Data (Above-ground biomass, below-ground biomass, dead wood, litter and soil organic carbon)	FSI, Studies by Local Institutions, Primary Data by Sampling	Statistical data	Regional, sub-regional, local level
3	Soil Data	Primary Data, Secondary Data from: Indian Institute of Soil Science, Central Soil Salinity Research Institute, National Bureau of Soil Survey and Land Use Planning .	Spatial, statistical data	Regional, sub-regional, local level
4	Land Use Land Cover	USGS and ISRO, FSI, WII	Spatial, statistical data	National, regional, sub-regional, local level
5	Administrative boundary	Survey of India, Individual Protected Areas, State Forest Departments	Spatial, statistical data	National to local level
6	Meteorological data (Rainfall, evapo-transpiration, temperature, wind speed, etc.)	Indian Meteorological Department	Maps, statistical data	Regional, sub-regional, local level
7	Demographic and other data	Census Report of India, National Statistical Office, Department of Economic Affairs.	Statistical data	Block level
8	Ecotourism (number of visitors, entry fee for parks)	State Tourism Department, Forest Field Office	Statistical data	Individual park / local level
9	Pollution Data (air and water quality)	CPCB, SPCB	Statistical data	Regional-, sub-regional-, basin- and local-level

The following section provides detailed documentation of forest valuation studies in India across locations, ecosystem services, methods of valuation, year of publication and year for which the data has been used.

Forest Economic Valuation Studies in India

Author(s)	Study Title	Location	Type of Ecosystem Service Studies	Ecosystem Service Mapped	Method	Year of publication	Biophysical Assessment	Economic Valuation	Year(s) of Data Sourcing	Biophysical Model
Pushpam Kumar, Madhu Verma, Michael D. Wood, Dhaval Negandhi	Guidance Manual for the Valuation of Regulating Services	India	Regulating services	13 Regulating services	Multiple methods	2010		*	-	-
Ruchi Badola, Syed Ainul Hussain, Bidyut Kumar Mishra, Bidyarani Konthoujam, Sneha Thapliyal, Parag Madhukar Dhakate	An Assessment of Ecosystem Services of Corbett Tiger Reserve, India	Corbett Tiger Reserve, India	Provisioning, regulating, and cultural services	Recreational value, Carbon sequestration, Other Indirect Costs	Travel cost, replacement cost, opportunity cost	2010		*	Various, 2004-2007	-
Paul J. Ferraro Kathleen Lawlor Katrina L. Mullan Subhrendu K. Pattanayak 2011	Forest Figures: Ecosystem Services Valuation and Policy Evaluation in Developing Countries	Indian Forest	Provisioning, and regulating services		Valuation estimates based on observed impacts in the context of real-world programmes	2011				
Gunjan Joshi and Girish C.S. Negi	Quantification and Valuation of Forest Ecosystem Services in the Western Himalayan Region of India	Western Himalayas	Provisioning and regulating services	Soil fertility, soil moisture retention, prevention of soil erosion, air and water purification	Market price	2011	*	*	Not mentioned	-
Madhu Verma and Dhaval Negandhi	Desired institutional and legal environment for implementing PES mechanisms in India	India	Provisioning, regulating, supporting and cultural services		Valuation estimates based on observed impacts in the context of real-world programmes	2011			Not mentioned	-

R. B. Lal, Madhu Verma, Swapan Mehra, Priyanka Batra	Nuts and bolts for India's REDD+ calculus	India	Provisioning services	Soil fertility, soil moisture retention, prevention of soil erosion, air and water purification	Market price	2011			-	-
Yashoda and B. V. Chinnappa Reddy	Recreationists Willingness to Pay for Conservation of a Forest Ecosystem: An Economic Study of Basavana Betta State Forest, Karnataka state, India	Karnataka	Cultural Services	Recreational Service	Willingness to pay	2012		*	2011	-
K. N. Ninan, Makoto Inoue	Valuing Forest Ecosystem Services: What we know and what we don't	India	Provisioning, regulating, supporting and cultural services	17 Ecosystem Services	Benefits transfer	2013			-	-
V. K. Bahuguna And N. S. Bisht	Valuation of Ecosystem Goods and Services From Forests in India	Indian Forest	Provisioning, regulating, supporting and cultural services	13 Ecosystem Services	Benefits transfer	2013	*	*	-	-
Malgorzata Blicharska, Grzegorz Mikusiński, Archana Godbole and Jayant Sarnaik	Safeguarding Biodiversity and Ecosystem Services of Sacred Groves – Experiences from Northern Western Ghats	Western Ghats	Regulating/ cultural services	7 Services	1. Value recognition; (2) awareness generation and incentives design; and (3) participatory planning and implementation	2013		*	-	-
World Bank	Diagnostic Assessment of Select Environmental Challenges Valuation of Biodiversity and Ecosystem Services in India	India	Provisioning, regulating, supporting and cultural services	13-15 Ecosystem Services	Benefit transfer	2013	*	*	2011-2012	-

S.P. Singh, and Rajesh Thadani	Valuing ecosystem services flowing from the Himalayan states for incorporation into national accounting	Himalaya n States	Provisioning, regulating, supporting and cultural services	13 Ecosystem Services	Benefit transfer	2013			-	-
Lal, R., Verma, M., Batra, P.	Analysing Forest Carbon Accounts for Sustainable Policy Options with Special Reference to Livelihood Issues	India	Provisioning, regulating, supporting and cultural services			2013		*	-	-
Luke Brander, Florian Eppink, Madhu Verma, Thang Dang, Bee Hong Yeo, Dhaval Negandhi	Regional Research To Inform The High Level Panel On Global Assessment of Resources for Implementing the Strategic Plan for Biodiversity 2011-2020	India	Provisioning, regulating, supporting and cultural services			2014			-	-
Verma, M., Negandhi, D., Mehra, S., Singh, R., Kumar, A. and Kumar, R.	High Conservation Value Forests: An Instrument for Effective Forest Fiscal Federalism in India	India	Provisioning, regulating, supporting and cultural services	Policy Input		2014	*	*	2013-2014	
Verma M, Negandhi D, Wahal A.K., Kumar R, Kinhal, G. A., and Kumar, A.	Revision of rates of NPV applicable for different class/category of forests	India	Provisioning, regulating, supporting and cultural services	14 Ecosystem Services	Multiple methods	2014	*	*	2012	-
Madhu Verma and Dhaval Negandhi	Economic Services Valuation of Tiger Reserves	Six tiger reserves of India viz. Corbett, Periyar, Rantham bore, Kaziranga , Sundarba ns and Kanha	Provisioning, regulating, supporting and cultural services	25 Ecosystem Services	Multiple methods	2015	*	*	2014	InVEST
K. N. Ninan, A. Kontoleon	Valuation of forest ecosystem services and disservices- Case Study of a protected area in India	Karnatak a, Nagarhol	Provisioning, regulating and cultural services	10 Ecosystem Services and 2 disservices (Forest fire and	Alternate cost, hedonic pricing, market price, benefit	2016			2013	-

		e National Park		wildlife damages)	transfer, opportunity cost, damage cost, travel cost					
Ruchi Badola, Syed Ainul Hussain, Pariva Dobriyal and Shivani Barthwal	Assessing the effectiveness of policies in sustaining and promoting ecosystem services in the Indian Himalayas	Himalaya n Regions				2015			1927-2008	-
Arun Pandit, A. Ekka, A. P. Sharma, B. K. Bhattacharjya, P. K. Katiha and D. K. Biswas	Economic valuation of natural ecosystems - an empirical study in a stretch of Bramhaputra River in Assam, north-east India	Assam	Provisioning, regulating, supporting and cultural services		Market price, revenue generation, travel cost	2015		*	2012	-
Diaz et al.	The IPBES Conceptual Framework — connecting nature and people	India	Provisioning, regulating, supporting and cultural services	Framework	Multiple methods	2015			-	-
Roan P. Lakerveld, S. Lele, T. A. Crane, K. P. J. Fortuin, O. Springate-Baginski	The social distribution of provisioning forest ecosystem services: Evidence and insights from Odisha, India	Orissa	Provisioning services			2015	*	*	-	-
Madhu Verma and Dhaval Negandhi	Economic Services Valuation and Accounting of Himachal Forests	Himachal Pradesh	Provisioning, regulating, supporting and cultural services	12 Ecosystem Services	Multiple methods/ consumer surplus, opportunity cost, proxy values)	2016	*	*	2012 2013	-
Shashi Kumar and Pradeep Chaudhry	Ecosystem services valuation of the forests of Arunachal Pradesh State, India	Arunanch al Pradesh	Provisioning, regulating, supporting and cultural services	14 Ecosystem Services	Benefits transfer	2016		*	Not mentioned	-
Bhaskar Sinha, Sameera Mishra	Ecosystem services valuation for enhancing conservation and livelihoods in a sacred	Indian Himalaya s	Cultural services		Contingent valuation	2015		*	2010	-

	landscape of the Indian Himalayas									
Pradeep Chaudhry , Shashi Kumar, Yogesh	Valuing Ecosystem Services: A Case Study of Pakke Tiger Reserve of Arunachal Pradesh, India	Pakke Tiger Reserve, Arunachal Pradesh, India	Provisioning, regulating, and cultural services	10 Ecosystem Services	Market price, benefit-transfer, travel cost	2016	*	*	2015	-
Ravindranath, N.H., Gundimeda, H., and Murthy, I.K.	Valuation of Forest Ecosystem Services and Biodiversity in The Western Ghats Case Study in Uttara Kannada	Western Ghats	Provisioning, regulating and cultural services	25 Ecosystem Services	Market price, benefit-transfer, contingent valuation	2016	*	*	Various, 2014	-
Sukumar, R. and Pani, N.	The Economics and Efficacy of Elephant-Human Conflict Mitigation Measures in Southern India	Karnataka	Provisioning, regulating, supporting and cultural services	Recreational value/ Wildlife damages)Disservices	Benefit-transfer, contingent valuation	2016	*	*	Nov 2014-Jan 2015	-
Ishwar, N.M., Das, S., Kumari, J., Prakash V. and Sinha, P.R.	An Economic Assessment of Economic Services Provided by Vultures: A Case Study from the Kanha-Pench Corridor	Kanha-Pench Corridor, Madhya Pradesh	Provisioning, Regulating, Supporting and cultural services	Carcass Removal Service, Cultural values	Replacement cost	2016	*	*	Oct 2014-Jun 2015	-
S. Ferrier, K N Ninan, P.Leadely, R. Alkemade and others (eds)	The Methodological Assessment of Scenarios and Models of Biodiversity and Ecosystem Services	India	Provisioning, regulating and cultural services	20 Ecosystem Services	Multiple methods	2016			-	-
Ghosh, Nilanjan, Ghose, Dipankar, Areendran, G., Mehra, Divya, Paliwal, Ambica, Raj, Krishna, Rajasekariah, Kiran, Sharma, Ambika, Singh, Anil Kumar, Srinivasan, Shashank and Worah, Sejal	Valuing Ecosystem Services At A Landscape Level The Case Of Terai Arc Landscape In Uttarakhand	Uttarakhand	Provisioning, regulating, and cultural services	9 Ecosystem Services	Market price, benefit-transfer, production function, replacement cost, avoided cost, contingent valuation	2017	*	*	Various, 2005-2016	-

Priya P. Joshi, Indu K. Murthy, Gurunath T. Hegde, Vani Sathyanarayan, Savithri Bhat, Vishal Patil, Tashina Esteves, N. H. Ravindranath	Biophysical quantification of biodiversity and ecosystems services of forest ecosystems in the Western Ghats: a case study of Uttara Kannada District, India	Karnataka	Provisioning, regulating, supporting and cultural services	Biophysical assessment		2017	*		2014	-
Ranjini Murali, Stephen Redpath, Charudutt Mishra	The value of ecosystem services in the high altitude Spiti Valley, Indian Trans-Himalaya	Himalayan Regions	Provisioning, regulating, supporting and cultural services	7 Ecosystem Services	Market price and replacement cost	2017		*	Not mentioned probably 2014-2015	-
Verma, M., et al.	Making the hidden visible: Economic valuation of tiger reserves in India	India	Provisioning, regulating, supporting and cultural services	23-25 Ecosystem Services	Market price, benefit-transfer, replacement cost, avoided cost, contingent valuation	2017	*	*	2014-2015	-
Pascual et al.	Valuing nature's contributions to people: the IPBES approach	India	Provisioning services	Framework		2017			Not mentioned	-
Verma, M., et al.	Valuation of Ecosystem Services from Tiger And Snow Leopard Landscapes - A manual on economic valuation approaches for practitioners	India	Provisioning, regulating, supporting and cultural services	23-25 Ecosystem Services valuation Framework	Multiple methods/primary data, spatial data, consumer surplus, opportunity cost, proxy values)	2017	*	*	2016	-
D. Bartlett, Gomez-Martin, S. Milliken, D. Parmer	Introducing landscape character assessment and the ecosystem service approach to India: A case study	Gujarat	Provisioning, regulating, supporting and cultural services	Biophysical assessment		2017	*	*	2015	-

Coastal, Marine and Mangrove Areas

In India, the Coastal, Mangrove and Marine ecosystems contributes to a major proportion of the fishery sector constituting about 6.3 per cent of the global fish production, the sector contributes to 1.1 per cent of the GDP and 5.15 per cent of the agricultural GDP in India (Source: National Fisheries Development Board, 2018). The total fish production of 10.07 million metric tonnes presently has nearly 35-40 per cent contribution from the Marine and Coastal Ecosystem(TEEB 2010).

Coastal and marine ecosystems, including mangroves, coral reefs, estuaries and marine waters, provide a host of services that are of vital importance to human well-being, livelihoods and survival. It provides a range of ecosystem services which ultimately helps in providing livelihoods to thousands of people. Below is the list of ecosystem services with their representative indicators for ecosystem benefit estimation (Figure 12):

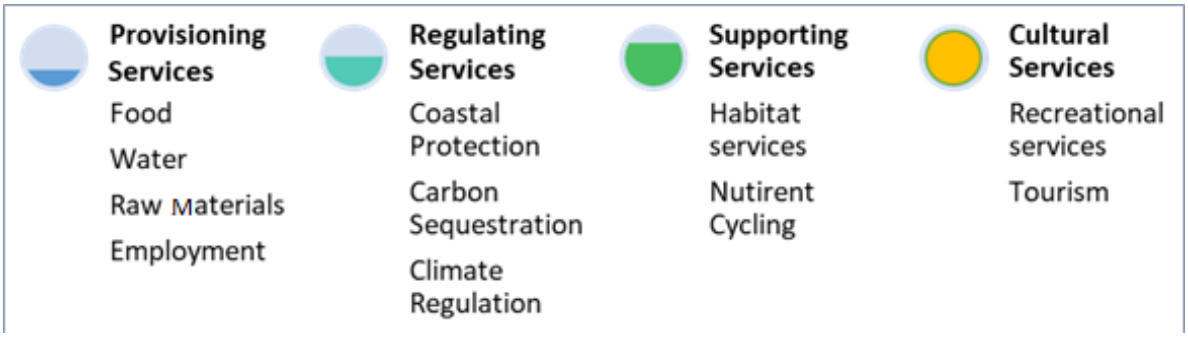

Figure 12: Major Ecosystem Services from Coastal, Marine and Mangrove Areas

Studies have been conducted to know the actual worth of these ecosystems, especially in coastal areas where the majority of people depend on coastal and marine ecosystems as a source for income generation(Anneboina and Kavi Kumar 2017). Figure 12 shows the percentage of studies done in ecosystem services in coastal, marine and mangroves regions.

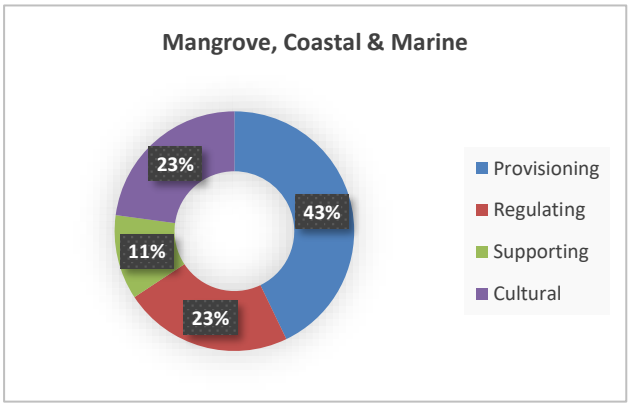

Figure 13: Coverage of Studies for Coastal, Marine and Mangroves

Studies aiming to value coastal, mangrove and marine ecosystem services in monetary units have been mapped in the report (World Bank, 2013). Coastal and marine ecosystem also provides recreational services as a major source of income generation (Mukhopadhyay et al. 2015). The data sources shown in Table 4 provides the information for Marine and Coastal Ecosystems Services studies.

Table 4: Data Requirements Sources for Marine and Coastal Ecosystems Studies

No.	Dataset	Data Source	Type of Data	Data Resolution
1	Coastal Boundaries	Space Applications Centre (SAC) - ISRO, ESSO-INCOIS-Indian National Centre for Ocean Information Services	Statistical data	Local level
2	Fisheries, Seaweed	CMFRI, The Seaweed Industry Association (USA), CSIR, CSMCRI	Statistical data	Regional, local level
3	Coastal Minerals	Indian Bureau of Mines	Statistical data	Local level
4	Shipping	Planning Commission's Total Transport System Study (TTS-RITES), EXIM Bank, EPCH, CAPEXEL, etc.	Transport data	Local level
5	Coastal Protection by Mangroves	Cyclone eAtlas, FSI, ISFR, National Institute of Oceanography	Statistical data, spatial	Regional, local level
6	Coastal Regulation Zones	National Institute of Oceanography	Statistical data, Spatial	Regional, local level
7	Land Use Land Cover	USGS and ISRO, FSI	Spatial, statistical data	National, Regional, Sub-regional, local level
8	Administrative Boundary	Survey of India	Spatial, statistical data	National to local level
9	Meteorological data	Indian Meteorological Department	Maps, statistical data	Regional, Sub-regional, local level
10	Demographic	Census report of India, National statistical office, Department of Economic Affairs, Central Water Commission, Ministry of Drinking Water and Sanitation	Statistical data	Block level
11	Coral Reef	National Level Studies, National Institute of Oceanography	Statistical data, spatial	Sub-regional, local level
12	Climate Regulation	National Level Studies, ESSO-INCOIS-Indian National Centre for Ocean Information Services	Statistical data, spatial	Regional, local level

The following section provides detailed documentation of coastal, marine and mangrove valuation studies in India across locations, ecosystem services, methods of valuation, year of publication and year for which the data has been used.

Marine and Coastal Economic Valuation Studies in India

Author(s)	Study Title	Location	Type of Ecosystem Service Studies	Valuation Technique	Year of Publication	Biophysical Assessment	Economic Valuation	Year(s) of Data Sourcing	Biophysical Model
Saudamini Das	Valuation of Planted Mangroves (TEEB)	India	Provisioning, regulating, supporting and cultural services	Socio-economic survey	2010	*	*	Various 1985 onwards	-
TEEB (2010)	Coastal and Marine Ecosystems (TEEB)	India	Provisioning, regulating, supporting and cultural services		2010	*	*		-
A. Ekka and Arun Pandit	Willingness to Pay for Restoration of Natural Ecosystem: A Study of Sundarban Mangroves by Contingent Valuation Approach	Sundarban Mangroves	Provisioning services	Contingent valuation	2012		*	2010-2011	-
World Bank	Diagnostic Assessment of Select Environmental Challenges Valuation of Biodiversity and Ecosystem Services in India	India	Provisioning, regulating, supporting and cultural services	Market price, contingent valuation	2013	*	*	2009	-
Nibedita Mukherjee, William J. Sutherland, Lynn Dicks , Jean Huge, Nico Koedam, Farid Dahdouh-Guebas	Ecosystem Service Valuations of Mangrove Ecosystems to Inform Decision Making and Future Valuation Exercises	India	Provisioning and regulating	Contingent valuation	2014	*	*	2011- 2012	-
Pranab Mukhopadhyay and Vanessa da Costa	Recreational Value of Coastal and Marine Ecosystems in India: A Partial Estimate	India	Cultural services	Travel cost	2015	*	*	2012-2013	-
Kavi Kumar, K. S., L. R. Anneboina, R. C. Bhatta, P. Naren, M. Nath, A. Sharan, P.	Valuation of Coastal and Marine Ecosystem Services in India: Macro Assessment	India	Provisioning, regulating, supporting and cultural services	Market price, benefit	2016	*	*	2012-2013	-

Mukhopadhyay, S. Ghosh, V. da Costa and S. Pednekar				transfer, travel cost					
Saudamini Das	Valuation of Planted Mangroves(TEEB)	Gujarat	Provisioning services	Socio-economic survey	2016	*	*	Various 1985 onwards, 2013- 2014	-
Mohamed, K.S., Kripa, V., Narayankumar, R., Prema, D., Venkatesan, V., Malayilethu, V., Sharma, J., and Sajikumar, K.K.	Assessment of Eco-labelling as Tool for Conservation and Sustainable Use of Biodiversity in Ashtamudi Lake, Kerala	Kerala	Provisioning, regulating and cultural services	Contingent valuation	2016	*	*	2014-	-
Sathyapalam, J.	Economic Value of Biodiversity Loss: A Study of By-Catch from Marine Fisheries in Andhra Pradesh	Andhra Pradesh	Provisioning services	Socio-economic survey	2016	*	*	2013-2015	-
Narayankumar, R., Jayasankar, J., Salim, S.S. and Ganga, U.	Economic Valuation of Seasonal Fishing Ban on Marine Fisheries Services in Selected Maritime States of India	India	Provisioning services	Contingent valuation and benefit transfer	2016	*	*	Not mentioned	-
Lavanya Ravikanth Anneboina, K.S. Kavi Kumar	Economic Analysis of Mangrove and Marine Fishery Linkages in India	West Bengal	Provisioning services	A. Stochastic frontier production function and b. Regression model	2017	*	*	1985-2011	-
D.Ganguly, G.Singh, R.Purvaja R.Bhatta, A.Paneer Selvam, K. Banerjee, R. Ramesh	Valuing the Carbon Sequestration Regulation Service by Seagrass Ecosystems of Palk Bay and Chilika, India	Tamil Nadu	Regulating services	Avoided cost	2017	*	*	May 2016	-

Studies on Cross-Cutting Issues, Policy and Economic Analysis

Valuation studies were also conducted from an interdisciplinary perspective such as solid waste management, environmental health and economics, national and international policy issues, water institutions and sustainable use, industrial pollution and policy and agriculture. These studies were conducted by the Environmental Economics Research Committee set up under the EMCaB programme. The projects were designed to investigate resource conflicts, aid in decision-making and also for academic research and education.

