ECOSYSTEM ACCOUNTS FOR INDIA

Report of the NCAVES Project

सत्यमेव जयते

Government of India
Ministry of Statistics &
Programme Implementation

NSO INDIA
Data for Development

Citation and reproduction

Disclaimer

The material has been prepared on the basis of information, presentations and websites of the concerned Ministries and Departments as well as other agencies of the Government. Every effort has been made in preparing this publication to ensure correctness of information. The National Statistical Office (NSO) accepts no responsibility for the differences between the stated figures and those published elsewhere. Due to the dynamic changes in the datasets, users are requested to check for updates with the source agencies.

Neither NSO, nor other third-party data sources, provide any warranty, including accuracy, completeness or fitness, for a particular purpose on use of such material and accept no responsibility or liability with regard to the use of this publication and the material featured therein.

Feedback and suggestions are welcomed by the EnviStats team at: ssd-mospi@gov.in

CONTENTS

ACKNOWLEDGMENTS

This report is presented by the Social Statistics Division of the National Statistical Office of the Ministry of Statistics and Programme Implementation (MoSPI), Government of India, as the nodal agency for implementation of the Natural Capital Accounting and Valuation of Ecosystem Services (NCAVES) in India.

Acknowledgements go to the European Union for funding the NCAVES Project and the Delegation of the European Union to India for supporting its implementation in India, and the UNSD and UN Environment for leading the NCAVES Project globally and supporting its management and implementation in India.

The activities undertaken during the project period benefitted greatly from the inputs of Bram Edens, Project Manager, UNSD and William Speller, Programme Officer, UNEP, Alessandra Alfieri, Chief, Environmental-Economic Accounts Section, UNSD and the members of the UN Technical Committee on the SEEA EA and its working groups. The Division also appreciates the contributions of Bethanna Jackson and Rubianca Benavidez of the Victoria University of Wellington, New Zealand. Thanks are also due to Altus Impact for their editing, design and strategic communication services for the report.

The Social Statistics Division acknowledges the efforts of Ms. Monica Sharma and Ms. Sonia Arora, who were commissioned by UNSD and UNEP as consultants. They assisted with the economic valuation, modelling and compiling the accounts released during the period.

The Social Statistics Division gratefully acknowledges the contribution of all the collaborating agencies, including those listed below, for supplying the requisite information:

1. The Forest Survey of India, the Botanical Survey of India, the Zoological Survey of India, the Wildlife Institute of India and the Divisions of the Ministry of Environment, Forest & Climate Change;
2. The Central Water Commission, the Central Ground Water Board and the Divisions of the Ministry of Jal Shakti;
3. The Ministry of Agriculture, Cooperation & Farmers Welfare;
4. The National Remote Sensing Centre, Ministry of Space; and
5. The Department of Land Resources, Ministry of Rural Development.

System of Environmental Economic Accounting

United Nations

UN environment programme

Funded by the European Union

Citation: Ecosystem Accounts for India - Report of the NCAVES Project. MoSPI, 2021.

ACRONYMS

AGB
Above Ground Biomass

APY
Area, Production and Yield

BCM
Billion Cubic Metres

BGB
Below Ground Biomass

BIP
Biodiversity Indicators Partnership

BSI
Botanical Survey of India

CBD
Convention on Biological Diversity

CCS
Cost of Cultivation Studies

CGWB
Central Ground Water Board

COFOG
Classification of the Functions of Government

COMAPS
Coastal Ocean Monitoring and Prediction System

CPCB
Central Pollution Control Board

CWC
Central Water Commission

DEM
Digital Elevation Model

DIN
Dissolved Inorganic Nitrogen

DIP
Dissolved Inorganic Phosphorus

DOM
Dead Organic Matter

EEZ
Exclusive Economic Zone

EFG
Ecosystem Functional Group

ENCS
Effective Number of Crop Species

ENS
Effective Number of Species

ESA CCI
European Space Agency Climate Change Initiative

FAO
Food and Agriculture Organization

FSI
Forest Survey of India

GDP
Gross Domestic Product

GeoTIFF
Geographic Tagged Image File Format

GHSL
Global Human Settlement Layer

GIS
Geographic Information System

GloREDa
Global Rainfall Erosivity Database

GPG
Good Practice Guidance

ha.
Hectare

HWSD
Harmonised World Soils Database

INR
Indian Rupee

IMD
Indian Meteorological Department

IMG
Inter-Ministerial Group

InVEST
Integrated Valuation of Ecosystem Services and Tradeoffs

IPBES
Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services

IPCC
Intergovernmental Panel on Climate Change

ISFR
India State of Forest Report

ISRO
Indian Space Research Organization

IUCN
International Union for Conservation of Nature

IUCN GET
International Union for Conservation of Nature Global Ecosystem Typology