Some important studies in sustainable water use were economic and environmental aspects of drinking water supply in rural Tamil Nadu Ravichandran and Boopathi (2002); economic and environmental performance of traditional water harvesting systems in western India (Das, 2002); economic analysis of rural pollution and health impacts in Northern India (Parikh, 2003). Other studies such as gas generation by solid waste treatment in a landfill system was investigated by Yedla and Parikh (2001); economic valuation of health damage (Balakrishnan, 2001); environmental cost of industrialization (Shah and Mehta, 2003).

Economic valuation in agricultural systems extends beyond marketed goods such as food, fibre and bioenergy. Additional services such as pest regulation, nutrient cycling and water-quality regulation were evaluated. Reddy et al. (2001) and Kumar (2002) carried out a study on economic assessment and environmental impact of biodiversity on and around farms and conducted economic land valuation for different agro-climatic zones of Karnataka respectively. There were also studies investigating into the common property resources in agriculture and institutions involved in mediating these resources (Roy et al., 2001; Bhattacharya and Husain, 2002; Pandey and Srivastava, 2002; Chakrabarty and Gupta, 2003).

To fill in the desired accounts as itemized in the above sections, Table 6 provides an overview of indicators/datasets to map, model, assess, quantify and value ecosystem services. The table has been classified into three main categories: 1) Core datasets, 2) Biophysical data and 3) Other required datasets. Further the data have been characterised into spatial and non-spatial type. These are potential sources that provide information for Indian scenarios but also there are international agencies /institutions that provide global datasets from which information can be derived to assess ecosystem services.

Table 5: Nature of Data Required and its Source for Assessing Various Ecosystem Services

Data Inventory				Fuelwood	Fodder	Food	Timber	Non-Timber Forest Products	Employment Generation	Carbon Sequestration	Water Purification	Water Provisioning	Gene-Pool Protection	Sediment Regulation/Retention	Biological Control	Pollination	Gas Regulation	Waste Assimilation	Flood Regulation	Recreation/Tourism	Habitat for Species	Nutrient Cycling/Retention
	Data Requirements	Data type	Sources																			
Core datasets	Administrative Boundary	Spatial	Survey of India, Forest Department								®	®		®				®	®	®	®	®
	Land use/land cover (LULC)	Spatial	NRSC, FSI				®			®		®		®	®				®		®	®
	Forest type	Spatial	FSI	®			®			®			®		®						®	
	Forest cover	Spatial	FSI, Forest Department	®			®			®			®		®	®	®				®	
	DEM (topography)	Spatial	ASTER									®		®								®
Bio-physical data	Carbon in above-ground biomass, below-ground biomass, dead organic matter, and soil	Non-Spatial	FSI							®												
	Precipitation	Spatial	IMD									®		®					®			®
	Evapotranspiration	Spatial	IMD									®		®					®			
	Soil type, soil depth, soil texture	Spatial	NBSS and LUP, Survey of India									®		®								

Wood stock, volume	Non-Spatial	FSI, Forest department	®																		
Agriculture data(productivity, produce)	Non-Spatial	Agriculture census, ICAR, IARI		®	®																
livestock feed	Non-Spatial	Livestock Census		®																	
Growing stock and flow, rotation and harvesting	Non-Spatial	FSI, Forest Department				®	®														
Population	Non-Spatial	Census of India, Forest Department						®													
Water demand, water requirement	Non-Spatial	CWC, CGWB, Watershed Department								®								®			
Health, environmental statistics	Non-Spatial	Indiastat, ZSI, Forest Department												®							
Vegetation Type	Non-Spatial	FSI, Forest Department, Biodiversity Information System(BIS)-IIRS												®	®					®	
Fragmentation	Spatial	FSI, Forest Department, BIS-IIRS												®	®					®	

	Disturbance Index	Spatial	FSI, Forest Department, BIS-IIRS												®	®					®	
	Biological Richness	Spatial	FSI, Forest Department, BIS-IIRS												®	®					®	
	Waste water information/water quality	Non-Spatial	CWC, CGWB, Watershed Department															®				
	NTFP extraction data (annual production)	Non-Spatial	Forest Department, Independent studies					®														
Other required datasets	Questionnaires and interviews	Non-Spatial	Forest Department																	®		
	Market value/price	Non-Spatial	Forest Department	®	®		®	®														®
	Wage rate	Non-Spatial	FSI, Forest Department						®													
	Benefit transfer method	Non-Spatial		®	®	®	®	®	®		®		®		®	®	®	®	®	®	®	®
	Social cost of carbon	Non-Spatial								®												

The specific requirements of data across various methods of capturing the physical and monetary values of ecosystem services is presented in Table 7 below. The data availability in India has been categorized as High /Medium/ Low based on literature review, data sources and availability of data thereof and previous experiences of authors in similar studies and meetings with experts.

Table 6: Data Requirement Across Valuation Techniques*:*

Ecosystem service	**Stock / Flow**	**Indicator/Index**	**Data requirements**	**Data Availability**	**Methods**
Timber	Stock	Biomass	Species-wise stand Stumpage value	Medium	Market price
	Flow	MAI	Species-wise stand volumetric equations	Medium	Market price
Employment generation	Flow	Man Days	Number of man-days generated	Medium	Market price
Agriculture	Flow	Agricultural Produce	Value of agriculture produce	High	Production function
Fuelwood	Stock	Biomass	Species-wise stand	Medium	Market price
	Flow	Extraction	Specific study on fuelwood extraction, Average household requirements	Medium	Market price
Fodder	Flow	Dependent Cattle Population	Dependent cattle units on forests; Cattle population in and around forest areas	High	Market price
NWFP	Flow	Extraction	Specific studies for nationalized NWFP, Plot data correlation with biomass	Medium	Market price
Fisheries	Flow	Extraction	Study on fish catch from wetlands / rivers inside forests	High	Market price
Recreation	Flow	Consumer Surplus	Visitation rates in NP/WLS/TR Willingness to Pay Studies Park Entry Fees	Medium	Travel cost method
Carbon storage	Stock	Carbon Stock	Carbon stock in various pools (AGB, Soil) Social Cost of Carbon	Medium	Production function
Carbon sequestered	Flow	MAI	Stand-level biomass data IPCC Coefficients	Medium	Production function
Water	Flow	Water Quantity, Evapotranspiration	Any hydrological modelling study?	Medium	Production function

			Any data on water flows? Economic value of water		
Nutrient regulation	Stock	NPK in Soils	Tested soil samples for NPK content? Organic carbon?	Low	Market-price
	Flow	Erosion Prevention	Study on erosion prevention from forests?	Low	Replacement cost
Erosion regulation	Flow	Erosion Prevented/Erodibility index	Study on erosion prevention from forests? Sediment excavation costs	Low	Replacement cost
Pollination	Flow	Agriculture production Biodiversity Habitat Index	Primary pollinator abundance in forests? Agriculture areas near forests?	Low	Production function
Habitat provision	Flow	Wildlife population	Population count of key species? Nursery areas for key species (e.g. *mahseer*)?	Low	Replacement cost
Research, education and nature interpretation	Flow		Qualitative description; number of studies carried out	Medium	Replacement cost
Gas regulation	Flow	Air Quality Index	Land-cover data	Low	Benefits transfer
Waste assimilation	Flow	Waste Treated	Cost of waste treatment plant	Medium	Avoided cost/ benefits transfer (land cover)
Biological control	Flow	Wildlife Population/ Diversity Index		Low	Benefits transfer (land cover)
Moderation of extreme events	Flow	Loss Avoided	Property loss avoided?	Low	Avoided damage to life and property
Coastal Regulation	Flow	Loss Avoided	Value of statistical life	Low	Avoided damage to life and property
Other services	Flow		Land-cover data	Medium	Benefits transfer

Kadekodi G.K. (2018) in his Dr. H.R. Arakeri Memorial lecture delivered at the Institute for Studies on Agriculture and Rural Development, Dharwad on August, 5, 2018 discusses the Indian government's initiatives in this direction of policy drives that can be drawn from valuation studies. Dr. Kadekodi mentioned that the study on the meaning and the value of tiger reserves (Verma et al., 2017). Among many others, the study reveals that

without tigers the total ecological value of the ecosystem services of a tiger reserve in India is in the range of US$ 251 to 292 per acre per year. The marginal value contribution per year of a tiger preserved in a 100 sq km forest is about US$ 33.69. After such a revelation (also acknowledged by the National Tiger Conservation Authority) the total number of tiger reserves in the country has been raised to 50, covering a total forest area of 71027 sq kms. The total tiger counts are expected to be in the range of 3000 in 2018. Likewise, Ninan (2016) enabled the Nagarhole Tiger Reserve to claim additional financial support to conserve both tigers and other wildlife.

The above raised policy questions and priorities discussed can be addressed by:

- ✓ Raising awareness of the importance of SEEA-EEA for policy planning and review.
- ✓ Setting and using an analytical framework for ecosystem assessment.
- ✓ Promoting consistency in the typology of ecosystems and ecosystem services.
- ✓ Biophysical mapping of ecosystem services using data and models to provide key information for policy makers and resource managers to sustainably manage important natural resources.
- ✓ Monetary and non-monetary valuation of ecosystem services.
- ✓ Mapping and valuation of ecosystem services as part of an integrated and stakeholder-based approach to sustainable land management and use of natural resources.

Constant interaction with all level stakeholders including the policy makers while conducting valuation and accounting exercise would greatly help in improving the knowledge base and understanding and would help in appropriate interventions in terms of programmes, policies and budgets and incentive-based mechanisms for sustainable management of India's resources.

MEETINGS, CONTACTS AND AVENUES FOR COOPERATION

Deliverable 3: Presentation of findings from meetings; names of people and institutions met, minutes of meetings; mapping of policy priorities, and possible avenues for their cooperation and contribution to SEEA-EEA India project

Wide consultations have been made to seek opinions of the experts as well as views of various policy makers and political leaders have been extracted from various sources. The outcomes of such meetings are summarized below in Table *7*.

Table 7: Summary of Views of Experts

S.No.	Name of the person and institutional affiliation (Date of Meeting)	Minutes of the meetings (suggested outcomes/data set creation /studies to be conducted)	Mapping of policy priorities and possible avenues for their cooperation and contribution to the SEEA EEA India project
1.	Dr. (Mrs.) Kanchan Chopra, Ex-director, Institute of Economic Growth, New Delhi (May 23, 2018)	To execute suggestions given in the Green National Accounts in India: A Framework Report , 2013 viz.; (i) to prepare Physical Supply and Use Tables (PSUT) and Asset Accounts for: land, forest and timber, and minerals; (ii) develop a medium-term plan (extending to a period of, say, 5 years) that would include (i) the preparation of MSUT for land, forest and timber, and minerals for implementing the SEEA in those sectors; (ii) the development of PSUTs and Asset Accounts for soil, water, carbon, and energy; and (iii) planning and collecting data for the purposes of valuing changes in water, carbon, and energy sectors; (iv) develop a medium-term plan for estimating NDP and (v) the development of a more complete set of national accounts, including a balance sheet for the nation; and a data manual that can be used for making adjustments to the SNA ; (vi) develop a long-term or (i) institutionalizing Physical Supply and Use Tables Mechanisms for periodic	Develop a medium-term plan for complete set of national accounts in India.

		collection of data, collecting and compiling data for valuation and preparation of Monetary Supply and Use Tables MSUTs for aquatic resources, air, and biodiversity and (vii) establishing a mechanism for estimating shadow prices and their natural ranges.	
2.	Dr. Rajesh Gopal, Secretary General, Global Tiger Forum, New Delhi (May24, 2018)	1. Economic valuation detrimental change of invasive species specially Lantana and Parthenium on the flow of ecosystem services. 2. To map the alien weeds invaded in selected Protected Areas in India. 3. To estimate value of economic and cultural value damage due to AWI. 4. To suggest appropriate management interventions and instruments/incentive-based mechanisms for eradication of AWI for PAs.	Appropriate budget allocations for AWI based on cost of damage
3.	Dr. Anandi Subramanian, Senior Economic Advisor with her colleagues Ms. Urmila, Joint Director, Ms. Poonam, GIS expert, Kumar Rajneesh, National Programme Co-ordinator, ENVIS.; Ministry of Environment, Forest and Climate Change, GoI, New Delhi (May 30, 2018 and June 13, 2018)	1. Generation of environmental data sets to develop Green Skills by generating grid-based district-wise data to survey. 2. Intensive work on invasive species and valuation of damaged ecosystems because of their invasion. 3. Complete documentation of para taxonomy and then its economic and non-economic value. 4. Creation of a hub for decision support system on valuation to the Ministry. 5. Bio geographic zone-wise valuation studies. 6. Case study on cold desert areas and grass/feed lands. 7. Stock and flow of natural accounting. 8. Institutional mapping for undertaking environmental valuation work. 9. Awareness building of value of natural resources. 10. Linkage study on sustainable development goals and national biodiversity targets. 11. Influential case studies on specific ecosystem services and ecosystems. 12. Modelling of ecosystems services.	Building of skills for generation of data bases for modelling mapping and monetisation of ecosystem services and subsequent preparation of green accounts of the country Creation of sample models of valuation Preparation of complete green accounts for resource's

4.	Shri Piyush Dogra, Environment Specialist, The World Bank, New Delhi (May 31, 2018)	1. Studies required for forest fire damage and eco-tourism value. 2. Valuation model to be used for precise valuation outcomes.	Capacity building for modelling and valuation of ecosystems to signal appropriate interventions to avert damages to ecosystems
5.	Shri Anupam Joshi, Sr. Environmental Specialist, The World Bank, New Delhi (June 06, 2018)	1. Creation of forest sector assets account across various states. 2. Modelling ecosystem services incremental change on account of ecosystem services improvement project. 3. Estimation of value addition potential of various NTFPs for developing livelihood support model. 4. Conducting intensive study on vegetation type and linkages with sedimentation and water flows. 5. Develop value addition and full value chain from NTFPs.	Preparation of country-wide forest asset accounts Valuation of NTFPS throughout its supply chain
6.	Shri Mark Gough, ED, Natural Capital Coalition, UK (June 06, 2018)	Corporate Environmental Accounting to capture positive and negative externalities across varied nature industries.	Mandatory building of corporate environmental accounts to reflect company's environmental responsibility and connect with their shareholders value
7.	Shri Swapan Mehra, CEO, IORA Ecological Solutions, New Delhi	1. Connect sustainability reports of companies with business and biodiversity conservation: to conduct corporate environmental accounting study to connect biodiversity with the business for a few major industries.	Sustainability Reports to internalize Externalities accounts

	(June 06, 2018)	2. Connecting SDGs with the natural resource conservation and expressing the integration through an index and internalizing the same in SEEA-EEA.	and company's investment on environment amelioration. Accounts to reflect business biodiversity connect.
8.	Shri Jigmet Tapka, Joint Secretary, Ministry of Environment, Forest and Climate Change, GoI, New Delhi (June 06, 2018)	Capturing the value of incremental change as a result of the conservation model developed in Ladakh in the last 20 years at landscape level covering both protected and non-protected areas with a focus on uniqueness value of the region.	Economic valuation of conservation of critical areas and linking the estimates with economic instruments
9.	Dr. Pushpam Kumar, Director, Ecosystem Services, UNEP, Nairobi, Kenya (June 06, 2018)	Mapping natural capital across with various sustainable development goals for assessing and accounting natural capital for achieving sustainable development goals.	States SEEA-EEA to be linked with the index for sustainable performance
10.	Shri Soumitra Dasgupta, AIG(WL), Ministry of Environment, Forest and Climate Change, GoI, New Delhi (June 14, 2018)	To get Protected Area Valuation and Accounting done for all PAs of the country based on the value a set of economic instruments to be created for their conservation and creation of corridors of animals.	Template for creating Protected Area Accounts
11.	Dr. Gopal Kadekodi, Ex-Director, ISEC Bangalore and	To create templates for valuation of ecosystem services across various biomes /ecosystems need to take the valuation work forward to produce	Building SEEA-EEA for States/Ecosystems and

	CMDR and Professor, IEG, New Delhi (August 24, 2018)	integrated Environmental-Economic Accounts and link the performance of states with set of incentives, rewards, payments and fines	creation of payments for Ecosystem mechanism
16.	Dr. K.N. Ninan, Ex. Head of the CEENR, ISEC, Bangalore, Chairperson, CEES, Bangalore. (August 24, 2018)	Need to do scenario analysis of Protected Areas with at least some case studies assessing drivers/changes impacting PAs and what proactive steps be taken to address their sustainable PA management for 25 to 50 years. Need for improvements in collection of forest data especially species and region-wise data on growing stock, biomass expansion factor (BEF) for different species, wood density and root to shoot ratio, dominant forest species in different forest regions/types. Need for more scientific data/studies for different forest types/region to generate data on evaporation/ runoff, soil erosion rates. Need to include these data in state forest report and compendium of environmental statistics published by CSO. Publication of short findings, briefs based on these in-depth studies for benefit of policy makers/practitioners and non-experts Need for more rigorous valuation studies of forest ecosystem services in different PAs, Wetlands, Mangroves, etc.	Capacity building programmes for policy makers, state Government officials and researchers in green accounting, valuation.

Various policy makers and political leaders have also recently been highlighting the need for Greening of the GDP of India. Excerpts from some such talks/statements are as follows:

1. **Shri Feroze Varun Gandhi, Member of Parliament, representing the Sultanpur constituency for the BJP:** India must calculate its green GDP to factor in the value of environment in its growth (*The Hindu*: May 24, 2018).

Natural Capital in the 21st Century

India must calculate 'its green GDP' to factor in the value of the environment in its growth

In his article for *The Hindu* he pointed out that India suffered a cost of $550 billion, about 8.5 per cent of GDP, due to air pollution, according to a World Bank report; the cost of externalities such as water pollution and land degradation were possibly far higher. Through commodity exports, we effectively transfer natural capital to our trade partners, raising the risk of desertification and land being degraded significantly. Within a century, our food production could see a loss of 10-40 per cent if these trends continue. So when we about GDP growth, we should also consider the decline in natural capital in our national accounts.

Estimation is a challenge

Many economists have pushed for an "environmental Kuznets curve", highlighting that the 'relationship between GDP per capita and the concentration of Sulphur Dioxide in the local air' is an inverted U curve. Such a relationship leads to the postulation that people from 'developing countries cannot place a weight on natural environment' and should consider pollution as an acceptable side-effect of GDP growth.

While India might have a GDP of $2.65 trillion in nominal terms, it fails to take into account the externalities of such economic growth. For example, India routinely suffers from high levels of air pollution that impose costs on local transport, health and liveability in urban and rural areas. When economic growth leads to the destruction of forests, wetlands and woodlands for agriculture, mining or even urban expansion, it is typically the poorest of the traditional dwellers who suffer. Ecological collapse can soon come, examples being the Darfur region in Sudan and countries in the Horn of Africa. All were subject to rapid socio-economic decline.

Some Attempts

India has sought to unveil "green GDP" figures in the past. In 2009, the Centre announced that it would publish a "green GDP" that would include the environmental costs of degrading and depleting our forests, grasslands and natural stock. An expert programme, sponsored by the Ministry of Statistics and Programme Implementation, released a Compendium of Environment Statistics 2013. While the Twelfth Five Year Plan undertook groundwater resource mapping at the national level, a similar focus is essential for data on land usage, forests and mineral wealth. 'India's current national accounts incorporate such environmental considerations in a limited fashion'. GDP includes the value of: minerals extracted; timber, fuelwood and non-timber forest products; natural growth of cultivated assets for some crops; and the output from dung manure. In addition, 'gross fixed capital formation contains output estimates from the improvement of land along with irrigation works and flood control projects'. However, even in GDP estimates of timber value, there is significant under-estimation — non-monetized goods and services provided from timber forests are not considered.

India should seek to publish "green GDP" figures that take into account depreciation of natural capital stock due to economic exploitation and environmental degradation. This can follow the template provided by the UN's System of Environmental-Economic Accounting.

A few studies have tried to document the ecological services offered by the natural capital in India. But we need a 'greater push for empirical studies of the potential value of such ecosystem services'. Adapting our national accounts in line with this framework will help in incorporating the value of the environment in our growth while helping us to focus on developing a feasible transition path to a green economy.

2. **Shri C.K. Mishra, Secretary, MoEFCC** : Green GDP is an important tool to factor in the impact of climate change and take suitable measures to correct such externalities (World Environment Day - High Level Dialogue Series, June 4, 2018).

The author also sought suggestions of the Experts, UNSD, UNDP and CSO team members on selection of case studies for a comprehensive set of state accounts as per SEEA-EEA framework, who recommended that the author should use the findings of landscape assessment and also advised to consider other factors like number of biomes in the state percentage forest cover, replicability of the case, openness of the state for such studies, presence and capacity of research institutes available to undertake such work. Table 10 in Section Four provides detailed justification of selection of state (s) using the above criteria.

IDENTIFICATION OF POTENTIAL CASE STUDIES

Deliverable 4:

- **Comprehensive list of potential case studies that may be undertaken as part of SEEA-EEA India.**
- **Priority 2-3 case studies for SEEA-EEA India, taking into account factors such as data availability and policy relevance, and clearly articulating the thematic and geographical scope of each case studies.**
- **For each of these case studies, identify relevant stakeholders, partners, and data sources.**
- **For each of these case studies, detail the policy questions being responded to by the compilation of ecosystem accounts, and map the relevant government agencies and departments with these policy questions.**
- **For each of these case studies, identify the scope of ecosystem asset and flow accounts to be part of the physical and monetary accounts for India.**
- **Develop a work programme to develop these accounts, including deliverables and timelines.**

Based on the all India review of studies in the previous section, current data availability and capacity to use modelling frameworks, a prerequisite for proper location of ecosystem services and based on ecosystem extent and conditions in the domain of ecosystem services valuation and green accounting, the following set of studies are proposed to cover the gap areas in individual ecosystem service based on primary studies, application of mapping tools for biophysical modelling, use of DPSIR frameworks, ecosystem type coverage, economy sector wise application of valuation and accounting tools and further they cover the spatial aspects and to cover the current requirement of SDGs and National Biodiversity Targets, their integration with SEEA-EEA and the current methodology of valuation including participatory methods as emphasized in ongoing IPBES assessments. The recommendations for the studies are based on the following nine selected criteria as stated below:

- Region
- Number of biomes
- Percentage of forest cover
- Unique ecosystems present in the state
- Replicability of accounts across states.
- Openness of the state to this kind of work is an important criterion for the work to be successful
- Presence and capacity of research institutes
- Spatial data availability
- Availability of earlier studies

The states have been scored and selected based on the literature review, authors experience in previous assignments and experts' interviews.

Criteria	Weightage		Score
No. of biomes	"+++"	5 and above	5
	"++"	3-5	3
	"+"	1-2	1
Percentage of Forest cover	"+++"	8 and above	5
	"++"	4-8 %	3
	"+"	0-4 %	1
Replicability	"+++"	More than 6 states	5
	"++"	3-6 states	3
	"+"	0-3 states	1
Openness	"+++"	Highly Proactive	5
	"++"	Moderate	3
	"+"	Low	1
Presence and capacity of research institutes (c)	"+++"	More than 4	5
	"++"	2 to 4	3
	"+"	0 -2	1
Spatial (economic and biophysical) data availability (D)	"+++"	Based on authors' previous assignments	5
	"++"		3
	"+"		1
Availability of earlier studies (E)	"+++"	More than 7	5
	"++"	4 to 7	3
	"+"	0-3	1

Table 8: States Scored Based on Selection Criteria

Region	State	No. of Biomes	% of Total Forest Cover of India	Score Based on Forest Area/Cover (1)	Zone Covered	Replicability of Accounts Across States. (A)	Openness of The State to This Kind of Work (B)	Presence and Capacity of Research Institutes (C)	Spatial (Economic and Biophysical) Data Availability (D)	Availability of Earlier Studies (E)	Score A-E	Total Score (1 + A-E)	State Selected
CENTRAL AND EASTERN REGION	Bihar	2	1.03	2	Gangetic Plain	"++"	"+"	"+"	"++"	"+"	7	9	**Madhya Pradesh**
CENTRAL AND EASTERN REGION	Chhattisgarh	2	7.84	4	Central Deccan Plateau	"++"	"+"	"+"	"++"	"+"	7	11	
CENTRAL AND EASTERN REGION	Jharkhand	2	3.33	2	Central Deccan Plateau	"++"	"+++"	"+"	"++"	"+"	13	15	
CENTRAL AND EASTERN REGION	Madhya Pradesh	3	10.93	8	Central Deccan Plateau, Lower Ganagetic Plains	"+++"	"++"	"++"	"+++"	"++"	19	**27**	
CENTRAL AND EASTERN REGION	Odisha	3	7.25	6	Eastern Ghats, Coastal	"++"	"+"	"+"	"++"	"+"	9	15	
CENTRAL AND EASTERN REGION	West Bengal	7	1.67	6	Trans Himalayas, Mangroves	"+++"	"++"	"+"	"++"	"+++"	17	23	
NORTH EASTERN REGION	Arunachal Pradesh	4	7.28	6	Trans Himalayas, Himalayas	"+++"	"++"	"+"	"+++"	"++"	15	21	**Assam**
NORTH EASTERN REGION	Assam	3	3.97	4	Eastern Himalayas	"+++"	"+++"	"++"	"+++"	"+++"	23	**27**	
NORTH EASTERN REGION	Manipur	2	2.45	2	Eastern Himalayas	"++"	"+"	"++"	"+"	"+"	9	11	
NORTH EASTERN REGION	Meghalaya		2.42	2	Eastern Himalayas	"++"	"+"	"++"	"+"	"+"	9	11	

NORTH EASTERN REGION	Mizoram	1	2.57	2	Eastern Himalayas	"++"	"+"	"++"	"+"	"+"	9	11	
NORTH EASTERN REGION	Nagaland	3	1.76	4	Eastern Himalayas	"++"	"+"	"++"	"+"	"+"	9	13	
NORTH EASTERN REGION	Sikkim	5	0.47	6	Eastern Himalayas	"+++"	"++"	"+++"	"++"	"+"	17	23	
NORTH EASTERN REGION	Tripura	1	1.09	1	Eastern Himalayas	"++"	"+"	"++"	"+"	"+"	9	10	
NORTHERN REGION	Haryana	3	0.22	4	Desert, Upper Gangetic	"+"	"+"	"+"	"+"	"+"	5	9	
NORTHERN REGION	Himachal Pradesh	6	2.13	6	Trans Himalayas, Himalayas, Upper Gangetic Plains	"+++"	"+++"	"++"	"+++"	"+++"	25	24	
NORTHERN REGION	Jammu and Kashmir	5	3.28	6	Trans Himalayas, Himalayas,	"++"	"++"	"+"	"+"	"++"	11	17	
NORTHERN REGION	Punjab	2	0.26	2	Desert, Upper Gangetic	"+"	"+"	"+"	"+"	"+"	5	7	
NORTHERN REGION	Uttar Pradesh	3	2.07	4	Desert, Upper Gangetic, Lower Gangetic plains	"++"	"+"	"+++"	"++"	"+"	13	17	
NORTHERN REGION	Uttarakhand	6	3.43	6	Trans Himalayas, Himalayas, Gangetic Plains	"+++"	"+++"	"+++"	"+++"	"+++"	25	**31**	**Uttarakhand**
SOUTHERN REGION	Andhra Pradesh	4	3.97	4	Western Ghats, Coastal, Deccan Peninsula, Eastern Ghats	"++"	"++"	"++"	"+++"	"++"	19	23	

SOUTHERN REGION	Karnataka	3	5.30	6	Western Ghats, Coastal, Deccan Peninsula, Eastern Ghats	"++"	"++"	"++"	"+++"	"+++"	25	**29**	**Karnataka**
SOUTHERN REGION	Kerala	1	2.87	2	Western Ghats, Coastal, Deccan Peninsula	"++"	"++"	"++"	"++"	"++"	15	17	
SOUTHERN REGION	Telengana	4	2.88	4	Western Ghats, Coastal, Deccan Peninsula, Eastern Ghats	"++"	"++"	"++"	"++"	"++"	15	19	
SOUTHERN REGION	Tamil Nadu	4	3.71	4	Western Ghats, Coastal, Deccan Peninsula	"++"	"++"	"+++"	"+++"	"+++"	21	25	
WESTERN REGION	Goa	1	0.31	2	Western Ghats, Coastal	"++"	"++"	"++"	"++"	"++"	15	17	**Rajasthan**
WESTERN REGION	Gujarat	5	2.08	6	Desert, Western Ghats	"++"	"++"	"++"	"++"	"+++"	17	21	
WESTERN REGION	Maharashtra	4	7.16	6	Western Ghats, Coastal	"++"	"++"	"++"	"++"	"++"	15	21	
WESTERN REGION	Rajasthan	3	2.34	4	Desert	"++"	"+++"	"++"	"+++"	"++"	19	**23**	

From Table 8, one state from each of the five regions has been selected based on the scores assigned to them. The five states are: Madhya Pradesh, Assam, Uttarakhand, Karnataka and Rajasthan.

Based on the rank matrix and literature review the following case studies were selected for conduct: A) State-Level Studies in Madhya Pradesh, Assam, Uttarakhand, Karnataka and Rajasthan; B) Primary Studies for Individual Ecosystem Services of Pollination; Gene Pool; Biological Control; and Gas Regulation; C) Study of Ecosystem Disservice of Alien Weed Invasion; and D) a Spatial Dimension Study on Urban Landscapes. The table below provides further detail on the coverage and rationale for each study.

<table>
<tr><th colspan="3">A. State Level Study</th></tr>
<tr><th>S.No.</th><th>Study Title (Score)</th><th>Coverage</th></tr>
<tr><td>1.</td><td>CASE STUDY I. Economic valuation and natural capital accounting for UTTARAKHAND (31)</td><td>Comprehensive set of State Accounts based on SEEA-EEA framework (ecosystem conditions, spatial dimension and variety of biomes and policy response)</td></tr>
<tr><td colspan="3">Rationale for the case study: The state's profile describes abundant natural resources present in the state needs sustainable utilization and management, therefore, a resource accounting exercise will aid in achieving it. According to the available studies complete economic valuation and accounting as per SEEA-EEA 2003 framework of Uttarakhand has been done earlier in the study (Madhu Verma 2007) for Henrich Boil Foundation, 13th and 14th study for Finance Commission of India (2009 and 2014), recent study on Green Accounting of Forest Resources, Framework for Other Natural Resources and Index for Sustainable Environmental Performance for Uttarakhand State (Draft) and in addition to this considerable work in ecosystem services valuation, payment for ecosystem services has been conducted in some of pristine areas of Corbett National Park and Himalayan regions. In terms of availability of the data, Uttarakhand may be selected as one of the case studies as it would be easier to identify the data gaps based on the previous studies. A detailed note for selection of the state has been attached in the case study in the next section of the report.</td></tr>
<tr><td>2.</td><td>CASE STUDY II: Economic valuation and natural capital accounting for KARNATAKA (29)</td><td>Comprehensive set of State Accounts based on SEEA-EEA framework (ecosystem conditions, spatial dimension and variety of biomes and policy response)</td></tr>
<tr><td colspan="3">Rationale for the case study: Owing to the richness of states for natural resources, the Central Statistics Organization in 2008 conducted a Natural Resource Accounting Study for the Land and Forestry Sector (excluding mining) using the SEEA 2003 framework. Under this project, eight case studies were conducted in forests, viz. value of NTFPs, grazing services for livestock, recreational value of Dandeli wildlife sanctuary, carbon sequestration of forests, valuation of fuelwood, value of medicinal plants, contribution of sacred groves and water benefits of forests. Using the physical flow of accounts, the land resources were estimated for soil restoration based on the restoration cost method. A detailed note for the case study is given below.</td></tr>
</table>

3.	CASE STUDY III. Economic Valuation and Natural Capital Accounting for MADHYA PRADESH (27)	Comprehensive set of State Accounts based on SEEA-EEA framework (ecosystem conditions, spatial dimension and variety of biomes and policy response)
Rationale for the case study: Even though Madhya Pradesh is highly enriched in natural resources still the state has observed a series of events like drought, food insecurity, climate change etc. Several programmes for drought recovery and climate change adaptation have been carried out throughout the state but the state still faces these problems. In the few decades the state has also observed many cases for illegal extraction of minerals which is one of the main concern for sustainable growth of the state. In order to ensure implementation due attention is given to forests and natural resources of the state, given their immense contribution to the society and economy, it is imperative to assess and value them appropriately. With such a high endowment of natural forests and other natural resources, ecosystem accounts will certainly help recognizing that the management of these resources is also of relevance in economic, planning, development and social policy contexts.		
4.	CASE STUDY IV. Economic Valuation and Natural Capital Accounting for ASSAM (27)	Comprehensive set of State Accounts based on SEEA-EEA framework (ecosystem conditions, spatial dimension and variety of biomes and policy response)
	Rationale for the case study: There are many studies conducted on diverse issues pertaining to natural resources, ecosystem services and valuation of its rich natural resorces in the state of Assam. Hence the data is available in a spatial-temporal fashion and can be extrapolated. Since Assam is the gateway to the land of seven-sisters comprising the states of Arunachal Pradesh, Manipur, Meghalaya, Mizoram, Nagaland and Tripura, the ecosystem valuation studies can also be replicated to other north – eastern parts. Assam shares the same physiography with the other sister states as a land of majestic mountains, mighty rivers, lovely woods, waterfalls, and serene silences.	
5.	CASE STUDY V: Economic Valuation and Natural Capital Accounting for RAJASTHAN (23)	Comprehensive set of State Accounts based on SEEA-EEA framework (ecosystem conditions, spatial dimension and variety of biomes and policy response)
	Rationale for the case study: This state also has the unique desert ecosystem, whereby the locals harvest resources from the deserts. This particular ecosystem has its own challenges that will aid in understanding and improving the ecosystem accounting processes for similar habitats in the world. Also, IIFM is conducting a study on valuation of economic contribution of forests and protected areas in the state along with capacity development of forest personnel on forest resource valuation. The state has replicability for states such as Gujarat, Haryana, and other desert states as well.	

B.	**Primary Studies on Estimation of Individual Ecosystem Services**	
6.	CASE STUDY VI. POLLINATION SERVICES	Measurement of ecosystem condition in assessing policy responses The selected ecosystem services are important as they contribute largely to the ecology of any biome. Despite this, these services rarely have any primary data available specific to India. Hence in most of the studies it was found that the appropriate valuation method was not being used to estimate the contribution of these services and therefore, these services were selected.
7.	CASE STUDY VII. GENE POOL	
8.	CASE STUDY VIII. BIOLOGICAL CONTROL	
9.	CASE STUDY IX. GAS REGULATION	
C.	**Ecosystem Disservice**	
10.	CASE STUDY X. Economic Valuation of Damage Due to Alien Weeds Invasion in Selected Protected Areas of India	Measurement of ecosystem condition in assessing policy responses.
D.	**Spatial Dimension Study : Urban Landscape and Ecosystem Services**	
11.	CASE STUDY XI: Economic Valuation of Ecosystem Services within Urban Ecosystem: Pilot study in two Indian cities- Delhi and Bhopal	Spatial Dimension and Biomes: Ecosystem Extent and Condition

The proposed studies have strong relevance to SEEA Accounts which expressed in the below Table 11 below.

Table 9: Mapping of Case Studies as Per SEEA-EEA Accounts

Case studies for respective SEEA Accounts	**State SEEA-Accounts**	**Primary Studies on Estimation of Individual Ecosystem Services**	**Ecosystem Dis-service**	**Spatial Dimension Study : Urban Landscape and Ecosystem Services**
Ecosystem Extent and Ecosystem Condition Accounts	✓	✓	✓	✓
Ecosystem Services	✓	✓		✓

Thematic Biodiversity, Water, Carbon and Land Accounts	✓			✓
SEEA-CF Physical Asset Accounts	✓			✓

CASE STUDY I: ECONOMIC VALUATION AND NATURAL CAPITAL ACCOUNTING FOR UTTARAKHAND

Introduction

Uttarakhand formerly known as Uttaranchal is a land of natural beauty, comprising 93 per cent mountainous and 71 per cent forest cover. Uttarakhand is often referred to as the Dev-bhumi ("Abode of Gods") due to many Hindu temples and is a major place of attraction for pilgrims and tourists. Its geographical location, the climate and vegetation of the region vary greatly with the elevation and is an eco-sensitive zone (Table *10*). Uttarakhand is known for the natural environment of the Himalayas, the Bhabhar and the Terai (Figure 17).

Figure 14: Uttarakhand State Boundary

Table 10: Demography of Uttarakhand

Geographic area (sq km)	53,843
Population (Census 2011)	10,086,292
Rural Population (%)	69.76
Number of districts	13
Agricultural land (% of total geographical area)	13.20
Recorded Forest Area (km2)	38,000
Per capita forest area (ha)	0.37
Forest area as percentage of geographical area	70.57
Forest cover (km2)	24,240
Major rivers	Ganga, Yamuna, Sarju and Kali
Major Source of Occupation	Agriculture, forest-based activities

Uttarakhand's Ecological Profile

Uttarakhand State, according to FSI 2017, has a total Recorded Forest Area of 38,000 Km^2 under various classes (Forest Survey of India, 2017), and has more than 12,000 glaciers and 8 major river catchments which act as the lifeline for the entire hydrological system of the Indo-Gangetic plain.

The forest cover as reported in ISFR 2017 is 24,295 Km^2 which includes 4969 Km^2 under Very Dense Forest (VDF), 12884 Km^2 Moderately Dense Forest(MDF), and 6442 Km^2 Open Forest (OF). The state also has 767 Km^2 under Tree Cover (Figure 15). In addition to this Uttarakhand has 355 Km^2 of area under water bodies in forest area and total carbon stock of 284.664 million tonnes (Forest Survey of India, 2017).

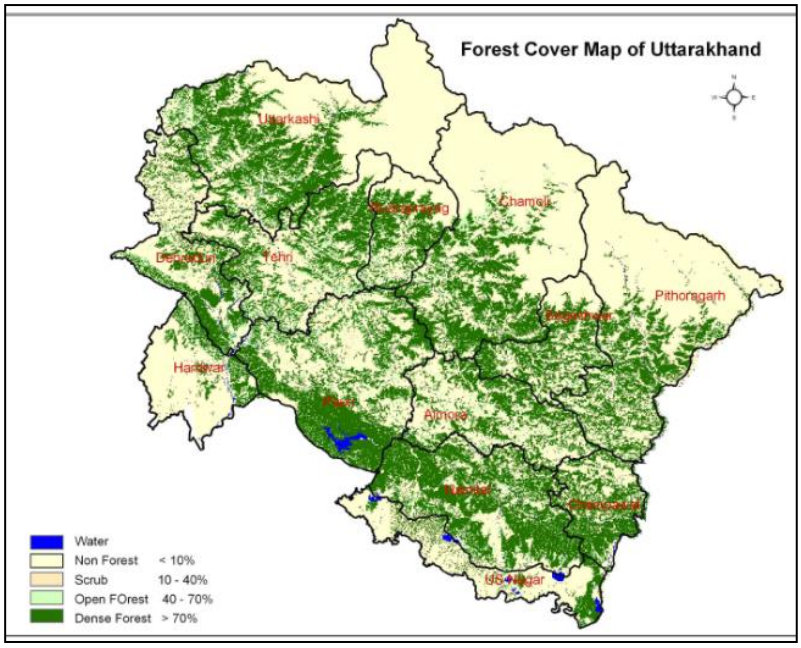

Figure 15: Forest Cover Map of Uttarakhand

(Source: Uttarakhand State Perspective and Strategic Plan)

The large forest area and unique climate contributes largely towards meeting national and international environmental commitments of India such as in achieving the national target of 33 per cent of forest cover, carbon sequestration, providing a livelihood, timber fodder, clean air, water and in achieving SDGs'. The forests of Uttarakhand are also critical owing to the rivers that emanate in the state and flow through them, with a large part of downstream India depending on resultant water resource.

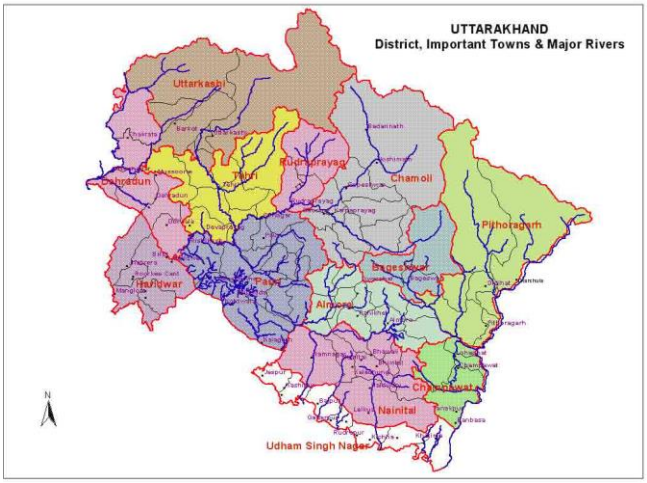

Figure 16: River Drainage Network of Uttarakhand

There are four major river systems viz. Ganga, Yamuna, Ramganga and Sharda originating from the state along with their tributaries which are major sources of water for drinking, irrigation and hydropower (Figure 19).

Uttarakhand has soil distribution which is generally fully shallow, gritty, impregnated with unweathered fragments of parent rocks and are not fully fertile.

Important minerals that are found in the state are high-grade limestone in Almora, Bageshwar, Dehradun, Nainital, Pauri-Garhwal, Pithoragarh and Tehri-Garhwal districts; magnesite and steatite in Almora, Bageshwar, Chamoli and Pithoragarh districts; and tungsten in Almora district.

Other minerals found in the state are asbestos in Chamoli district; barytes and marble in Dehradun district; copper in Almora, Dehradun and Pithoragarh districts; dolomite in Dehradun, Nainital and Tehri-Garhwal districts; graphite in Almora district; gypsum in Dehradun, Pauri-Garhwal and Tehri-Garhwal districts; lead-zinc and silver in Dehradun and Pithoragarh districts; and rock phosphate in Dehradun and Tehri-Garhwal districts. The production value of mineral in Uttarakhand was 89 crores in 2015-16.

Rationale for SEEA EEA Accounting in Uttarakhand

Uttarakhand has hilly and mountainous terrain that is prone to natural disasters, the state of Uttarakhand falls within Zone IV and Zone V of seismicity. Nineteen per cent of the state area is under permanent snow cover, glaciers and steep slopes where it is not possible to grow trees owing to physical limitations. The state of Uttarakhand is also prone to massive natural calamities, such as rains, cloudbursts, flash floods, landslides, floods, hailstorms and water logging events.

Despite these constraints, Uttarakhand offers a rich natural base which provides several benefits not only to the state but to the entire country and the rest of the world, the current recorded contribution of Natural Resources (Agriculture, Forestry, Fishing, Mining and Quarrying) in the Gross State Domestic Product of Uttarakhand is reflected as 10.28 per cent only.

Due attention is given to forests and natural resources in the state, given their huge potential to contribute in the society and economy, it is imperative to assess and value them appropriately. With such a high endowment of natural forests and other natural resources ecosystem accounts will provide several important pieces of information in support of policy and decision-making relating to environment and natural resources management, recognizing that the management of these resources are of relevant in economic planning, development and social policy contexts.

Justification for Selection of State for SEEA-EEA Accounting Case Study

Uttarakhand in the light of making a substantial contribution towards sustainable development has made several efforts in the field of valuation and accounting of forest resources, partial implementation of payment for ecosystems and is a leading state in conducting research work in the field of environment and forests. Extensive work has been done on ecosystem valuation on Jim Corbett National Park located in Nainital district of Uttarakhand.

One of the recent studies conducted by the Indian Institute of Forest Management to assertain the economic value of the state's natural resources and contribution, it was found that the total flow value of ecosystem services from Uttarakhand's forests are nearly around 95,000 crores. (IIFM, 2018).

Table 11: Economic Value Estimates for Different Ecosystem Services

Ecosystem Services	**Economic Value (INR crores)**
Provisioning Services (A)	**13,018.20**
Regulating Services (B)	**80,771.10**

Cultural Services (C)	9.9
Supporting Services (D)	**1313.4**
Total	95,112.60

The study also highlights the importance of monitoring the health of the state's natural resources actively and the development of Sustainable Environment Performance Index (SEPI).

The index aggregates indicators that reflect:

1. State of air quality, water quality, land use and agriculture, forests and biodiversity.
2. Measures of the impact of the current state of the environment and resource extraction on ecosystem and human health.
3. Policy responses and society's efforts to preserve the environment, and
4. India's commitment towards the SDGs covering the issues and aspects of the sustainable environment that are relevant for policy analysis and decision-making.

Keeping in view the recent studies, research work undertaken in the past in the field of valuation and accounting, ecological importance of the state and its contribution in terms of ecological benefits, Uttarakhand may be considered as an ideal state for a case study to develop full-fledged SEEA EEA accounting using the SEEA-EEA framework (Figure 23).