JRC
Joint Research Centre

km
Kilometre

LCR
Land Consumption Rate

LD
Land Degradation

LUCI
Land Utilisation Capability Indicator

LUE
Land Use Efficiency

LULC
Land Use Land Cover

LUS
Land Use Statistics

MEA
Multilateral Environmental Agreement

Mha
Million Hectares

million cum
Million Cubic Metre

mm
Millimetre

MoEF&CC
Ministry of Environment, Forest and Climate Change

MoES
Ministry of Earth Sciences

MoSPI
Ministry of Statistics and Programme Implementation

N.I.
Nutrient Index

NBSS&LUP
National Bureau of Soil Survey & Land Use Planning

NCA
Natural Capital Accounting

NCAVES
Natural Capital Accounting and Valuation of Ecosystem Services

NCCR
National Centre for Coastal Research

NRC
Natural Resources Census

NRSC
National Remote Sensing Centre

NSO
National Statistical Office

NTFP
Non Timber Forest Products

NWIA
National Wetland Inventory and Assessment

PGR
Population Growth Rate

RFA
Recorded Forest Area

RR
Resource Rent

RUSLE
Revised Universal Soil Loss Equation

SCC
Social Cost of Carbon

SDG
Sustainable Development Goals

SECT
SEEA Ecosystem Condition Typology

SEEA
System of Environmental Economic Accounting

SEEA-CF
System of Environmental-Economic Accounting Central Framework

SEEA EA
SEEA Ecosystem Accounting

SFD
State Forest Departments

S.No.
Serial Number

SNA
System of National Accounts

SOC
Soil Organic Carbon

SRTM
Shuttle Radar Topography Mission

SRU
Standard River Units

SWQM
Seawater Quality Monitoring

TOF
Trees Outside Forest

UNCCD
United Nations Convention to Combat Desertification

UNFCCC
United Nations Framework Convention on Climate Change

UNSD
United Nations Statistical Division

WII
Wildlife Institute of India

WQI
Water Quality Indices

ZSI
Zoological Survey of India

MESSAGE

The progressive realization to blend economic development with environmental balance for bringing about sustainable development, has led to conscious efforts towards protecting the nature. The need for the day is a working model for integrating sustainable development, social, ecological, economic, spatial and cultural dimensions. The System of Environmental Economic Accounting (SEEA) is such a framework, which helps bring together different sets of information, in a coherent and consistent manner.

The Ministry of Statistics & Programme Implementation under the EU-funded project, "Natural Capital Accounting & Valuation of Ecosystem Services", has taken several initiatives for the implementation of the SEEA framework. This report chronicles these initiatives, which would form the base of the future action plan for environmental accounting in India.

We are thankful to the United Nations Statistics Division, the United Nations Environment Programme and the European Union for their guidance and support during this Project. We are also thankful to the Ministries/Departments and Organizations of the Government of India, for their support, without which these initiatives could not have taken shape.

I take this opportunity to congratulate and convey my appreciation for team of officers of the Social Statistics Division, who under the able leadership of Dr. Shailja Sharma, DG(Statistics), National Statistical Office, took up the challenge of implementing the Project and have been able to successfully achieve the intended objectives in the short span of three years.

(Kshatrapati Shivaji)
Secretary
New Delhi - January 2021

MESSAGE

The Ministry of Statistics & Programme Implementation has been alert and active in bringing in vogue the concept of Natural Capital Accounting in datasets relating to environment. The availability of the right data would help the policy makers to factor in the value of nature and its ecosystem services in policymaking. We would like to facilitate an increased uptake and mainstreaming of the System of Environmental Economic Accounting (SEEA) through demonstrating its relevance to ongoing policy processes.

The Ministry of Statistics & Programme Implementation has initiated the work of compilation of environmental accounting under the "Natural Capital Accounting and Valuation of Ecosystem Services" Project. Apart from compiling and releasing three publications on environmental accounts under the title "EnviStats India", the Ministry has also set up a mechanism for continuously improving the coverage and timeliness of these accounts.