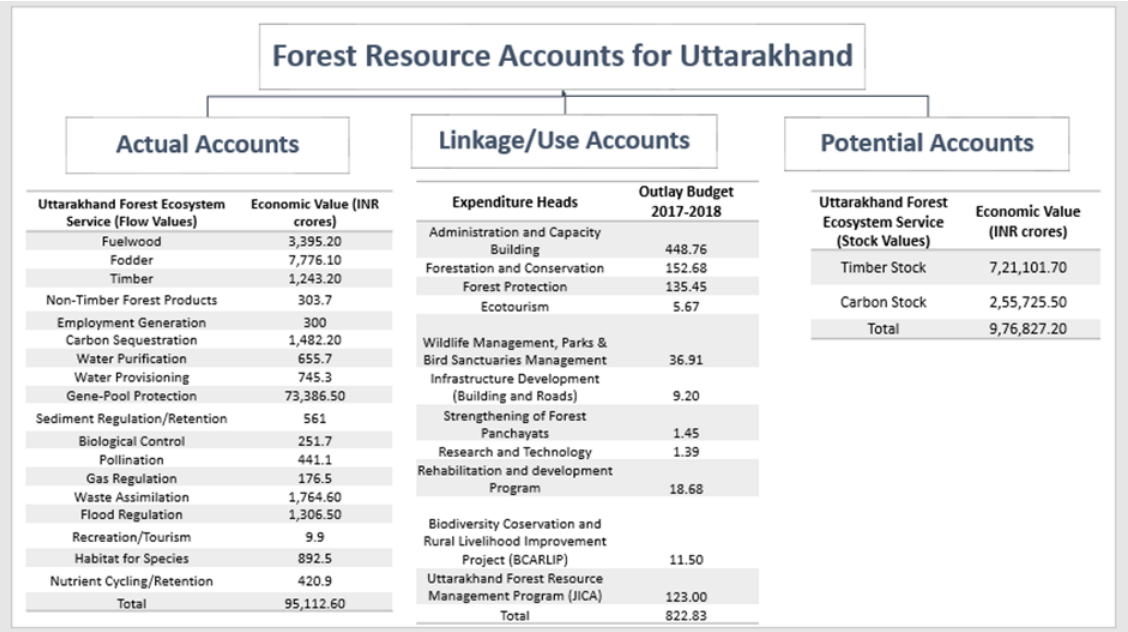

Figure 17: Forest Resource Accounting for Uttarakhand (Xu. et al. 1995)

Recommended Institutes

Some of the major institutes who have conducted studies in allied fields are the Indian Council of Forestry Research and Education (ICFRE), Forest Survey of India (FSI), Forest Research Institute(FRI), Indian Institute of Forest Management(IIFM), Institute of

Himalayan Environmental Research and Education (INHERE), GB Pant Institute of Himalayan Environment and Development(GBIHED).

The Indian Institute of Forest Management has been working in the field of Ecosystem Service valuation for the past 2 decades. IIFM's study for the 13th and 14th Finance Commission has made a significant impact on the allocation of funds for the forestry sector. As a result, the 13th Finance Commission increased the allocation of budget under the forestry sector from 1000 crores to 5000 crores and further the 14th Finance Commission for the first time, incorporated forest cover into the main formula for the allocation of the single, divisible pool of taxes among the states.

Also, IIFM has conducted many studies in economic valuation and natural resources accounting in Himachal Pradesh and Madhya Pradesh for CSO and the Himachal Pradesh Forest Department in 2005-06 and 2013-17 and currently accomplishing total assets and flow services from Uttarakhand's forest using the SEEA framework.

IIFM Team has also undertaken capacity building programmes at the Statistics Finland and LUKE, NRM Institute Finland and has experience of natural resource accounting being done in Finland.

Given below is the list of institutes working actively in Uttarakhand and can be selected for conducting research and case studies.

Institutions Working in Uttarakhand
A. In Dehradun
Directorate of Economics and Statistics
Indian Council of Forestry Research and Education (ICFRE)
Forest Survey of India (FSI)
Forest Research Institute(FRI)
Rural Livelihoods Entitlement Kendra (RLEK)
Institute of Himalayan Environmental Research and Education (INHERE)
National Sample Survey Office (NSSO)
Indian Institute of Remote Sensing
People's Science Institute (PSI)
National Institute of Hydrology (NIH)
Wadia Institute of Himalayan Geology
Himmotthan Society
Centre for Ecology development and Research (CEDAR)
Indian Institute of Soil and Water Conservation (IISWC)
B. In Pantnagar
GB Pant Institute of Himalayan Environment and Development
C. In Delhi
The World Bank – executed BCRLIP project which generated complete atlas of the landscape and watershed maps for Uttarakhand state
World Wide Fund (WWF), New Delhi
D. Bhopal
Indian Institute of Forest Management (IIFM), Bhopal

List of policy questions relevant to the state of Uttarakhand

- What are the drivers causing changes in Uttarakhand's ecosystems and their services?

- What are the status and trends of Uttarakhand's ecosystems and the services they provide to society?
- How should the Government and all relevant stakeholders incorporate the economic values of ecosystem services into decision-making?
- What is the influence of ecosystem services provisioning on human well-being inside and outside the state?
- Who and where are the beneficiaries of ecosystem services flow, and how does this affect how they are valued and managed?
- How can we promote further investments in conservation and creation of green infrastructure and preventing damage?
- How can we minimise cost of inaction and benefits of action?
- How can we identify and prioritize the sectors which needs immediate attention for sustainable development and management of natural resources?
- How can national indicators for sustainable development be integrated into the SEEA which can help to support reporting on progress towards SDG targets?
- How can we create a synergy between different departments/institutions/policy makers/ministry/etc. working in this domain?
- How can improved investment be based on cost of damage of catchment?

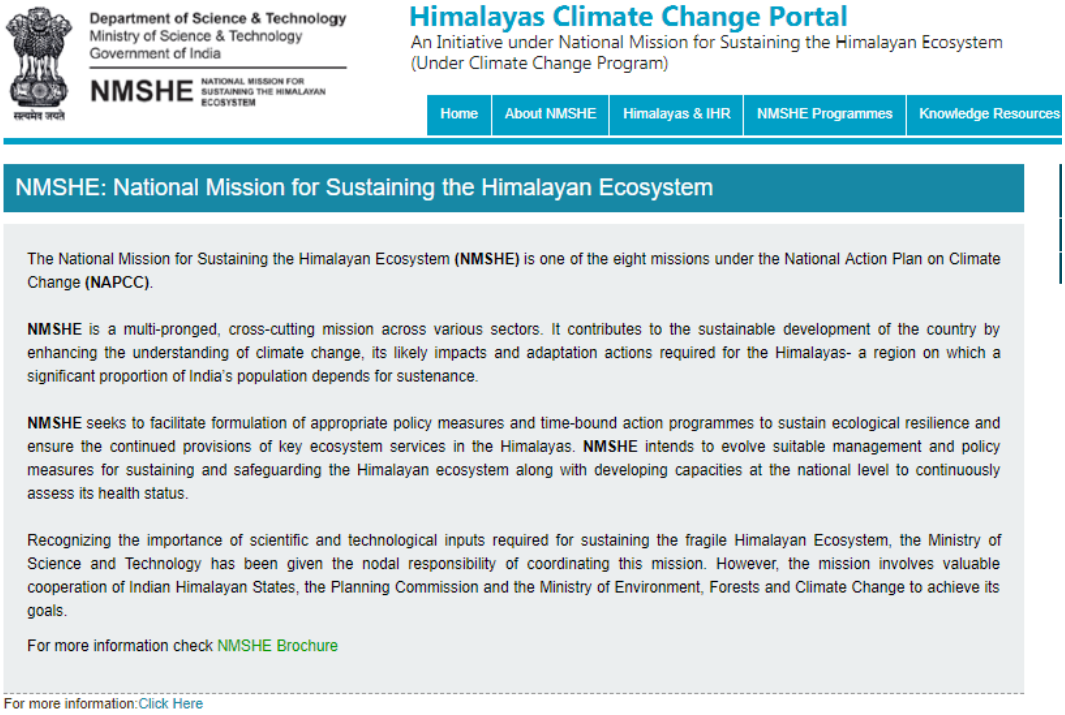

Figure 18: One of the Important Mission Where SEEA-EEA Accounting May Help

Major Attributes of Uttarakhand for Suitability for State Level Case for SEEA-EEA

<table>
<tr><th>S.No.</th><th>Attribute</th><th>Uttarakhand</th></tr>
<tr><td></td><td></td><td></td></tr>
<tr><td>1.</td><td>Area of the state (square km)</td><td>53483</td></tr>
<tr><td>2.</td><td>Population</td><td>10116752</td></tr>
<tr><td>3.</td><td>No. of Biomes</td><td>1. Tropical and subtropical moist broadleaf forests
2. Tropical and subtropical coniferous forests
3. Temperate broadleaf and mixed forests
4. Temperate coniferous forests
5. Tropical and subtropical grasslands, savannas, and shrublands
6. Montane grasslands and shrublands</td></tr>
<tr><td>4.</td><td>Ecosystems Mapped</td><td>Forests, Wetlands, Glaciers/Himalayan Ecosystem (Cold Desert), Riverine, Agriculture, Grassland</td></tr>
<tr><td>5.</td><td>Land-Use Pattern</td><td>
<table>
<tr><th>Land Use</th><th>Area (in thousands) (ha)</th><th>Percentage</th></tr>
<tr><td>Total geographical area</td><td>5348</td><td>NA</td></tr>
<tr><td>Reporting area for land utilization</td><td>5673</td><td>100.00</td></tr>
<tr><td>Forests</td><td>3486</td><td>61.45</td></tr>
<tr><td>Not available for cultivation</td><td>441</td><td>7.77</td></tr>
<tr><td>Permanent pastures and other grazing lands</td><td>199</td><td>3.51</td></tr>
<tr><td>Land under misc. tree crops and groves</td><td>384</td><td>6.77</td></tr>
<tr><td>Culturable wasteland</td><td>303</td><td>5.34</td></tr>
<tr><td>Fallow lands other than current fallows</td><td>71</td><td>1.25</td></tr>
<tr><td>Current fallows</td><td>35</td><td>0.62</td></tr>
<tr><td>Net area sown</td><td>754</td><td>13.29</td></tr>
</table>
</td></tr>
</table>

6.	State Level Biophysical Assessment Done (Yes/No)	Many organizations have worked in the past on biophysical assessment in the state.
7.	No of studies-Valuation and Accounting and other Indices	Six (Valuation of Ecosystem Services and Forest Governance – A Scoping Study for Uttarakhand, Assessing the Effectiveness of Policies in Sustaining and Promoting Ecosystem Services in the Indian Himalayas, Ecosystem Services Valuation Hariyali Sacred Landscape in Garhwal Himalayas, Economic Valuation of Jim Corbett Tiger Reserve, Valuation and Accounting for Forest Resources and Index for Sustainable Environmental Performance)
8.	Institutions/Organizations worked in this domain other than Government Organizations	**A. In Dehradun** Directorate of Economics and Statistics Indian Council of Forestry Research and Education (ICFRE) Forest Survey of India (FSI) Forest Research Institute(FRI) Rural Livelihoods Entitlement Kendra (RLEK) Institute of Himalayan Environmental Research and Education (INHERE) National Sample Survey Office (NSSO) Indian Institute of Remote Sensing People's Science Institute (PSI) National Institute of Hydrology (NIH) Wadia Institute of Himalayan Geology Himmotthan Society Centre for Ecology Development and Research (CEDAR) Indian Institute of Soil and Water Conservation (IISWC) **B. In Pantnagar** GB Pant Institute of Himalayan Environment and Development (GBIHED) **C. In Delhi** The World Bank – executed BCRLIP project which generated complete atlas of the landscape and watershed maps for Uttarakhand state

		World Wide Fund (WWF), New Delhi **D. Bhopal** Indian Institute of Forest Management (IIFM), Bhopal
9.	Ecosystem Management Unit/Spatial Unit	Forest (Circle/Division), Freshwater, Glaciers (Himalayan ranges), Riverine (Ganga - Watershed), Grassland (Division), Agriculture (District)
10.	Environmental Concerns of the State	Water Conservation Forest degradation Non-biodegradable waste Illegal wildlife trade No protocol for disaster management Eco-tourism
11.	State initiatives for valuation, bio-physical assessment, and accounting	Department of Economics and Statistics, Government of Uttarakhand has taken the initiative to get the study conducted on valuation for natural resources of Uttarakhand.
12.	Response of state to support future studies/work	The Planning Department of the Government of Uttarakhand is keen to conduct such studies and has shown a positive response on this.
13.	Policy questions addressing the key issues	Green Bonus for better managing the natural resources and compensating communities conserving natural resources, in project decision-making, resource allocation, investment planning, permitting subsidies, etc.
14.	Purpose/Intention of using the outcomes of the study	Addressing key issues of natural resource management specially the man-made and natural disasters.
15.	Data Sources	NSSO, FSI, Forest Department, Bhuvan, ENVIS, DES, SPCB, Biodiversity Board, CWC, etc.
16.	Availability of Spatial data	Maps, LULC and other spatial data: Available at local level.
17.	Replicability of Uttarakhand Case	In all Himalayan states (10 N0.)

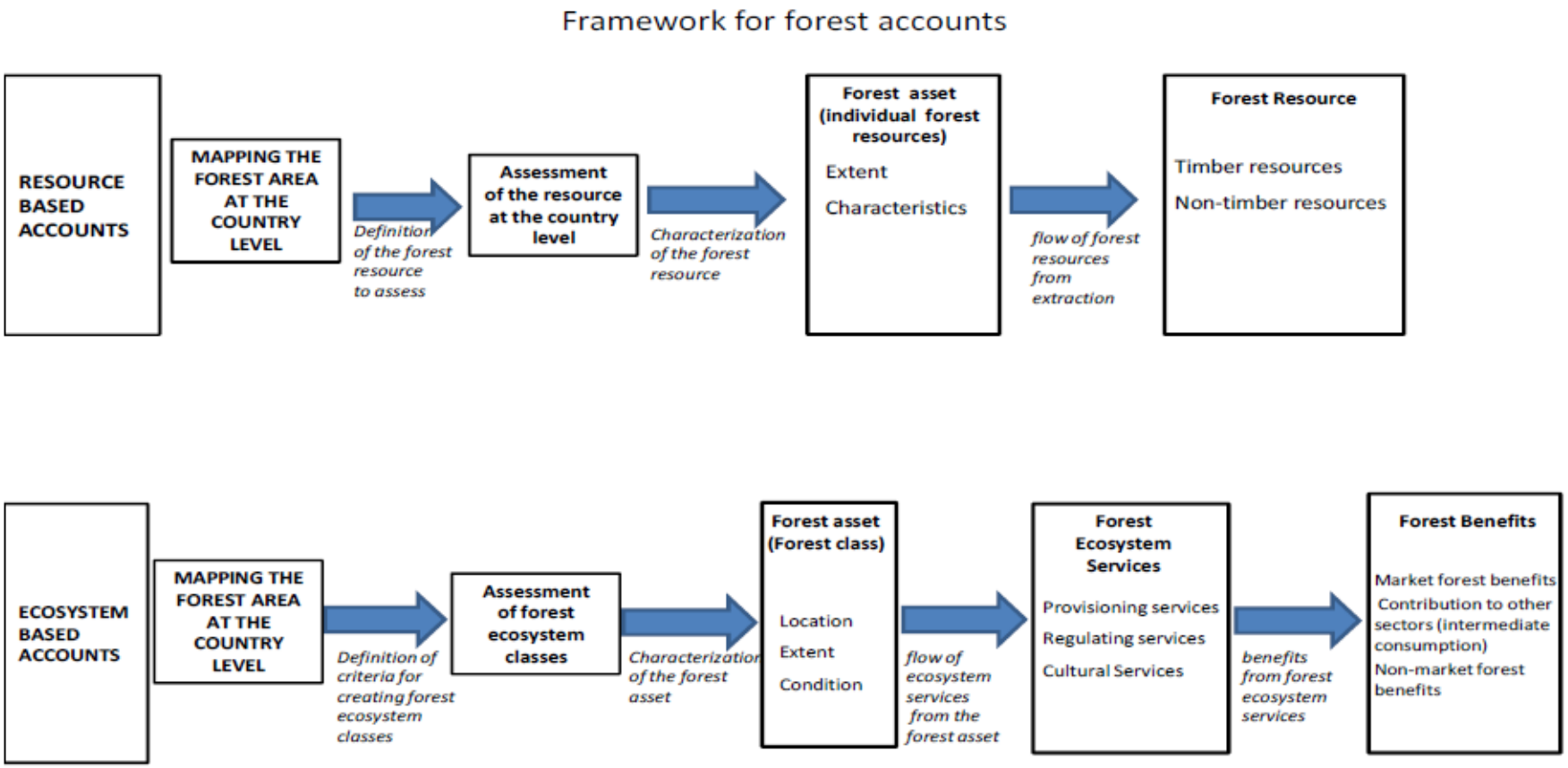

Figure 19: Framework of Forest Account Used for Uttarakhand SEEA-EEA Study

Source: (Adopted from WAVES-SEEA 2015 Module.)

Tables for Forest Accounts

Physical Asset Account for Forests (In Hectares (ha))					
	Opening Stock	Addition to Stock	Reduction to Stock	Net Changes in Stock	Closing Stock
Forests and Other Wooded Land	3799960	-	-	-	3799960
Forest Land	2654700	-	-	-	2654700
Primary Forest	2361157.51	-	-	-	2361157.51
Other Natural Regenerated Forests	79834.586	-	6684.096	6684.096	73150.49
Total Natural Forests	2440992.096	-	-		2434308
Planted Forests	139211	12799		12799	152010
Other Wooded Land	-	-	-	-	-
Total Forest Land	2580203.096	12799	6684	6115(+)	2586318

Asset Accounts Timber	**Physical Value (in m^3)**
Opening Stock (Growing Stock)	418332000
Addition	
Mean Annual Increment	
Extractions	
By State Forest Corporation	308885
For Right Holders	9646.6
Losses	
Forest Fires	55914.59
Forest Diversion	22968.37
Closing Stock	419227744.4

Area Accounts for Uttarakhand's Forests (In square km)					
Forests and Other Wooded Land	Opening Stock (2013 ISFR)	Addition to Stock	Reduction to stock	Net Changes in Stock	Closing Stock(2017 ISFR)
Reserve Forests	24643	1904	0	1904	26547
Protected Forests	9885	0	0	0	9885
Unclassed and Vested Forests	123	1445	0	1445	1568
Forest Land (Under Forest Department)	34651	3349	0	3349	38000
Tree Outside Forests and Tree Cover	703	64	0	64	767
Total Forest and Tree Cover	**35354**	**3413**	**0**	**3413**	**38767**

Physical Assets Account for Timber Resources												
	Opening Stock (Growing Stock)		Addition to Stock			Reduction to Stock					Net Changes in Stock	Closing Stock
Type of Timber Resources	**Area Coverage in Hectares**	**Volume in Cubic Metres**	**Natural Growth**	**Reclassification**	**Total Addition**	**Removals**	**Felling Residual**	**Losses/ Catastroph-ic Losses**	**Reclassif-ication**	**Others (Overall Reduction Observed from 2015 to 2017)**		
Mainly Natural Regeneration	8,38,596.98	97252091.77	0	0	0	308885 (Timber) + 83063 (Firewood) = 391948	10 % of the Total Removals = 39194.8	Forest Fire (55914.59)	Forest Diversion (22968.37)	2658352.427	2823723.751	94428368.02
Protection, Unalloted, etc.	2,25,125.11	26107759.01	0	0	0					713758.7533	758153.425	25349605.58
Selection Group, Protection and Improvement	8,63,348.15	100122485	0	0	0					2736813.636	2907065.891	97215419.06
Coppice with Standards	55,229.31	6404943.081	0	0	0					175076.9127	185968.1326	6218974.948
Clear Felling with Simple Coppice	95,195.90	11039868.52	0	0	0					301771.003	320543.6345	10719324.89
Plantation/Afforestation	1,39,211.07	16144307.79	0	0	0					441299.0919	468751.5149	15675556.27
Mainly Artificial Regeneration	2,25,160.49	26111862.03	0	0	0					713646.5987	758048.2473	25353813.78
Other/Unclassed	1,44,451.00	16751982.47	0	0	0					457909.67	486395.4072	16265587.06
Total	**25,86,318.0**	**299935299.6**									**8708650.003**	**291226649.6**

Proposed Framework for Measures of Ecosystem Condition and Extent at End of Accounting Period

	Ecosystem Extent	**Characteristics of Ecosystem Condition**				
		Vegetation	Biodiversity	Soil	Water	Carbon
Type of EU	Area	Indicators (e.g. biomass)	(e.g. species richness)	Indicators (e.g. organic matter content)	Indicators (e.g. water quality)	Indicators (e.g. Net carbon balance)
Forest ecosystem units						
Broadleaved upland forests						
Conifer upland forests						
Conifer low land forests						
Mixed upland forest						

Proposed Framework Table for Water Supply Accounts

	Surface Water			Ground Water		
	Artificial Reservoirs	**Lakes**	**Rivers and Streams**	**Glaciers, Snow and Ice**	**Other Sources**	**Total**
Opening Stock of Water Resources						
Additions to Stock						
Returns						
Precipitation						
Inflows from other inland water resources						
Discoveries of water in aquifers						
Total additions to stock						
Reductions in Stock						
Abstraction/Extraction						
Domestic Use						
Industrial Use						
Agriculture						
For hydropower generation						
Evaporation and actual evapotranspiration						
Total reductions in stock						
Closing stock of water resources						

Proposed Framework Change Matrix for Land Use

Land Use Type	Agriculture	Barren / Unculturable / Wastelands	Built-up	Forest	Grass/Grazing	Snow and Glaciers	Wetlands / Water Bodies	Total
Agriculture								
Barren / Unculturable / Wastelands								
Built-up								
Forests								
Grass/Grazing								
Snow and Glaciers								
Wetlands / Water Bodies								
Total								

Conducive policy climate of the state for the internalization of ecosystem system valuation and accounting in decision support system

Having used findings of various economic valuation and green accounting studies both from Uttarakhand and from neighbouring similar nature state of Himachal Pradesh and having gone through capacity building in the domain of Environmental Accounting, there is immense awareness amongst the policy makers and practitioners to internalize and execute the SEEA-EEA framework in the state.

Major Studies:

Badola, R., Hussain, S. A., Mishra, B. K., Konthoujam, B., Thapliyal, S., & Dhakate, P. M. (2010). An assessment of ecosystem services of Corbett Tiger Reserve, India. *Environmentalist*, *30*(4), 320–329. https://doi.org/10.1007/s10669-010-9278-5

Verma C. Khanna, A. Edgaonkar, A. David, G. Kadekodi, R. Costanza, and R. Singh., M. D. N. (2015). Economic valuation of tiger reserves in India: a value+ approach, (January), 284.

Verma, M. (2007). Valuation of Forest Ecosystem Services in Uttarakhand Himalayas, (May).

Verma, M., Negandhi, D., Swapan, M., Rohit, S., Anmol, K., & Rajesh, K. (2014). High Conservation Value Forests for 14th Finance commission of India :

CASE STUDY II:

ECONOMIC VALUATION AND NATURAL CAPITAL ACCOUNTING KARNATAKA

Introduction

Karnataka as the seventh largest state of India has a population of 6.25 crores with 50.9 per cent males and 49.1 per cent females (2011 Census of India). It has a rich history with the Mauryan and Nandan dynasties establishing their first empires. It has many archaeological sites such as Hampi, Badami and Bijapur. The mountain chain of Western Ghats which is older than the Himalayas is recognized as a UNESCO World Heritage Site and there are 10 sites in Karnataka. Table *12* shows the demography of Karnataka and Figure *20* shows the location of Karnataka state.

Table 12: Demography of Karnataka

Features	Detail
Geographic area (sq km)	1,91,791
Population (Census 2011)	61,130,704
Rural population (%)	61.43
Number of districts	30
Agricultural land (% of total geographical area)	25.3
Recorded forest area (km2)	30,730
Per capita forest area (ha)	0.07
Forest area as percentage of geographical area	19.58
Forest cover (km2)	37,550
Major rivers	Krishna, Cauvery, Pennar, Netravati, Kalinadi, Manjra, Bhima, Tungabhadra
Major Source of Occupation	Service-based industry, industry agriculture

Figure 20: Karnataka State Location

Ecological Profile of Karnataka

The state has a geographical area of 1,91,791 sq km and the forest covers around 19.58 per cent of the state's geographical area Figure 21. The total forest area is 37,550 sq km of which 4,502 sq km is Very Dense Forest (VDF), 20,444 sq.km is Moderately Dense Forest (MDF) and 12,604 sq km is Open Forest (OF) (FSI, 2017). Between 2015–2017, the state has added about 1,100 sq km of forest (Forest Survey of India, 2017).

The total GSDP from the forest sector is Rs. 10,27,068 crores and forestry and logging contribute to Rs. 7,20,704 lakhs and forestry contribution to GDP is 0.702 per cent, this suggests that forests play an important part in the economy of the state.

The state has rich biodiversity and varies in climatic zones, topography and soils. The state is home to 4500 species of flowering plants, 600 species of birds, 160 species of mammals, 230 species of reptiles and amphibians and 800 species of fish. The state also supports 10 per cent and 25 per cent of the total tiger and elephant population respectively.

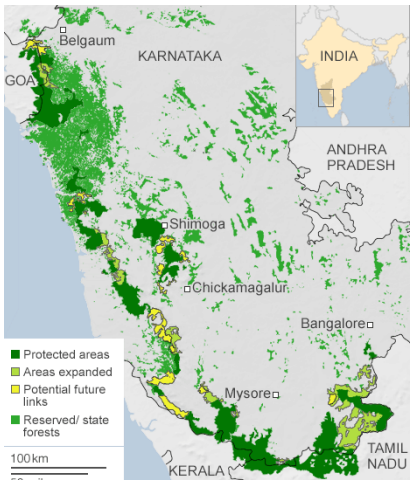

Figure 21: Forest Cover Map of Karnataka

(Source: Nature Conservation Foundation)

The water resources of Karnataka accounts for 6 per cent of the country's surface area and about 40 per cent flow in the major eastern flowing rivers Cauvery, Krishna, Kabini, Tungabhadra (Figure 22).

Figure 22: River Basin Map of Karnataka (CSO, 2008)

The mineral resources are diverse (Figure 23) such as asbestos, bauxite, dolomite, gold, limestone, quartz, etc. In addition, Karnataka is the sole producer of felsite and also a leading producer of gold. The production value of minerals in Karnataka was 5,843 crores in 2015-16. Owing to the diverse environment, the soils also vary from black soil, laterite soil, red soil, coastal alluvial and dark brown clayey soil.

Figure 23: Mineral Resource Distribution in Karnataka

Institutional Setup and Capacities

There are prominent institutions that work in economic valuation and ecosystem services in Karnataka. These include: Institute for Social and Economic Change (ISEC), Centre for Multi-Disciplinary Development Research (CMDR), Ashoka Trust for Research in Ecology and the Environment (ATREE), Azim Premji University (APU), Indian Institute

of Management-Bangalore(IIM-B), and Centre for Economics, Environment and Society (CEES).

Need for Ecosystem Accounting in Karnataka

The state's profile described above shows that its abundant natural resources need sustainable utilization and management, therefore, a resource accounting exercise will aid in achieving it. With regard to this, the Central Statistics Organization in 2008 conducted a Natural Resource Accounting study for the land and forestry sector (excluding mining) using the SEEA 2003 framework. Under this project, eight case studies were conducted in forests viz. value of NTFPs, grazing services for livestock, recreational value of Dandeli wildlife sanctuary, carbon sequestration of forests, valuation of fuelwood, value of medicinal plants, contribution of sacred groves and water benefits of forests. Using the physical flow of accounts, the land resources were estimated for soil restoration based on the restoration cost method.

At present, the carbon stock in Karnataka state is 475.085 million tonnes which is 6.71 per cent of the total forest carbon of the country (FSI, 2017). Given the current state of anthropogenic and natural impacts on the natural resources, appropriate assessment and valuation will help in managing the resources sustainably. To achieve this, ecosystem accounts of the SEEA 2013 provides the framework that addresses crucial information that can assist in decision-making and improving the policy development process to ensure sustainable use of natural resources as it delivers and enables economic growth for the state.

Justification SEEA-EEA Accounting for Karnataka

Karnataka has conducted many studies on diverse issues pertaining to natural resources, hence the data is available in a spatio-temporal fashion and the data can be extrapolated. In addition, there are well established institutions with reputed academics who are working on social and environmental issues in the state. This will ease the process of conducting the study in a structured manner and in collaboration with others.

In addition, this study will be conducted using the SEEA-EEA 2013 framework that includes ecosystem assets that have provisions for modelling and scaling information on ecosystem services, their condition and capacity to provide these services.

Also, IIFM has conducted many studies in economic valuation and natural resources accounting currently conducting total flow services from Uttarakhand's forests using the SEEA framework.

Recommended Institutions

To conduct Karnataka state study, it is recommended that Dr. Karachepone N. Ninan from CEES, Bangalore, who has previously conducted many studies in economics and policy aspects of biodiversity conservation in the Western Ghats, work in consortium with IIFM, Bhopal. The CEES mission applies scientific and social methodologies to address the development and environmental challenges to provide sustainable solutions.

List of Policy questions relevant to the state of Karnataka

- What are the drivers causing changes in Karnataka's ecosystems and their services?
- What are the status and trends of Karnataka's ecosystems and the services they provide to society?
- How would the Government and relevant stakeholders incorporate the economic values of ecosystem services into decision-making?
- What is the influence of ecosystem services provisioning on human well-being inside and outside the state?
- Who and where are the beneficiaries of ecosystem services flow, and how does this affect how they are valued and managed?
- How can we promote further investments in conservation and creation of green infrastructure and preventing damage?
- How can we minimize cost of inaction and benefits of action?
- How can we identify and prioritize the sectors which needs immediate attention for sustainable development and management of natural resources?
- How can national indicators for sustainable development be integrated into the SEEA which can help to support reporting on progress towards SDG targets?
- How can we create a synergy between different departments/institutions/policy makers/ministries/etc. working in this domain?
- How can improved investment be based on cost of damage of catchment?

Major attributes of Karnataka for Suitability for State Level Case for SEEA-EEA

<table>
<tr><th>S.No</th><th>Attribute</th><th>Karnataka</th></tr>
<tr><td></td><td></td><td></td></tr>
<tr><td>1.</td><td>Area of the state (square km)</td><td>1,91,791</td></tr>
<tr><td>2.</td><td>Population</td><td>61,130,704</td></tr>
<tr><td>3.</td><td>No. of Biomes</td><td>1. Tropical and subtropical moist broadleaf forests
2. Tropical and subtropical dry broadleaf forests
3. Deserts and xeric shrublands</td></tr>
<tr><td>4.</td><td>Ecosystem Mapped</td><td>Forests, Wetlands, Riverine, Agriculture, Grassland, Coastal and Marine</td></tr>
<tr><td>5.</td><td>Land-Use Pattern</td><td>
<table>
<tr><th>Land Use</th><th>Area (in thousands) (ha)</th><th>Percentage</th></tr>
<tr><td>Total geographical area</td><td>19179</td><td>NA</td></tr>
<tr><td>Reporting area for land utilization</td><td>19051</td><td>100.00</td></tr>
<tr><td>Forests</td><td>3072</td><td>16.13</td></tr>
<tr><td>Not available for cultivation</td><td>2163</td><td>11.35</td></tr>
<tr><td>Permanent pastures and other grazing lands</td><td>923</td><td>4.85</td></tr>
<tr><td>Land under misc. tree crops and groves</td><td>290</td><td>1.52</td></tr>
</table>
</td></tr>
</table>

		<table><tr><td>Culturable wasteland</td><td>413</td><td>2.17</td></tr><tr><td>Fallow lands other than current fallows</td><td>516</td><td>2.71</td></tr><tr><td>Current fallows</td><td>1500</td><td>7.87</td></tr><tr><td>Net area sown</td><td>10174</td><td>53.41</td></tr></table>
6.	State Level Biophysical Assessment Done (Yes/No)	Biophysical assessment of the natural resources of the state has been carried out by local agencies.
7.	No. of Studies-Valuation and Accounting	PA-2 Valuation and Accounting for Forest Resources, Watershed Level Biophysical Modelling.
8.	Institutions/Organizations worked in this domain other than Government Organisation	Institute for Social and Economic Change (ISEC), Centre for Multi-Disciplinary Development Research (CMDR), Ashoka Trust for Research in Ecology and the Environment (ATREE), Azim Premji University (APU), Indian Institute of Management-Bangalore(IIM-B), Centre for Economics, Environment and Society (CEES).
9.	Ecosystem Management Unit/Spatial Unit	Forest (Circle/Division), Freshwater, Riverine (Watershed/ Catchment Area), Grassland (Division), Agriculture (District), Coastal Region (Coastal Regulation Zone (CRZ))
10.	Environmental Concerns of the State	Coastal degradation Increasing solid waste/ air pollution Water shortage Water resource management Rapid Urbanization
11.	State response/initiatives for valuation, biophysical assessment, and accounting	Studies have been initiated by central agencies for forest resource accounting at protected area level.
12.	Response of state to support future studies/work	The state has shown a positive response to conduct valuation and accounting studies in the state.
13.	Purpose/Intention of using the outcomes of the study	Addressing key issues of natural resource management specially the man-made and natural disasters
14.	Data Sources	NSSO, FSI, Forest Department, ENVIS, Bhuvan, SPCB, Biodiversity Board, CWC, etc.
15.	Availability of spatial data	Maps, LULC and other spatial data: Available at local level.
16.	Replicability of Karnataka	(05 No.: 4 States and 1 UT) Kerala, Tamil Nadu, Goa, Maharashtra, West Andhra Pradesh.

Major Studies:

Verma C. Khanna, A. Edgaonkar, A. David, G. Kadekodi, R. Costanza, and R. Singh., M. D. N. (2015). Economic valuation of tiger reserves in India: a value+ approach, (January), 284.

Ninan, K. N., & Kontoleon, A. (2016). Valuing forest ecosystem services and disservices – Case study of a protected area in India. *Ecosystem Services*, *20*, 1–14. https://doi.org/10.1016/j.ecoser.2016.05.001

CASE STUDY III.

ECONOMIC VALUATION AND NATURAL CAPITAL ACCOUNTING FOR MADHYA PRADESH

Introduction

Madhya Pradesh, the second largest state cover 9.38 per cent of the total geographical area of the country. Also known as the state of diamonds, the state of Madhya Pradesh is richly endowed with mineral wealth. It is one of the pioneers in making forestry people-oriented with 15228 Joint Forest Management Committees (JFMCs) involved in protection and management of about 70 per cent of the forest area.

Figure 24: State of Madhya Pradesh

The agriculture sector being the backbone of the economy contributes almost 25 per cent of the Gross State Domestic Product (GSDP) and is the main source of employment for over two-thirds of the total population and constitutes about 60- 75 per cent of the rural income.

Table 13: Demography of Madhya Pradesh

Geographic Area (sq km)	308,252
Population (Census 2011)	7.33 crores
Rural population (%)	72.37
Number of districts	52
Agricultural land/Net sown area	50.14
Recorded Forest Area (km2)	86910
Per capita forest area (ha)	0.12
Forest area as percentage of geographical area	28.26
Forest cover (km2)	77414
Major rivers	Narmada, Tapti, Chambal, Betwa, Son, Sindh, Jamni, Dhasan, Ken, Mahi
Major source of occupation	Agriculture, forest-based activities

Madhya Pradesh Ecological Profile

Madhya Pradesh, according to FSI 2017, has a total Recorded Forest Area of 86910 Km^2 under various classes (Forest Survey of India, 2017), and connects the Western Ghats and the north east, two of the biodiversity hotspots in the country.

The forest cover as reported in ISFR 2017 is 77414 km^2 which includes 6149 km^2 under Very Dense Forest (VDF), 30426 Km^2 Moderately Dense Forest(MDF), and 27904 km^2 Open Forest (OF) shown in (Figure 25). The state also has 8073 km^2 under Tree Cover. In addition to this Madhya Pradesh has 2319 km^2 of area under water bodies in the forest area and total carbon stock of 695.994 million tonnes (FSI, 2017) which is 9.82 per cent of total forest carbon of the country.(Forest Survey of India 2011)

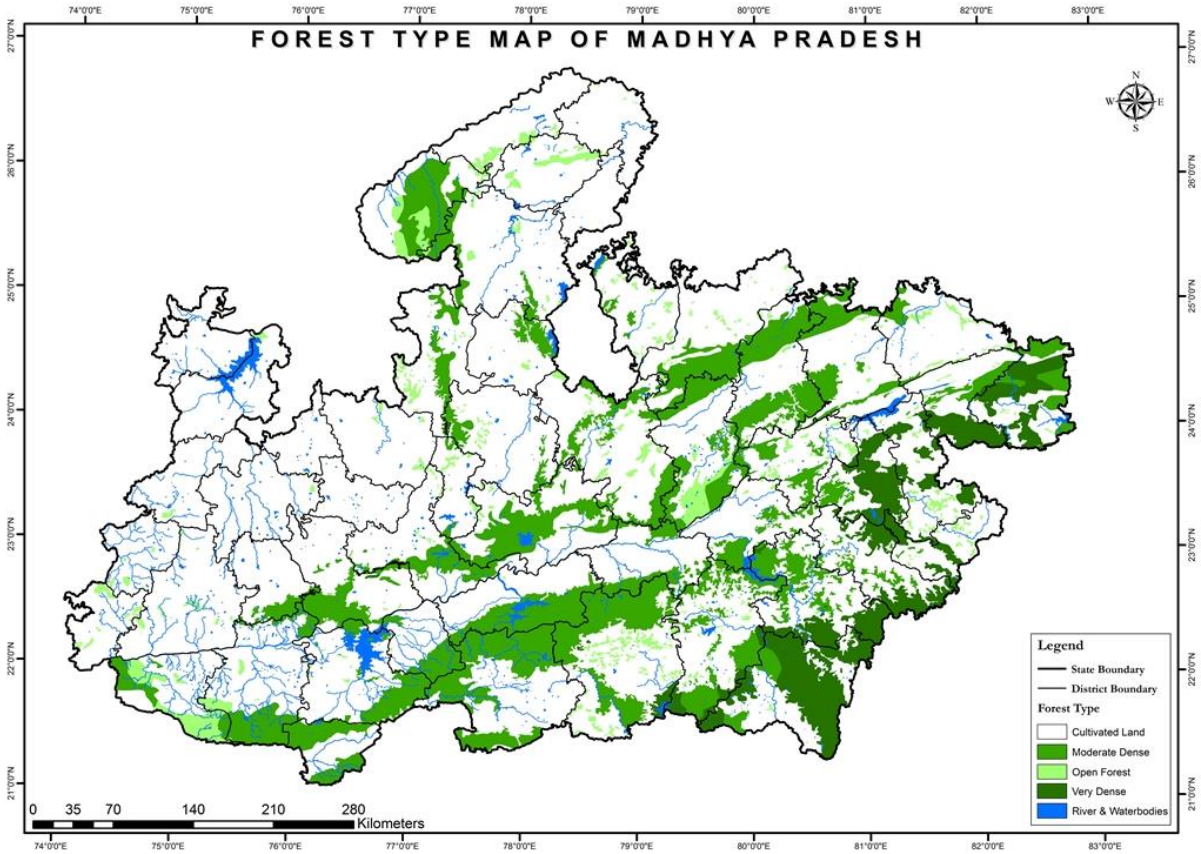

Figure 25: Forest Cover Map of Madhya Pradesh

(Source: http://www.skmcccepco.mp.gov.in)

The State of Madhya Pradesh is richly endowed with mineral wealth. It is the sole producer of diamonds in the country. Coal, limestone, manganese ore, bauxite, copper ore, dolomite, fire clay, slate pyrophyllite-diaspore are the main minerals found in the state. Besides these minerals, the state is fast emerging as a dimensional stone producer. The state due to its favourable geological and geotectonic settings, is the largest producer of copper, limestone, slate, diaspore and pyrophyllite. Madhya Pradesh is also the largest producer of cement accounitng to a total of 15 per cent of the total country's production.

Madhya Pradesh is also the leading producer of manganese , dolomite, rock phosphate and fire clay. In terms of the mineral production the state ranks third next only to Jharkhand and Chhattisgarh.

Being located at the centre of India, most of the rivers are interstate rivers. The rivers namely, Chambal, Sindh, Betwa and Ken flow northward and meet the Yamuna whereas the river Sone falls directly into the Ganga. Narmada, Tapi and Mahi rivers flow westward and meet the Arabian Sea, whereas Wainganga and Pench rivers meet Godavari in the south (Figure 26).

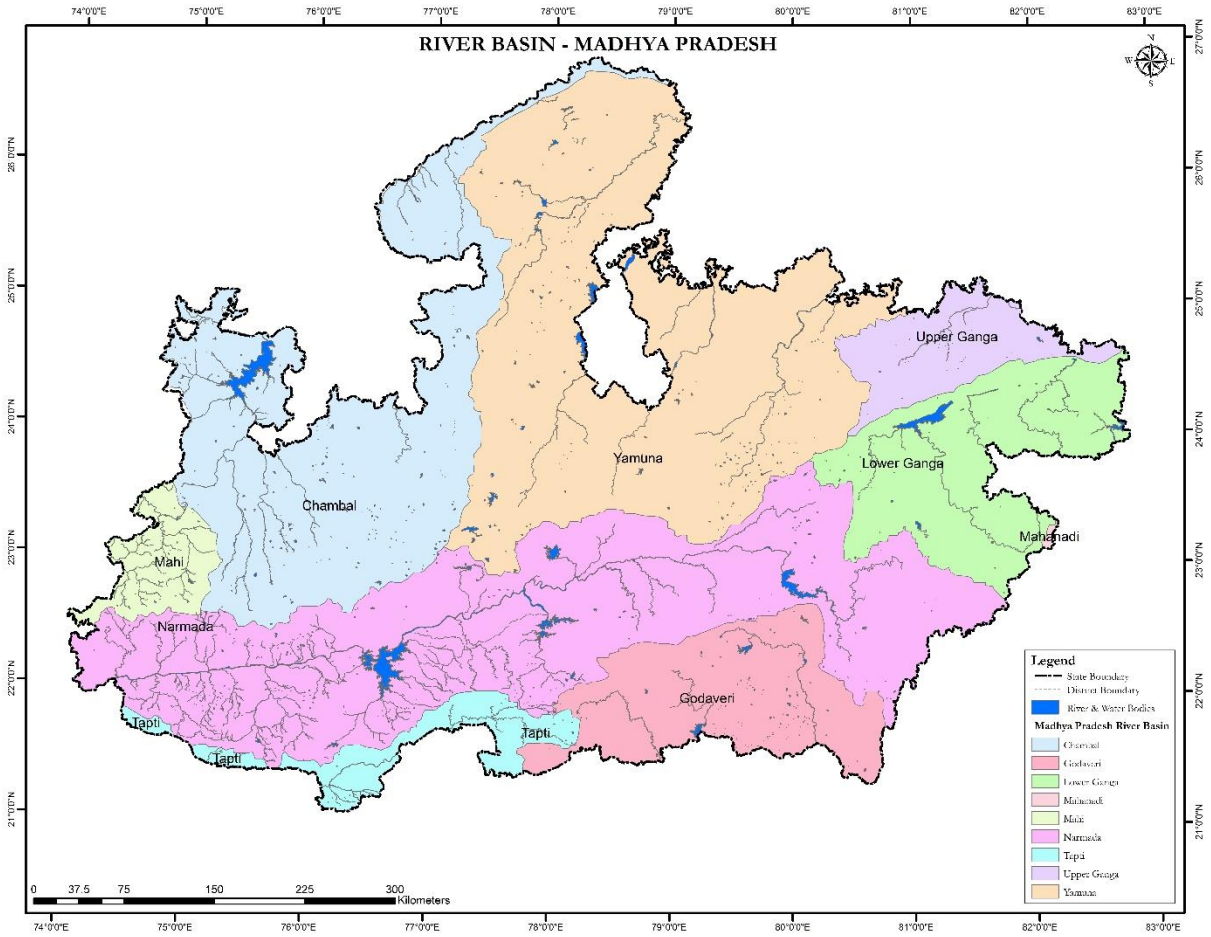

Figure 26: River Basin of Madhya Pradesh

(Source: http://www.mpenvis.nic.in)

Rationale for SEEA EEA Accounting in Madhya Pradesh

Even though Madhya Pradesh is highly enriched in natural resources still the state has experienced a series of events like droughts, food insecurity, climate change etc. Several programmes for drought recovery and climate change adaptation have been carried out throughout the state but the state still faces these problems. Regarding the forest resources of Madhya Pradesh, the state observed a reduction of 12 square km due to development activities, submergence, agriculture, mining and rotational felling. Areas such as Bundelkhand are still facing a huge scarcity of water despite the presence of various big rivers like Betwa, Ken, Dhasan, Sonar and their various other tributaries, has become a synonym for drought, unemployment and perennial water stress(Pathak 2017). In the few decades the state has also experienced numerous cases of illegal extraction of minerals which is one of the main concerns for sustainable growth of the state.

In order to ensure that due attention is given to forests and natural resources of the state, given their great contribution to the society and economy, it is imperative to assess and value them appropriately.

With such a vast endowment of natural forests and other natural resources, ecosystem accounts will certainly help recognizing that the management of these resources is also of relevance in economic, planning, development and social policy contexts.

Justification for Selection of State for SEEA-EEA Accounting Case Study

Madhya Pradesh, located in the central part of India has four important types of forests namely: Tropical Moist, Tropical Dry, Tropical Thorn, and Subtropical Broadleaved Hill forests (Figure 27). Based on the composition of forest terrain, there are three important forest formations namely Teak forests, Sal forests and miscellaneous forests. The state's location, ecosystem, terrain, geology, type of forest and species found makes the replicability of the valuation and accounting results more relevant than any other state. The results of the case study may be extended to the adjacent states with similar topology.

Figure 27: Forest Classification of India

Source: http://agritech.tnau.ac.in/forestry/forest_india_types.html

In 2006, an attempt was made to prepare Natural Resource Accounts Land and Forestry Sector for Madhya Pradesh by the Indian Institute of Forest Management, Bhopal. The project was funded by the Central statistical Organisation (CSO)(Madhu Verma et al. 2006). The study took care of the following dimensions while preparing the resource accounts:

For Land Sector

- Trends in land use pattern,
- Trends in uncultivable, fallow and degraded lands,
- Loss of productivity and production due to different types of soil degradation
- And replacement costs of degradation.

For Forestry

- Accounting for implicit depletion/degradation of assets which were not done before.
- Compiling raw data from multiple sources and present them in a coordinated manner.
- Area and volume accounts for the forestry sector.

Land Resource (Core) Account	In million Rs.				
	1997-98	1998-99	1999-2000	2000-01	2001-02
Opening area	**2287066**	**2461109**	**1188882**	**2539697**	**2708814**
New areas for agriculture	1466.632	472.4121	-9247.54	9941.063	-5046.62
Land use conversion	-3226.59	14644.77	2674.909	4889.048	15487.89
Other volume changes	-11146.4	-6613.77	611.4077	-11081.8	-13573.7
Adjustment	204989	-1300729	1364877	158687.1	-2705682
Closing area	2274160	2469613	1182921	2543446	2705682

Figure 28: Land Resource Monetary Accounts

Activity/Forest types	Sal	Teak	other Misc. Sp.	Total
(1) Opening stock	**20045.7**	**91906.7**	**23720.2**	**135672.6**
Changes due to economic activity				
Depletion (--)	359.1	1646.4	1861.1	3866.6
Timber Logging/harvest	66.2	303.6	78.4	448.2
Fuel-wood extraction	208.7	956.8	1683.2	2848.6
Illegal logging	69.9	320.3	82.7	472.9
Logging damage	14.3	65.7	16.9	96.9
Afforestation (+)	104.1	62.0	123.7	289.8
(2) Net Changes (net of depletion and afforestation)	**-254.9**	**-1584.4**	**-1737.4**	**-3576.8**
Other volume changes				
Additions (+)	338.1	2325.6	480.2	3143.9
Natural growth (Mean Annual Increment)	334.1	2297.7	474.4	3106.2
Regeneration	4.1	27.9	5.8	37.7
Reductions (--)	234.8	1438.2	315.2	1988.1
Forest fires	2.3	16.1	3.3	21.7
Submergences	77.0	353.0	91.1	521.1
Animal grazing	155.5	1069.1	220.7	1445.3
(3) Net Volume Changes (net of additions and reductions)	**103.4**	**887.4**	**165.0**	**1155.8**
(4) Other accumulations (--)	**18.2**	**83.5**	**21.5**	**123.2**
Encroachment	7.6	34.7	9.0	51.2
Transfer of land to other activities	10.6	48.8	12.6	72.0
Net volume change (5=2+3+4)	**-169.8**	**-780.5**	**-1594.0**	**-2544.2**
(6) Closing Stocks (6=1+5)	**19875.9**	**91126.3**	**22126.2**	**133128.4**

Framework Adapted From Haripriya 2000

Figure 29: Monetary Accounts for Forest Resources of Madhya Pradesh

In 2014, the 14th Finance Commission considerably increased the devolution of taxes from the centre to states from 32 per cent to 42 per cent. The 14th Finance Commission believed that a large forest cover provides huge ecological benefits, but there is also an opportunity cost in terms of area not available for other economic activities and this also serves as an important indicator of fiscal disability. The criteria for the distribution of funds is given below.

Table 14: Criteria for Distribution as Per Tax Devolution Formula

Horizontal Devolution Formula in the 14th Finance Commission	
Variable	**Weight Accorded**
Population (1971)	17.5
Population (2011)	10
Fiscal capacity/Income Distance	50
Area	10
Forest Cover	7.5
Fiscal Discipline	0
Total	100

Madhya Pradesh was second after Arunanchal Pradesh (13.2 per cent) to receive the benefits due to its forest resources accounting for 10.6 per cent of the total fund for the forestry sector. By conducting the SEEA -EEA accounting, we can get to know the actual improvements the state observed after receiving the funds from the centre for the better management of the natural resources and answer some of the important policy questions for the state.

Recommended Institutes

Some of the major institutes who have conducted studies in allied fields are Tropical Forest Research Institute works under the Indian Council of Forestry Research and Education (ICFRE), Indian Institute of Forest Management(IIFM), Indian Institute of Soil Science, (IISS), etc.

The Indian Institute of Forest Management has been working in the field of Ecosystem Service valuation for the past 2 decades. IIFM's study for the 13th and 14th Finance Commission has made a significant impact on the allocation of funds for the forestry sector. As a result, the 13th Finance Commission increased the allocation of budget under the forestry sector from 1000 crores to 5000 crores and further the 14th Finance Commission for the first time, incorporated forest cover into the main formula for the allocation of the single, divisible pool of taxes among the states.

Also, IIFM has conducted many studies in economic valuation and natural resources accounting in Himachal Pradesh and Madhya Pradesh for CSO and the Himachal Pradesh Forest Department in 2005-06 and 2013-17 and currently accomplishing total assets and flow services from Uttarakhand's forest using the SEEA framework.

IIFM Team has also undertaken capacity building programmes at the Statistics Finland and LUKE, NRM Institute Finland and has experience of natural resource accounting being done in Finland.

Given below is the list of Institutes that are working actively in Madhya Pradesh and can be selected for conducting research and case studies.

Institution Working in Madhya Pradesh
Bhopal
Indian Institute of Forest Management (IIFM), Bhopal

Indian Institute of Soil Science, (IISS)
Jabalpur
Tropical Forest Research Institute, Jabalpur
Delhi
The World Bank
World Wide Fund (WWF), New Delhi

List of policy questions relevant to the state of Madhya Pradesh

- What are the drivers causing changes in Madhya Pradesh's ecosystems and their services?
- What are the status and trends of Madhya Pradesh's ecosystems and the services they provide to society?
- How would the Government and relevant stakeholders incorporate the economic values of ecosystem services into decision-making?
- What is the influence of ecosystem services provisioning on human well-being inside and outside the state?
- Who and where are the beneficiaries of ecosystem services flow, and how does this affect how they are valued and managed?
- How can we promote further investments in conservation and creation of green infrastructure and preventing damage?
- How can we minimize cost of inaction and benefits of action?
- How can we identify and prioritize the sectors which needs immediate attention for sustainable development and management of natural resources?
- How can national indicators for sustainable development be integrated into the SEEA which can help to support reporting on progress towards SDG targets?
- How can we create a synergy between different departments/institutions/policy makers/ministries/etc. working in this domain?
- How can improved investment be based on cost of damage of catchment?

Major Studies

Forest Survey of India. 2011. "Methodology Used by FSI in Carbon Stock Accounting." *Carbon Stock in India's Forests*: 10.

FSI 2017. Indian State of Forest Report. Dehradun: Forest Survey of India (FSI).

Pathak, Hemant. 2017. "Rivers Conservation Challenges and Opportunities : A Case Study of BundelKhand, Madhya Pradesh, India." *International Journal of Enviromental Science and Natural Resources* 7(5): 1–3.

Verma, Madhu et al. 2006. Central Statistical Organization (CSO), Ministry of Statistics and Programme Implementation (Government of India), *Natural Resource Accounting of Land and Forestry Sector (Excluding Mining) for the States of Madhya Pradesh and Himachal Pradesh*. http://mospi.nic.in/mospi_new/upload/iifm_nra_project_30apr08_final.pdf.

Major Attributes of Madhya Pradesh for Suitability for State Level Case for SEEA-EEA

<table>
<tr><th>S.No</th><th>Attribute</th><th>Madhya Pradesh</th></tr>
<tr><td>1.</td><td>Area of the state (square km)</td><td>308252</td></tr>
<tr><td>2.</td><td>Population</td><td>72597565</td></tr>
<tr><td>3.</td><td>No. of Biomes</td><td>1. Tropical and subtropical moist broadleaf forests
2. Tropical and subtropical dry broadleaf forests
3. Deserts and xeric shrublands</td></tr>
<tr><td>4.</td><td>Ecosystem Mapped</td><td>Forests, Wetlands, Riverine, Agriculture, Grassland, Desert</td></tr>
<tr><td>5.</td><td>Land-Use Pattern</td><td>
<table>
<tr><th>Land Use</th><th>Area (in thousands) (ha)</th><th>Percentage</th></tr>
<tr><td>Total geographical area</td><td>30825</td><td>NA</td></tr>
<tr><td>Reporting area for land utilization</td><td>30757</td><td>100.00</td></tr>
<tr><td>Forests</td><td>8696</td><td>28.27</td></tr>
<tr><td>Not available for cultivation</td><td>3401</td><td>11.06</td></tr>
<tr><td>Permanent pastures and other grazing lands</td><td>1337</td><td>4.35</td></tr>
<tr><td>Land under misc. tree crops and groves</td><td>19</td><td>0.06</td></tr>
<tr><td>Culturable wasteland</td><td>1160</td><td>3.77</td></tr>
<tr><td>Fallow lands other than current fallows</td><td>621</td><td>2.02</td></tr>
<tr><td>Current fallows</td><td>582</td><td>1.89</td></tr>
<tr><td>Net area sown</td><td>14941</td><td>48.58</td></tr>
</table>
</td></tr>
<tr><td>6.</td><td>State Level Biophysical Assessment Done (Yes/No)</td><td>State level studies have been executed for biophysical studies.</td></tr>
<tr><td>7.</td><td>No of Studies-Valuation and Accounting</td><td>State Level Study-1, PA-4-5, Wetland-2-3</td></tr>
<tr><td>8.</td><td>Institutions/Organization worked in this domain other than Government Organization</td><td>Bhopal
Indian Institute of Forest Management (IIFM), Bhopal
Indian Institute of Soil Science, (IISS)
Jabalpur
Tropical Forest Research Institute, Jabalpur
Delhi
The World Bank
World Wide Fund (WWF), New Delhi</td></tr>
<tr><td>9.</td><td>Ecosystem Management Unit/Spatial Unit</td><td>Forests (Circle/Division), Freshwater, Riverine (Watershed/ Catchment Area), Grassland (Division) , Agriculture (District)</td></tr>
<tr><td>10.</td><td>Environmental Concerns of the State</td><td>Water scarcity
Drought
Illegal extraction of natural resources
Forest degradation
Water conservation
Increasing solid waste/air pollution</td></tr>
<tr><td>11.</td><td>State Response/Initiatives</td><td>Planning Department and Forest Department</td></tr>
</table>

	for Valuation, Bio-Physical Assessment, and Accounting	
12.	Response of state to support future studies/work	The state has shown positive response to conduct valuation and accounting studies in the state.
13.	Policy questions addressing the key issues	The state has one of the largest covers of forest resources but is facing a problem of forest degradation, water scarcity, increasing food insecurity. Natural resources accounting can prove to be a handy tool for addressing these key issues.
14.	Purpose/Intention of using the outcomes of the study	Addressing key issues of natural resource management specially the man-made and natural disasters
15.	Data sources	NSSO, FSI, Forest Department, MPENVIS, Bhuvan, SPCB, Biodiversity Board, EPCO, CWC etc.
16.	Availability of spatial data	Maps, LULC and other spatial data: Available at local level.
17.	Replicability of case of Madhya Pradesh	In 5 Five states : Uttar Pradesh, Chhattisgarh, Maharashtra, Gujarat, Rajasthan.

Thematic Biodiversity, Water, Carbon and Land Accounts

Thematic accounts are standalone accounts on topics of interest in their own right and also of direct relevance in the measurement of ecosystems and in assessing policy responses. The thematic accounts described in this chapter cover accounts for land, carbon, water and species-level biodiversity and reflect the discussion of these accounts in the SEEA Central Framework (for land and water) and in the SEEA EEA (for carbon and species-level biodiversity). Accounting for biodiversity considers both ecosystem and species-level biodiversity. Biodiversity is considered primarily a characteristic of ecosystem assets rather than an ecosystem service. In accounting terms, this permits recognition of declines or improvements in biodiversity over time and links to the capacity of ecosystems to supply ecosystem services. (Technical Recommendations SEEA 2012, EEA, 2017).

CASE STUDY IV:

ECONOMIC VALUATION AND NATURAL CAPITAL ACCOUNTING FOR ASSAM

Introduction

Assam is one of the states of India and it is situated in the north-eastern region, which is the land of hills, valleys, mighty river Brahmaputra and land of Mother Goddess Kamakhya. Assam is the largest state considering its population and geographical area among the eight sister states of north east India. The state Assam shares its border with 7 states such as Arunachal Pradesh, Manipur, Meghalaya, Mizoram, Nagaland and West Bengal. The state has 78,438 square kilometres of coverage, i.e. about 2.4 per cent of the country's total geographical area, provides shelter to 2.58 per cent of the population of the country. The population of Assam is about 31,169,272 as in the 2011 census, of which 15,954,927 are males and 15,214,345 are females. The sex ratio (females per 1000 males) is 954 and the female literacy ratio is 73.18 per cent.

Table 15: Demography of Assam

Features	Detail
Geographic area (sq km)	78,438
Population (Census 2011)	31,169,272
Rural population (%)	86
Number of districts	33
Agricultural land (% of total geographical area)	54.11
Recorded forest area (km2)	28105
Per capita forest area (ha)	0.11
Forest area as percentage of geographical area	35.83
Forest cover (km2)	27538
Major rivers	Brahmaputra, Barak
Major source of occupation	Agriculture

Figure 30: Assam's Geographical Location

Ecological Profile of Assam

The state of Assam has recorded forest area of around 28105 km^2 and accounting for 35.83 per cent of its geographical area. According to FSI, the legal status of reserved forest constitutes 66.58 per cent and unclassed forest 33.43 per cent of the total forest area. Assam is one of the richest biodiversity zones in the world and consists of tropical rainforests, deciduous forests, riverine grasslands, bamboo orchards and numerous wetland ecosystems. Assam has five national parks and 18 wildlife sanctuaries covering an area of 0.40 million hectares constituting 4.98 per cent of its geographical area. According to FSI, the state has three tiger reserves with an area of 27673 km^2 which is 35 per cent of the state's geographical area.

Assam has wildlife sanctuaries, the most prominent of which are two UNESCO World Heritage sites-the Kaziranga National Park, on the bank of the Brahmaputra, and the Manas Wildlife Sanctuary, near the border with Bhutan. Assam has conserved the one-horned Indian rhinoceros from near extinction, along with the pygmy hog, tigers and numerous species of birds, and it provides one of the last wild habitats for the Asian elephant. Kaziranga and Manas are both World Heritage Sites. The state has the largest population of the wild water buffalo in the world. The state has the highest diversity of birds in India with around 820 species. With subspecies the number is as high as 946. The mammal diversity in the state is around 190 species.

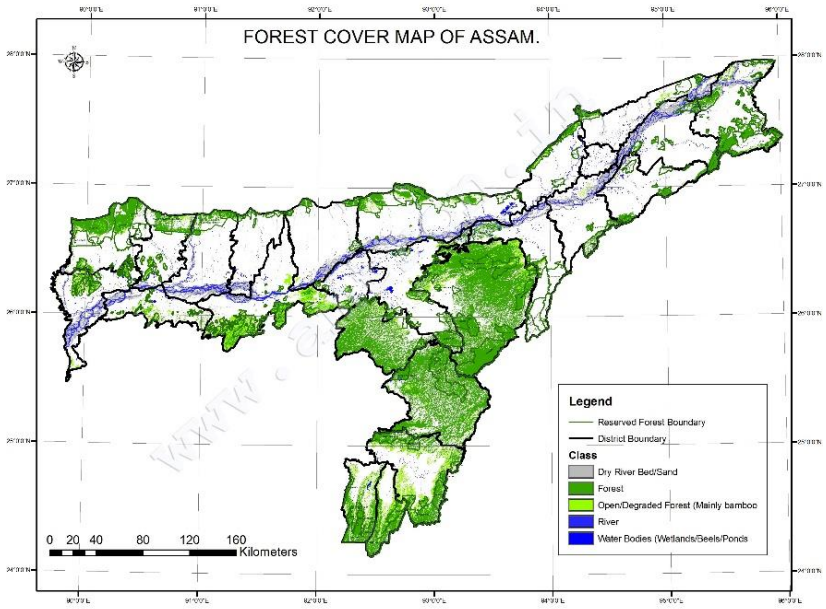

Figure 31: Forest Cover in Assam

Assam is endowed with enormous water resources. The state is drained by the networks of two river system, viz. the Brahmaputra and the Barak. There are about 73 important tributaries of the Brahmaputra river and 11 tributaries of the Barak river. There are about 3513 numbers of wetlands of different sizes and shapes in the state, constitutes around 1.29 per cent of the total geographical area of the state, which is about 1012.32 sq km during the pre-monsoon season.

The Economic Importance of Brahmaputra

People and communities in 22 districts of Assam use the Brahmaputra river for meeting their livelihood needs through fishing, cultivation of different types of crops, irrigation and riverine transport. The Brahmaputra river and its tributaries carry more than 30 per cent of the total water resources potential of the country. The total amount of goods transported through this system was 3, 56,552 Metric tons. Operation of ferry services has given rise to creation of employment for 5344 persons. In the last few years there has been a spurt of activity in identifying 46 dams in the Brahmaputra basin in Assam of which three of them are in various stages of operation and are expected to produce more than 2000 MW of power. Nineteen important tourist hot spots in the state are situated in places on the banks of river Brahmaputra.

In protected areas of Assam the total number of tourists to the state increased from 3493527 to 4463479 in the last 10 years resulting in revenue accrual of ₹191 lakhs in the form of rental charges for different types of accommodations. A sizeable chunk of this tourist flow and revenue earned can be attributed to tourism activities on the river Brahmaputra.

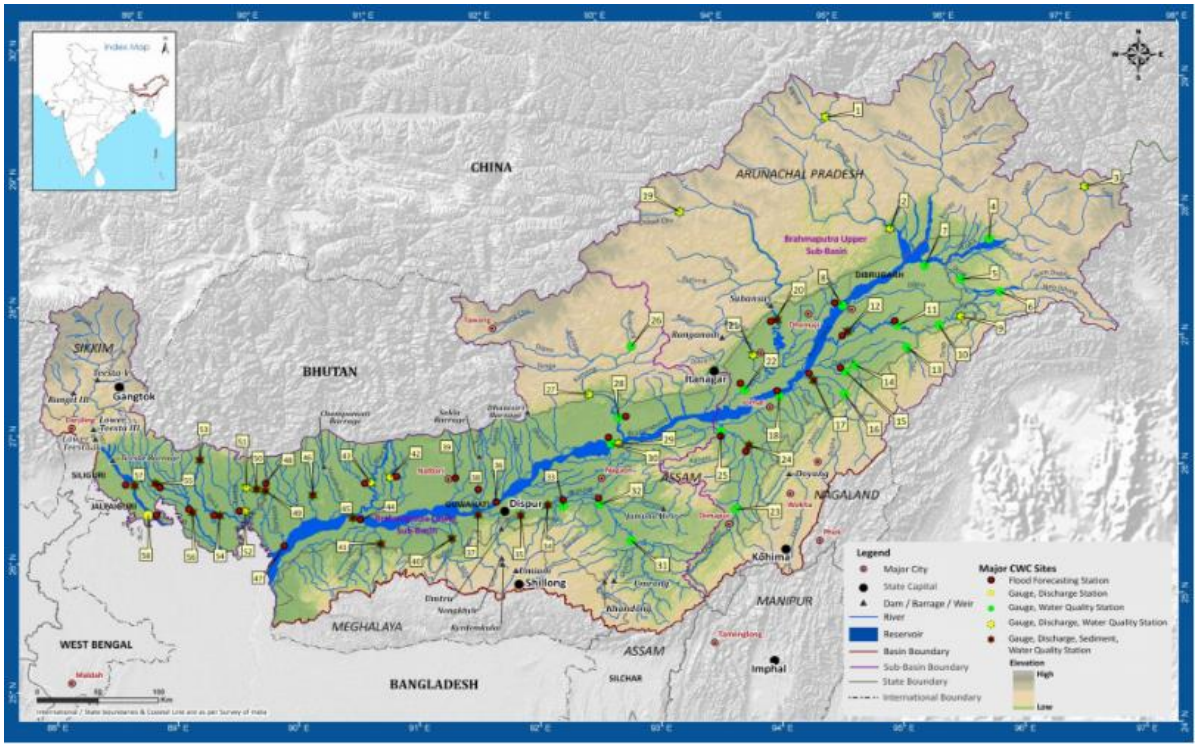

Figure 32: The Brahmaputra Basin in India

Assam is full of natural bounties and rich in every aspect of nature including mineral wealth. According to the Directorate of Geology and Mining, coal, cement grade limestone, china clay, iron ore, glass sand, sillimanite, granite, etc. are the main economic minerals of Assam. Assam is also the third largest producer of petroleum and natural gas in the country and has ample reserves of limestone. Crude oil is the chief mineral available in Assam. The state accounts for about 15 per cent of Indian crude oil output.

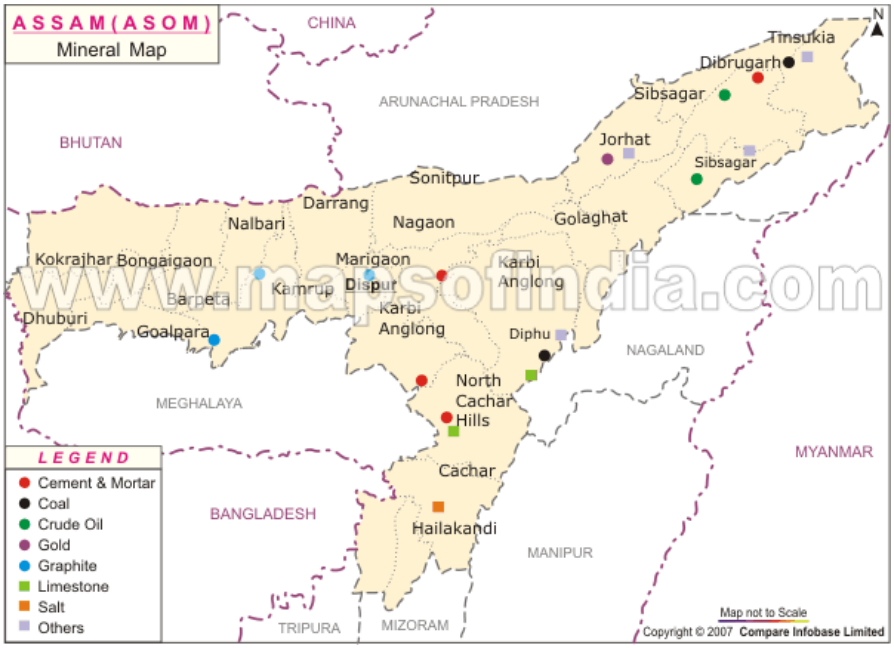

Figure 33: Minerals in Assam

Assam is also counted as one of the prime Eco-Tourism destinations in India. It is fast emerging as a major tourist destination in India with its splendid tourist attractions. The tourist visits in Assam have been increasing steadily during the last few years. According to India Brand Equity Foundation, in 2017, 6.07 million tourists arrived in the state of Assam. The tour of cities reveals the abundant scenic beauty that this state holds in store. It is also an abode of wildlife enthusiasts due to the unique ecology. With the majestic Brahmaputra river, magnificent hills, its rich flora and fauna and wildlife, the state is a tourist paradise. The cultural tourist attractions of the state also include many ancient temples and shrines. Kamakhya temple which dates back to pre-historic times is one of the most revered religious places in the country.

Rationale for SEEA-EEA Accounting in Assam

The biodiversity of Assam, a state in north-east India, makes it a biological hotspot with many rare and endemic plant and animal species. Therefore, for a state like Assam with rich culture, it is important to highlight the synergies between nature's contribution to the lives of people by not only highlighting the economic contribution but by also capturing its role in the culture and local traditions. Using protocols developed by Intergovernmental Science-Policy Platform for Biodiversity and Ecosystem Services (IPBES), these values can be highlighted. Inclusion of these values gives us a broader spectrum and help in recognizing the overall contribution of forests to human well-being. The indigenous and local knowledge of biodiversity and ecosystem services helps in accentuating the intrinsic value of land and its resources.

Justification for Selection of State for SEEA EEA Accounting

There are many studies conducted on diverse issues pertaining to natural resources, ecosystem services and valuation in the state of Assam. Hence the data is available in a spatial-temporal fashion and can be extrapolated. Since Assam is the gateway to the land of seven-sisters comprising the states of Arunachal Pradesh, Manipur, Meghalaya, Mizoram, Nagaland and Tripura, the ecosystem valuation studies can also be replicated to other north-eastern parts. Assam shares the same physiography with all other sister states as a land of majestic mountains, mighty rivers, lovely woods, waterfalls, and serene silences.

Institutional Setup and Capacities

There are a few institutes that conduct studies on agriculture and natural resources. These include:

Guwahati, Assam
Central Inland Fisheries Research, Guwahati
Indian Institute of Technology, Guwahati
Assam Remote Sensing Application Centre
Jorhat, Assam
Assam Agricultural University
Rain Forest Research Institute
Delhi
WWF

Bhopal
Indian Institute of Forest Management

List of Policy questions relevant to the state of Assam

- What are the drivers of changes in Assam's ecosystems and their services?
- What are the status and trends of Assam's ecosystems and the services they provide to society?
- How would the Government and relevant stakeholders incorporate the economic values of ecosystem services into decision-making?
- What is the influence of ecosystem services provisioning on human well-being inside and outside the state?
- Who and where are the beneficiaries of ecosystem services flow, and how does this affect how they are valued and managed?
- How can we promote further investments in conservation and creation of green infrastructure and preventing damage?
- How can we minimize cost of inaction and benefits of action?
- How can we identify and prioritize the sectors which needs immediate attention for sustainable development and management of natural resources?
- How can national indicators for sustainable development be integrated into the SEEA which can help to support reporting on progress towards SDG targets?
- How can we create a synergy between different departments/institutions/policy makers/ministries/etc. working in this domain?
- How can accounting help the preserve/conserve pristine Himalayan ecosystem and Brahmaputra Riverine Ecosystem in Assam and other Himalayan states?

Major Attributes of Assam for Suitability for State Level Case for SEEA-EEA

<table>
<tr><th>S.No.</th><th>Attribute</th><th>Assam</th></tr>
<tr><td>1.</td><td>Area of the state (square km)</td><td>78,438</td></tr>
<tr><td>2.</td><td>Population</td><td>31,169,272</td></tr>
<tr><td>3.</td><td>No. of Biomes</td><td>1. Temperate broadleaf and mixed forests
2. Tropical and subtropical grasslands, savannahs, and shrub-lands
3. Tropical and subtropical moist broadleaf forests</td></tr>
<tr><td>4.</td><td>Ecosystem Mapped</td><td>Forests, Wetlands, Riverine, Agriculture, Himalayan Ecosystem</td></tr>
<tr><td>5.</td><td>Land-Use Pattern</td><td>
<table>
<tr><th>Land Use</th><th>Area (in thousands) (ha)</th><th>Percentage</th></tr>
<tr><td>Total geographical area</td><td>7844</td><td>NA</td></tr>
<tr><td>Reporting area for land utilization</td><td>7850</td><td>100.00</td></tr>
<tr><td>Forests</td><td>1853</td><td>23.60</td></tr>
<tr><td>Not available for cultivation</td><td>2626</td><td>33.45</td></tr>
<tr><td>Permanent pastures and other grazing lands</td><td>160</td><td>2.04</td></tr>
</table>
</td></tr>
</table>

<table>
<tr><td></td><td></td><td>
<table>
<tr><td>Land under misc. tree crops and groves</td><td>196</td><td>2.50</td></tr>
<tr><td>Cultivable wasteland</td><td>77</td><td>0.98</td></tr>
<tr><td>Fallow lands other than current fallows</td><td>59</td><td>0.75</td></tr>
<tr><td>Current fallows</td><td>126</td><td>1.61</td></tr>
<tr><td>Net area sown</td><td>2753</td><td>35.07</td></tr>
</table>
</td></tr>
<tr><td>6.</td><td>State Level Biophysical Assessment Done (Yes/No)</td><td>State level studies have been executed for biophysical studies.</td></tr>
<tr><td>7.</td><td>No of studies-Valuation and Accounting</td><td>State Level Study-1, PA-3, Wetland-1</td></tr>
<tr><td>8.</td><td>Institutions/Organizations worked in this domain other than Government Organisation</td><td>
<table>
<tr><td>Guwahati, Assam</td></tr>
<tr><td>Central Inland Fisheries Research, Guwahati</td></tr>
<tr><td>Indian Institute of Technology, Guwahati</td></tr>
<tr><td>Assam Remote Sensing Application Centre</td></tr>
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<tr><td>Assam Agricultural University</td></tr>
<tr><td>Rain Forest Research Institute</td></tr>
<tr><td>Delhi</td></tr>
<tr><td>WWF</td></tr>
<tr><td>Bhopal</td></tr>
<tr><td>Indian Institute of Forest Management</td></tr>
</table>
</td></tr>
<tr><td>9.</td><td>Ecosystem Management Unit/Spatial Unit</td><td>Forests (Circle/Division), Freshwater, Riverine (Watershed/ Catchment Area), Grassland (Division), Agriculture (District)</td></tr>
<tr><td>10.</td><td>Environmental Concerns of the State</td><td>Flood
Illegal Extraction of Natural Resources (e.g. Agarwood from tree outside forest)
Forest Degradation
Water Conservation
Food insecurity</td></tr>
<tr><td>11.</td><td>State Response/Initiatives for Valuation, Bio-Physical Assessment, and Accounting</td><td>Planning Department and Forest Department</td></tr>
<tr><td>12.</td><td>Response of State to support future studies/work</td><td>The state has shown positive response to conduct valuation and accounting studies in the state.</td></tr>
<tr><td>13.</td><td>Policy questions addressing the key issues</td><td>The state has a large cover of forest and water resources but is facing a problem of forest degradation, floods, increasing food insecurity. Natural resources accounting can prove to be a handy tool for addressing these key issues.</td></tr>
<tr><td>14.</td><td>Purpose/Intention of using the outcomes of the study</td><td>Addressing key issues of natural resource management specially the manmade and natural disasters</td></tr>
<tr><td>15.</td><td>Data sources</td><td>NSSO, FSI, Forest Department, ASSAMENVIS, Bhuvan, SPCB, Biodiversity Board, EPCO, CWC, WWF, etc.</td></tr>
<tr><td>16.</td><td>Availability of spatial data</td><td>Maps, LULC and other spatial data: Available at local level.</td></tr>
<tr><td>17.</td><td>Replicability of case of Assam</td><td>In 7 north eastern states</td></tr>
</table>

References:

Anuradha Singha, and Alok Sen. (2013). The Kaziranga National Park of India: An Economic Valuation. Retrieved September 17, 2018, from https://www.lap-publishing.com/catalog/details//store/ru/book/978-3-659-40192-3/the-kaziranga-national-park-of-india:-an-economic-valuation

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CASE STUDY V:

ECONOMIC VALUATION AND NATURAL CAPITAL ACCOUNTING FOR RAJASTHAN

Introduction

Rajasthan is the largest state of India and is known as 'the land of kings'. It has a population of 6.8 crores with males representing 51.8 per cent and females 48.1 per cent (2011 Census of India). Located in the north-west part of the country the state shares its international borders with Pakistan in the west. It has a geographical area of 3,42,239 sq km which constitutes around 10.41 per cent of the country's geographical area (Source: FSI 2017). The state has historical roots in the Indus valley civilization and has a rich architectural heritage represented by numerous forts and palaces. Table 16 shows the demography of Rajasthan and Figure 34 shows the location of Rajasthan state.

Table 16: Demography of Rajasthan

Features	Detail
Geographic area (sq km)	3,42,239
Population (Census 2011)	68,548,437
Rural population (%)	75.13
Number of districts	33
Agricultural land (% of total geographical area)	52.6%
Recorded forest area (km2)	32,737
Per capita forest area (ha)	0.04
Forest area as percentage of geographical area	9.57%
Forest cover (km2)	16,572
Major rivers	Luni, Banas, Chambal, Mahi
Major source of occupation	Agriculture, Industry

Figure 34: Rajasthan's State location

Ecological Profile of Rajasthan

The forests in Rajasthan covers around 4.84 per cent of the state's geographical area. The total forest area is 16,572 sq km of which 78 sq km is Very Dense Forest (VDF) 4,340 sq km is Moderately Dense Forest (MDF) and 12,154 sq km is Open Forest (OF). Between 2015-2017, the state has added about 466 sq km of forest (FSI, 2017). The land cover of the map of Rajasthan is shown in Figure 35.

The forestry sector contributes to about 2.19 per cent to the state's GSDP and the GVA at 2013-2014 prices were Rs. 16,842.46 crores. The state has three different types of forests: Broad leaved hill forests, Dry deciduous forests, and Thorn forests (Reddy et al., 2011). The climate varies from arid to sub-humid. The state has over 2000 plant species, 87 species of mammals, 114 species of fish, over 500 species of birds and about 81 species of reptiles. The state is home to three tiger reserves: Ranthambore, Sariska and Mukundara tiger reserves.

Water is a scarce resource as Rajasthan is an arid state (about 70 per cent). It has only 1.16 per cent of surface water and 1.7 per cent of groundwater. The major rivers of the state are Banas, Luni, Chambal, Mahi, Banganga and Sabarmati rivers. Despite this, it constitutes only 1 per cent of the country's water resources, additionally, increasing demands of water for agriculture and industrial purposes has driven the groundwater status in various blocks to be over-exploited (Figure 36)

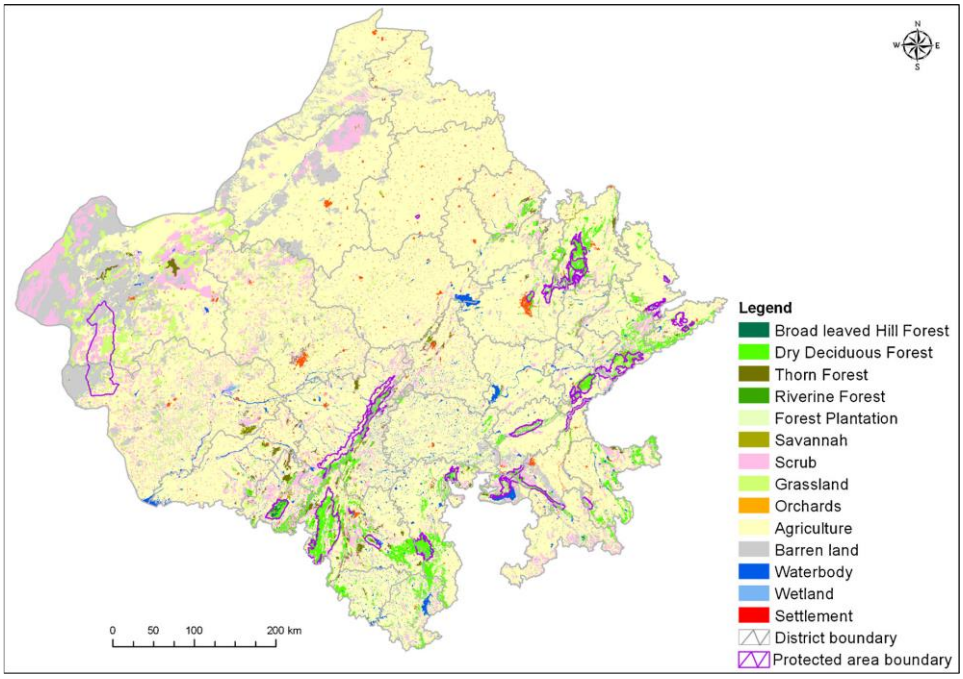

Figure 35: Land use Map of Rajasthan

Source: Krishna et al. (2014)

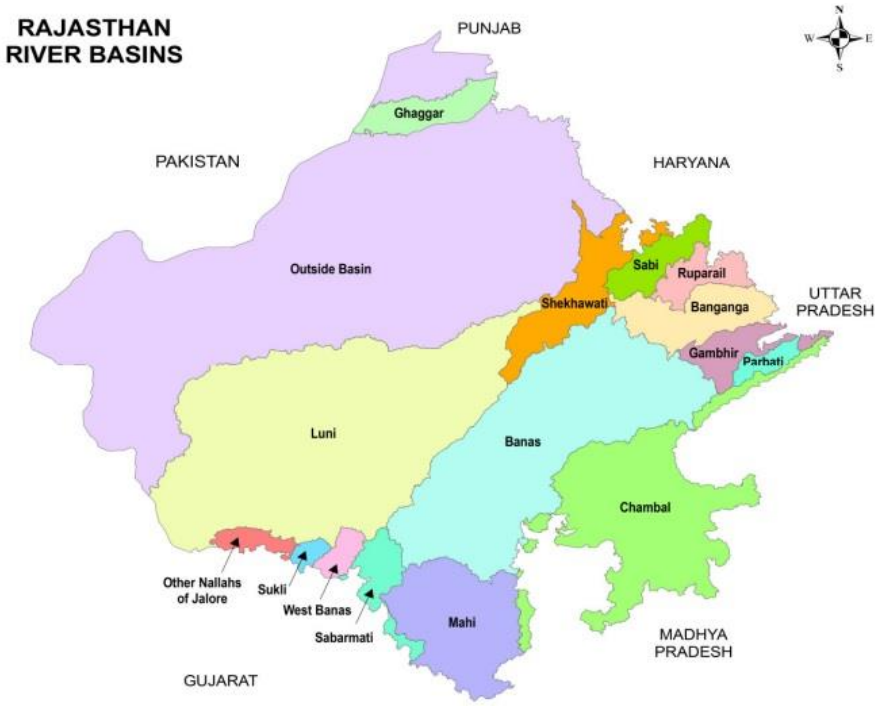

Figure 36: River Basin Map of Rajasthan

Source: https://www.rajras.in/index.php/rajasthan-river-basins-features-stretch

The state has vast mineral resources (57 minerals are mined) and it has a share of 20.26 per cent of mineral production in the country. Figure 37 shows the mineral deposits in Rajasthan. The contribution of the mining sector to GSDP (2013-2014) was 5.44 per cent and GVA was estimated at Rs. 13,323.73 crores. The value of mineral production in 2016-

2017 was Rs. 23,001 crores. However, decline in the GSVA in the mining sector is expected.

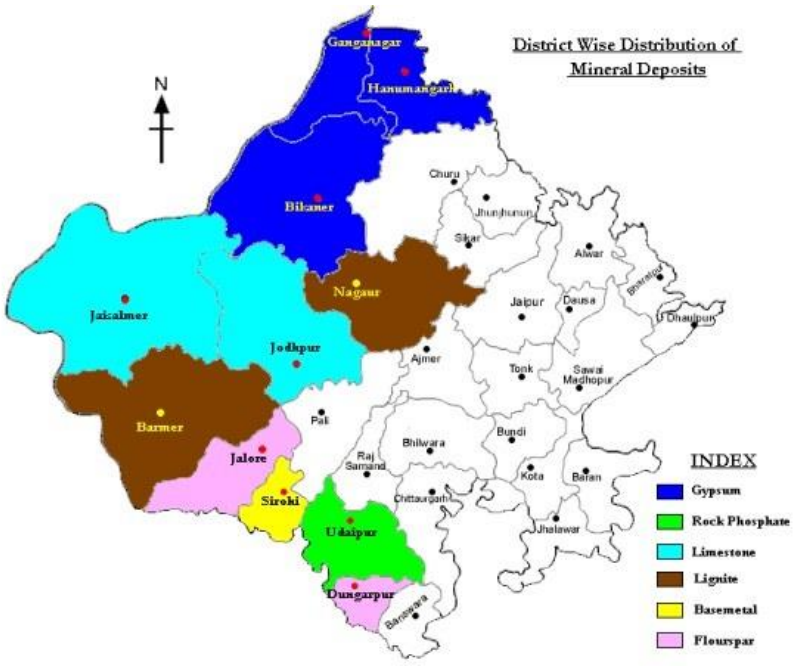

Figure 37: Mineral Resource Distribution in Rajasthan

(Source: http://www.rsmm.com/all_minerals)

Institutional Setup and Capacities

There are a few institutes that conduct studies on agriculture and natural resources. These include the Central University of Rajasthan, Central Arid Zone Research Institute (CAZRI), University of Rajasthan and Indian Institute of Management Udaipur (IIMU).

Need for Ecosystem Accounting in Rajasthan

The GSDP of Rajasthan for the year 2017-18 has shown an increase of 10.67 per cent over the preceding year (Rajasthan, 2018). This indicates that fast growth can be anticipated in the following years. Therefore, it can increase pressure directly or indirectly for ecosystems to generate the ecosystem services. Presently, the carbon stock in Rajasthan (2017) is 89.660 million tonnes which is 1.27 per cent of the total forest carbon of the country (FSI, 2017). This illustrates that in spite of having 16,500 sq km of forests there is less carbon stock when compared to other states owing to unique forest types. Therefore, accounting of natural resources will enable better management and accountability for resource use.

Justification for SEEA-EEA Accounting in Rajasthan

Resource accounting in Rajasthan using the SEEA framework has not been done before and this provides an opportunity to conduct the ecosystem accounts in a structured framework. This state also has the unique desert ecosystem, whereby the locals harvest resources from the deserts. This particular ecosystem has its own challenges that will aid

in understanding and improving the ecosystem accounting processes for similar habitats in the world.

Also, IIFM is conducting a study on valuation of the economic contribution of forests and protected areas in the state along with capacity development of forest personnel on forest resource valuation.

Recommended Institutions

The study can be done in cooperation with the Central Arid Zone Research Institute (CAZRI), University of Rajasthan and IIFM, Bhopal. Additionally, the institutes in Rajasthan have conducted studies on several aspects of protected areas and data can be used for building ecosystem accounts.

List of Policy questions relevant to the state of Rajasthan

- What are the drivers causing changes in Rajasthan's ecosystems and their services?
- What efforts are being made by the government to protect t its unique sand dunes and dry desert ecosystem
- What are the status and trends of Rajasthan's ecosystems and the services they provide to society?
- How would the Government and relevant stakeholders incorporate the economic values of ecosystem services into decision-making?
- What is the influence of ecosystem services provisioning on human well-being inside and outside the state?
- Who and where are the beneficiaries of ecosystem services flow, and how does this affect how they are valued and managed?
- How can we promote further investments in conservation and creation of green infrastructure and preventing damage?
- How can we minimize cost of inaction and benefits of action?
- How can we identify and prioritize the sectors which needs immediate attention for sustainable development and management of natural resources?
- How can national indicators for sustainable development be integrated into the SEEA which can help to support reporting on progress towards SDG targets?
- How can we create a synergy between different departments/institutions/policy makers/ministries/etc. working in this domain?
- How can improved investment be based on cost of damage of catchment?

Major Attributes of Rajasthan for Suitability for State Level Case for SEEA-EEA

S.No	Attribute	Rajasthan
1.	Area of the state (square km)	3,42,239
2.	Population	68,548,437

<table>
<tr><td>3.</td><td>No. of Biomes</td><td>1. Tropical and subtropical moist broadleaf forests
2. Tropical and subtropical dry broadleaf forests
3. Deserts and xeric shrublands</td></tr>
<tr><td>4.</td><td>Ecosystem Mapped</td><td>Forest, Wetlands, Desert Ecosystem, Riverine, Agriculture, Grassland</td></tr>
<tr><td>5.</td><td>Land-Use Pattern</td><td>
<table>
<tr><th>Land Use</th><th>Area (in thousands) (ha)</th><th>Percentage</th></tr>
<tr><td>Total geographical area</td><td>34224</td><td>NA</td></tr>
<tr><td>Reporting area for land utilization</td><td>34270</td><td>100.00</td></tr>
<tr><td>Forests</td><td>2728</td><td>7.96</td></tr>
<tr><td>Not available for cultivation</td><td>4265</td><td>12.45</td></tr>
<tr><td>Permanent pastures and other grazing lands</td><td>1699</td><td>4.96</td></tr>
<tr><td>Land under misc. tree crops and groves</td><td>18</td><td>0.05</td></tr>
<tr><td>Culturable wasteland</td><td>4336</td><td>12.65</td></tr>
<tr><td>Fallow lands other than current fallows</td><td>2108</td><td>6.15</td></tr>
<tr><td>Current fallows</td><td>1565</td><td>4.57</td></tr>
<tr><td>Net area sown</td><td>17551</td><td>51.21</td></tr>
</table>
</td></tr>
<tr><td>6.</td><td>State Level Biophysical Assessment Done (Yes/No)</td><td>Biophysical assessment has been done in previous studies.</td></tr>
<tr><td>7.</td><td>No of Studies-Valuation and Accounting</td><td>State level PA 7-8</td></tr>
<tr><td>8.</td><td>Institutions/Organsations worked in this domain other than Government Organisation</td><td>There are a few institutes that conduct studies on agriculture and natural resources. These include the Central University of Rajasthan, Central Arid Zone Research Institute (CAZRI), University of Rajasthan and Indian Institute of Management Udaipur (IIMU).</td></tr>
<tr><td>9.</td><td>Ecosystem Management Unit/Spatial Unit</td><td>Forests (Circle/Division), Freshwater, Salt Water Ecosystem (Sambhar lake), Riverine (Watershed/ Catchment Area), Grassland (Division), Agriculture (District), Desert (Desert National Park)</td></tr>
<tr><td>10.</td><td>Environmental Concerns of the State</td><td>Increasing Mining activities
Rapid Urbanisation
Water scarcity
Illegal wildlife trafficking</td></tr>
<tr><td>11.</td><td>State Response/Initiatives for Valuation, Bio-Physical Assessment, and Accounting</td><td>State Forest Department has initiated forest resource accounting at state level.</td></tr>
<tr><td>12.</td><td>Response of State to support future studies/work</td><td>The state has shown a positive response to conduct valuation and accounting studies in the state.</td></tr>
</table>

13.	Policy questions addressing the key issues	
14.	Purpose/Intention of using the outcomes of the study	Addressing key issues of natural resource management specially the man-made and natural disasters
15.	Data sources	NSSO, FSI, Forest Department, ENVIS, Bhuvan, SPCB, Biodiversity Board, CWC, etc.
16.	Availability of spatial data	Maps, LULC and other spatial data: Available at local level.
17.	Replicability of case of Rajasthan state	(6 No. : 5 States and 1 UT Gujarat, Madhya Pradesh, Uttar Pradesh, Punjab, Haryana, Delhi (UT)

Major Studies

FSI 2017. Indian State of Forest Report. Dehradun: Forest Survey of India (FSI).

KRISHNA, H. P., REDDY, S. C., SINGH, R. and JHA, C. S. 2014. Landscape Level Analysis of Disturbance Regimes in Protected Areas Of Rajasthan, India. *Journal of Earth System Science,* 123**,** 467-478.

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CASE VI. POLLINATION SERVICES

Introduction

The majority of the world's flowering plants depend on pollination services by animals, mostly insects. They aid in reproduction, fruit development and dispersal in plants both in natural and agroecosystems. Pollination services are invaluable for agriculture and food production and there are 87 major food crops that are produced for human consumption that depend on these services. However, only 35 per cent of crops are dependent on pollinators. Therefore assessing them based on crop dependence on pollinators can give an appropriate value of the pollination service (Klein et al., 2007).

A study done by Partap et al. (2012) in the Hindu Kush Himalayan region assessed the economic value of insect pollination and quantified the potential economic loss from its failure. The study was conducted in three states in India, viz. Himachal Pradesh, Kashmir and Uttarakhand for fruits, vegetables, spices, nuts, oilseeds and, pulses. The study estimated the value of insect pollinators was USD 426.8 million for Kashmir, USD 365 million for Himachal Pradesh and USD 166.8 million for Uttarakhand. The study employed a bioeconomic method that was developed by Gallai et al. (2009). The method employs a dependence ratio where the disappearance of pollinators leads to a crop production loss and therefore a corresponding loss in crop value.

Methodology

Though fruit crops are most commonly dependent on insect pollinators, other agricultural products are also pollinated to various degrees, hence, the dependence of crops on insect pollination varies from crop to crop. Based on the studies done by Gallai et al. (2009) and Klein et al. (2007), the dependence ratio of world agriculture crops that are consumed by humans have been compiled and a toolkit was developed by FAOSTAT (FAO Statistics Office). This tool can be used for calculating the economic impact of insect pollination of the agricultural production.

Though, the tool consists of a broad range of produce from around the world, indigenous and wild products consumed at the local level especially from forests are not accounted and data on their dependence ratio on pollinators are unavailable. Additionally, the diversity of pollinators in forests are high with different species contributing to varying levels of pollination to evaluate forest pollination services.

Data Requirement

To estimate the value of pollination services from the agricultural system, the following data is required:

a. Crop of interest
b. Price of crop production
c. Production level of crops

Executing Agency: Keystone Foundation, Karnataka

List of policy questions relevant to the case on pollination service:

- What is the impact on human well-being and food production in response to pollination declines?
- What is the role of native and managed pollinators?
- What cost is being borne to substitute pollinators and decline in food production?

CASE VII. GENE POOL

Introduction

Genetic diversity indicates the species richness and species population that provides the basis for developing commercial cultivars, livestock, and commercial products (medicine, cosmetics). Gene pool in agriculture may have been lost owing to adoption of monoculture farming practices and through species extinction(Leroy et al., 2018). Additionally, sacred groves and reverent species such as tigers, elephants and snakes play an important role in the socio-cultural aspect (Sangha et al., 2018).

Methodology

Mean species abundance of original species gives an indicator of biodiversity intactness. It is defined as mean abundance of original species relative to their abundance in the pristine, mature state of the ecosystem. It is quantified using datasets from peer-reviewed work that have estimated species abundance in the ecosystems.

Alternatively, since different species are used by various communities, participatory research methods such as questionnaires, conducting interviews and focus group discussions can provide a wide range of information.

Data Requirement

Data indicators to assess genetic diversity include:

a. The dependence of households on native crops species indicate the value of the crops
b. Domesticated animals show the diversity of breeds that were farmed from wild species
c. Area of genetic reserve habitat such as tiger reserves provide information on social and intrinsic value species

Executing Agency: GB Pant Institute of Himalayan Environment and Development

List of policy questions relevant to the gene pool:

- How can the scientific mapping and valuation of gene flow be done?
- How can the conceptual framework enhance understanding of the gene pool - landscape connectivity from a systems perspective?

CASE VIII: BIOLOGICAL CONTROL

Introduction

Biological control is the use of predators, parasites, or pathogens to suppress a pest population and decrease the damage it causes. Biological control can also be understood by the action of parasites, predators, or pathogens in maintaining other organisms' population density at a lower average than they would occur in their absence. Conserving beneficial predators and parasites around the farm or garden has been recommended to help suppress pests and increase crop yields (Kumar, 2010). Native plants may play a role in helping to enhance the abundance and performance of helpful arthropods. Many beneficial predators and parasites (also known as natural enemies) rely on plant nectar and pollen to help sustain them. In addition to these food sources, plants can also provide needed alternative prey and shelter from adverse environmental conditions (Power, 2010).

Methodology

Biological control can be understood by measuring the abundance of both pest species and pest controlling species, statistics on pest species and their predators can aid in identifying the effects of biological control. The areas in which diseases or pests occur can be studied along with spatial changes over time. Health, agricultural and environmental statistics are useful indicators in assessing biological control service (De Lange and van Wilgen, 2010). Changes in habitat quality can be understood by the heterogeneity of habitats or the percentage of natural habitats in agricultural landscapes that sustain the lifecycle of pest control species. Biological control can be a measure to understand these indicators: predator abundance/activity, herbivore abundance, crop damage, and crop yield.

Data Requirement

Data indicators of biological control include:

a. Expenditures on pest control activities, disease prevention and replacement cost of biological control services such as birds, bats by pesticides or genetic engineering
b. Assessing diversity of the relevant species and linking the result to changes in land cover / land use

Executing Agency: Global Tiger Forum

List of policy questions relevant to the regulation of biological control:

- What is the health cost saving due to biological control?
- What are the health benefits of biological control?
- What premium value can be sought on such products?
- What are the expenditures on insect control activities, disease prevention, and replacement cost of replacing bird biological control services by pesticides or genetic engineering due to declined function of biological control?

CASE IX. GAS REGULATION

Introduction

Life on earth exists within a narrow band of chemical balance in the biosphere. Any change in this balance can have serious implications on social and economic processes (de Groot et al., 2012). Natural ecosystems help in regulating air composition and quality. Ecosystems have an influence on air composition in two ways: they emit chemicals/gases into the atmosphere, acting as sources; or extracting chemicals from the atmosphere, acting as sinks(Pushpam, 2010). For instance: Lakes serve as a sink for industrial emissions of sulphur compounds and Vegetation fires emit particulates, ground-level ozone, and volatile organic compounds.

Trees trap airborne particulate matter and help to improve air quality and human health. Air quality regulation is particularly important in the urban context, with rising populations and industrial growth. Natural forests or urban trees can affect air quality in the following ways: (i) converting carbon dioxide to oxygen through photosynthesis;(ii) intercepting particulate pollutants (dust, ash, pollen and smoke) and absorbing toxic gases such as ozone, sulphur dioxide, and nitrogen dioxide, (iii) emitting various volatile organic compounds contributing to ozone formation in cities (iv) lowering local air temperatures (v) reducing building temperature extremes in both summer and winter and consequently reduce pollution emissions from power-generating facilities (Kumar, 2010). Gas regulation as a service has been used along with the broad category of climate regulation.

Methodology

Gas regulation or Air Quality Regulation can be measured by remote sensing and GIS-based approaches along with modelling softwares like InVEST, disposition model or stomatal flux model (Manes et al., 2016). It can also be measured by estimating the amount of aerosols or chemicals "extracted" from the atmosphere.

Urban Forest Effects model (UFORE) and i-tree models help to calculate values of dry deposition i.e. the rate at which pollutants accumulate on surfaces in dry weather, and then multiplied that uptake rate by total green area and pollution concentration. Some studies have also used the contingent valuation method for assessing Willingness-to-Pay (WTP) for air quality (Rice, 2015).

Data Requirement

Possible data requirement for biophysical assessment of gas regulation include:

a. Total forested/green area
b. Leaf Area Index (LAI)
c. Level and concentrations of particulate matter, SOx, NOx, and other gases

Executing Agency : IIT, Delhi

List of policy questions relevant to gas regulation:

- What is the status of biogeochemical processes which maintains a certain air quality?
- What is the influence of declining gas regulation on the greenhouse effect and thereby on the overall climate?
- What additional cost is to be budgeted to mitigate the damage due to declined gas regulation function?

CASE X. ECONOMIC VALUATION OF DAMAGE DUE TO ALIEN WEEDS INVASION (AWI) IN SELECTED PROTECTED AREAS OF INDIA

Justification of the Study

Intentional and unintentional introductions of invasive species into new environments have had, and continue to have profound ecological, human, social and economic effects at national, regional and global scales. Natural habitats of indigenous species have been disturbed, ecosystem functioning degraded, and aesthetics of natural environments impaired due to biological invasions. This worrying phenomenon has received recognition from ecologists, economists and public entities with environmental protection and management oversight (Marbuah et al. 2014).

Invasive alien species are plants, animals, pathogens and other organisms that are not native to an ecosystem, and that may cause economic or environmental harm or adversely affect ecosystem functioning and human health and are greatest threats to biodiversity and to the ecological and economic well-being of the planet (MAPS, 2016).

In the Indian Context Lantana is one of the world's worst weeds of South American origin that threatens native biodiversity of forest ecosystems across India. It was introduced into India as a garden ornamental and a bio hedge plant in the early part of the 19th century and now it has virtually invaded all the tropical and subtropical regions of India. Although attempts have been made to control Lantana by physical, chemical and biological methods, there is no success either in its control or the prevention of its spread. No effective management strategy is yet available for the containment of this obnoxious alien weed. Measuring the economic impact of alien species often assists managers and funding organizations to determine priorities for control – the species causing the most economic damage or loss are often the first to be controlled, or at least assessed for control. However, many of the impacts relate to change in ecosystem structure, or extinction of individual species, which are very difficult to attach monetary values to. The situation is similar to other weeds that have vigorously invaded various tiger habitats of India.

Measuring the economic impact of alien species very often assists managers and funding organizations to determine priorities for control – the species causing the most economic damage or loss are often the first to be controlled, or at least assessed for control. However, many of the impacts relate to change in ecosystem structure, or extinction of individual species, which are very difficult to attach monetary values. According to Pimentel et al (2001) alien species invasions cause more than US$ 314 billion per year in damage around the world. Many invasive alien species have caused major economic losses in agriculture and forestry. Weeds in US agriculture cause 12 per cent reduction in potential crop yields. It is likely that non-native weeds result in US$ 27.9 billion in losses. Pest insects and mites cause about US$ 16 billion in crop losses in the USA each year.

Thus the study intends:

1. To map the alien weeds invaded in selected protected areas in India
2. To estimate value of economic damage due to AWI
3. To highlight the cultural values damage due to AWI

4. To suggest appropriate management interventions and instruments/incentive-based mechanisms for eradication of AWI for protected areas

Executing Agency: IIFM with NTCA and GTF

List of policy questions relevant to the Alien Weeds Invasion in PAs

- What is the extent of biodiversity loss due to alien invasive species?
- What is the cost for ecosystem recovery?

CASE XI. ECONOMIC VALUATION OF ECOSYSTEM SERVICES WITHIN THE URBAN ECOSYSTEM

Pilot Study in Two Indian Cities- Delhi and Bhopal

Introduction

Urban ecosystems are a unique representation of synergies between natural and built (man-made) capital. Natural ecosystems within the urban areas are important for the well-being of citizens and have intrinsic cultural and social value. For example, urban parks have a special place in community events, for outdoor activities, or serve as a historical or cultural landmark (like Jallianwalla Bagh in Amritsar, India), etc.

Social and Cultural Benefits of Urban-Natural Ecosystems

- Add aesthetic value and add colour to the neighbourhood.
- Attract birds and provide shade to all.
- Provide a sense of privacy, solitude and security, and create a feeling of relaxation and well-being.
- Provide proximity to nature.
- Add value to the locality.
- Deeply associated with local traditions and community programmes.

India has around 24.16 per cent of its total geographical area (including Tree Outside Forest) under forest cover (ISFR, 2017). There are many studies for estimating the worth of ecosystem services emerging from forest areas. Urban ecosystems, however, generally do not have large patches of forests. The sustainability of these urban ecosystems thrive on crucial ecosystem functions from the natural ecosystems around, viz. nearby forests, urban green spaces, wetlands and riverine systems.

Natural Air conditioners

Urban green spaces can reduce air temperature by moderating sunlight. Further cooling occurs via transpiration. The conversion of water to air vapour removes heat energy from the air.

Trees in an urban setting are vital for oxygen production and water recharge function. A single large tree can release up to 400 gallons of water into the atmosphere each day. One acre of trees produces enough oxygen for 18 people every day. One acre of trees absorbs enough carbon dioxide per year to match that emitted by driving a car 26,000 miles. According to the US Department of Agriculture, "One acre of forest absorbs six tons of carbon dioxide and puts out four tons of oxygen. Meanwhile, urban neighbourhoods with mature trees can be up to 11 degrees cooler in summer heat than neighbourhoods without trees. Furthermore, large trees remove 60-70 times more pollution than small trees. A typical medium sized tree can intercept as much as 2,380 gallons of rainfall per year".

Natural Wind Break and Pollution control mechanism

Urban green spaces can reduce air pollution and maintain water quality in the area. They also absorb and block noise and reduce glare. A well placed tree can reduce noise by as much as 40 percent.

On the other hand, urban cities benefit greatly by the presence of wetlands in their vicinity. They act as a buffer ecosystem and support many ecosystem functions and processes for the city/urban ecosystem.

For instance, the East Kolkata Wetland contains rare floral and faunal biodiversity and sustains many local as well as migratory species of birds. It supports vegetation which provide green space to sequester carbon and controlling air quality. This wetland is very important for the natural drainage course of the region. It contains a buffer for tidal activities, intertidal salt marshes and salt meadows. The wetland acts as natural waste assimilation and treatment facility for the city of Kolkata acting as sewage farms, settling ponds and oxidation basins. It receives tonnes of municipal and sewage waste daily, partially treated waste is used for aquaculture. Small plots within the wetlands are used for agriculture, horticulture, and vegetable farming. Riverine ecosystems provide water supply and also maintain crucial ecological functions to maintain the ecosystem integrity and sustainability.

Study Area

Bhopal

Bhopal, the capital of Madhya Pradesh lies in the eastern edge of the Malwa Plateau and is situated in the central part of the state. The city boundary is shown in Figure 41. Topography of the city is undulating. The hill range located in the northern part of the city extend in a north-south direction. A high altitude zone exists to the east of the Baen river. The city can be divided into two broad regions (i) Berasia shrub Forest and (ii) Bhopal plateau, on the basis of the physio-cultural characteristics. The main reserved forest ranges are Berasia, Bhopal, Ramtek and Sohaya. Some pockets of protected forests are also located in this tract.

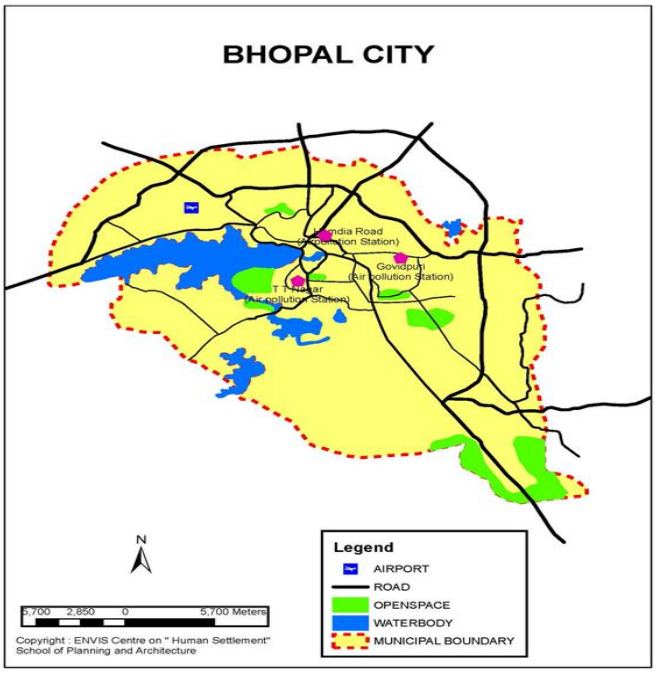

Figure 38: Bhopal City Overview

According to the Census of India 2011, out of the total area of 2,77,880 hectares, 42,309 hectares of land is forest land. Thus about 15.22 per cent of total land is covered under the forest area. The forests of the Bhopal may be divided into the following types (i) Dry deciduous teak forests. (ii) Fort hill teak forests (iii) Mixed forests.

Bhopal is known for its natural beauty and cultural heritage. The lakes and greenery of this city have been a constant attraction and are associated with the very perception of this city amongst people. The city is expanding as well as showing socio-economic growth. Bhopal is also known as the "city of lakes". It has approximately 30,000 acres of green cover as it has two large lakes and several natural parks including a national park where animals are kept in their natural habitat.

According to IISC Bangalore, Bhopal's tree cover has shrunk from 66 per cent to 22 per cent over a two-decade span. The pollution affects our daily life and even our human structures and hence should be controlled if it cannot be stopped. Many research studies have proved that trees are one of the most important tools to control different kinds of pollution. Bhopal still remains one of India's greenest cities, 16th largest by population with 1.6 million people. Bhopal is among the first 20 cities selected in the first round of smart cities challenge under Government of India's (GoI) smart cities mission to implement the smart city proposal.

Delhi

Delhi, officially known as, the National Capital Territory (NCT) is a Union Territory in India. Spread across an area of 1,483 sq km (approximately 0.05 per cent of the total geographical area of the country). Along with the neighbouring cities of Faridabad, Noida, Gurgaon and Ghaziabad it forms the National Capital Region (NCR) (Figure 42) and with an estimated population of over 26 million, it is one of the largest urban areas of the country. Rainfall in Delhi ranges from 400-600 mm. The temperatures go as high as 45 degrees in summer and as low as 4-5 degrees in winter. It has 9 districts and as per the 2011 census, it has a population of 16.79 million which is 1.38 per cent of the country's population. It has mainly urban population (97.50 per cent) and a population density of 11,320 per square kilometre making it one of the most populous cities of the country and also worldwide.

Figure 39: Delhi City Overview

Delhi has been the centre of political, cultural and historical events for decades. It finds its mention right from the era of the Mahabharata to the era of British rule in India. The monuments, heritage trees and cultural landmarks are spread across the city to tell the tales of its social and cultural heritage.

Recorded forest area in Delhi is 102 sq km which is 6.88 per cent of its geographical area. The figure includes forest cover within green wash (10.19 sq km) and forest cover outside green wash (182.22 sq km). Additionally, it has a tree cover of 113 sq km and per capita forest cover is 0.002 ha. (ISFR, 2017). The river Yamuna, the Aravalli range and the plains between both these form the alluvial deposits which dominates the physiography of Delhi.

Delhi is also one of the most polluted cities in the world (WHO, 2014). Recently it was in the news for recorded high suspended particulate matter (SPM) and Respiratory SPM

(RSPM). In this context the value of trees and other natural ecosystems rises significantly higher to curb the pollution and other vices prevalent in the city.

A Delhi-based NGO, Delhi Greens has released a report entitled "Report on Economic Valuation of Oxygen Supplying Ecosystem Service from a Healthy Tree" which shows that an average adult tree absorbs 7-8 litres of air per minute amounting to 11,000 litres of air per day. About 20 per cent of this is oxygen and nearly 15 per cent is exhaled. They have estimated the economic worth based on the daily need of oxygen for human beings based on the market value of an oxygen cylinder.

Study Proposal

Urban ecosystems are growing at a faster rate and therefore to derive synergies between urban and natural systems we should provide innovative solutions to the emerging problems pertaining to the environment. While this holds true for all urban ecosystems, Delhi and Bhopal city are chosen for piloting this study. As the rapidly growing urbanization schemes are hampering these vital natural links, there is an urgent need to measure the worth of the benefits to incorporate the value of their contribution into human well-being and overall development.

Objectives

- The proposed study will highlight the synergies between the natural capital and built capital in an urban ecosystem.
- Measure the worth of ecosystem services (benefits) emanating from these natural ecosystems like forest patches/areas, wetlands and riverine ecosystems. To make informed decisions it is important to have sustainable practices and to conserve our natural wealth.
- The study will help in mapping and measure the value of benefits for further policy implications.
- With emerging new growth and conservation targets, it will also help in accommodating contributions at local (city-level) into achieving national targets and SDGs.
- The study can also provide the basis of setting up incentive-based mechanisms for conservation.

Some Incentive Based Mechanisms

- Tax benefits
- Green credits
- Issuing coupons as rewards
- Research grants
- Priority ratings
- Certification
- Providing subsidies

Incentivizing Conservation: Case from USA, Oregon's Forest

In the USA, Oregon's forest resource trust provides financial and technical assistance to qualified private and local government owners to plant trees and improve management of forestlands for timber production and environmental purposes. A similar programme in North Carolina assists landowners with practices that improve tree growth and overall forest health. Between 1978 and 2009, participants planted 1.2 million acres of trees.

Executing Agency: Indian Institute of Forest Management (IIFM) Bhopal, Centre for Environment Planning & Technology (CEPT) Ahmedabad and School of Planning and Architecture (SPA) Bhopal/Delhi

List of policy questions relevant to the urban ecological systems

- How can the urban ecosystem services be mapped?
- What are the knowledge gaps in mapping ecosystem services?
- What is the step-wise framework for mapping ecosystem services?
- How can valuation and accounting of urban ecological systems be used to demonstrate suitable interventions to improve services like water purification, air quality, floral biodiversity etc.?
- How can ecosystem services and urban development complement each other?

Annexure I

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CMDR - Centre for Multidisciplinary Development Research
ICIMOD - International Centre for Integrated Mountain Development
IEG - Institute of Economic Growth
IGIDR - Indira Gandhi Institute of Development Research
IIMB - Indian Institute of Management Bangalore
IITB - Indian Institute of Technology Bombay
INSEE - Indian Society for Ecological Economics
IRADe - Integrated Research for Action and Development
ISEC - Institute for Social and Economic Change
ISI - Indian Statistical Institute
JNU - Jawaharlal Nehru University
MSE - Madras School of Economics
NIFPF - National Institute of Public Finance and Policy
TERI - The Energy and Resources Institute
WII - Wildlife Institute of India
WWF - World Wildlife Fund

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