We wish to acknowledge the support of the members of the "Inter-Ministerial Group on Environmental Accounting in India", which has helped the Ministry in all its efforts for developing an improved information system on the natural capital and flows of ecosystem services in the country.

The work related to environment accounting in India is still in its early stages, primarily because of the large number of subjects to be covered under this domain. The Ministry looks forward to collaborating actively with the various stakeholders, including line ministries, state governments, multilateral organizations and research institutions, so that the system of environmental accounting can be strengthened for improved environmental management.

I compliment the hard work put in by Ms. P. Bhanumati, DDG, Shri Rakesh Kumar Maurya, DDG and the team of officers under the able guidance of Shri Awadhesh Mishra, ADG for their achievements in successfully implementing the NCAVES project in India.

(Shailja Sharma)
Director General
New Delhi - 11th January 2021

MESSAGE

With ever-growing realization of the importance of the environment in the economy as well as in other social systems, there are constant efforts to dovetail environmental concerns with the economic development. The System of Environmental Economic Accounting (SEEA) helps in studying this linkage, by juxtaposing information related to a broad spectrum of environmental and economic issues including, in particular, the assessment of trends in the use and availability of natural resources, the extent of emissions and discharges to the environment resulting from economic activity, and the amount of economic activity undertaken for environment protection.

The National Statistical Office (NSO), Ministry of Statistics & Programme Implementation, India has the mandate for development of methodology & concepts and preparation of national resource accounts. Keeping this in mind, NSO India has been quick to adopt the UN-SEEA framework and has been publishing results under the same since 2018 under the title, 'EnviStats India'.

India is richly endowed with natural resources of different kinds and environmental accounting for a country like India is, therefore, packed with challenges. From integrating huge datasets and several microscopic studies to synchronising all of these so that they yield consistent estimates is both enormous and challenging. India's participation in the EU-funded Project on "Natural Capital Accounting and Valuation of Ecosystem Services" (NCAVES) has helped set up collaborations with several data sources and consolidate the relevant datasets, leading to the compilation of System of Environmental-Economic Accounting (SEEA) compliant indicators and accounts.

Under the NCAVES project, India has focused primarily on compilation on ecosystem extent, condition and ecosystem services accounts for selected ecosystem services with a focus on biodiversity and derivation of SDGs based on SEEA. The work done in the project has laid a solid foundation for moving forward towards the complete set of accounts in the years to come.

Coming together is a beginning; keeping together is a progress and working together is a success. The Division is thankful to the international, national and state agencies for the cooperation, technical support and quality data that we received from them. The Division is exploring new areas and subjects and is open to suggestions for further improvement.

(Awadhesh Kumar Mishra)
Additional Director General
New Delhi - 11th January 2021

TEAM ASSOCIATED WITH THE REPORT

Mr. Awadhesh Kumar Mishra
Additional Director General

Ms. P. Bhanumati
Deputy Director General

Mr. Rakesh Kumar Maurya
Deputy Director General

Ms. Kajal Jain
Director

Dr. (Ms.) Sudeepta Ghosh
Joint Director

Ms. Avneet Kaur
Deputy Director

Mr. Krishna Kumar Tiwari
Deputy Director

Mr. Kuwar Alok Singh Yadav
Deputy Director

Ms. Ruchi Mishra
Assistant Director

Mr. Rajesh Kumar Panwar
Senior Statistical Officer

Ms. Nikita Kumari
Junior Statistical Officer

Ms. Sonia Arora, Ms. Monica Sharma
Consultants

ANNOTATED OUTLINE

In 2017, the United Nations Statistics Division (UNSD), the United Nations Environment Programme (UNEP), the Secretariat of the Convention on Biological Diversity (CBD) and the European Union (EU) launched the project "Natural Capital Accounting and Valuation of Ecosystem Services" (NCAVES). This project, which is funded by the EU through its Partnership Instrument, aims to assist the five participating partner countries, namely Brazil, China, India, Mexico and South Africa, to advance the knowledge agenda on environmental-economic accounting, and in particular ecosystem accounting.

This report provides an overview of work undertaken in India as part of the NCAVES project.

Section 1: The introduction provides an overview of natural capital accounting, the System of Environmental-Economic Accounting (SEEA), the SEEA Ecosystem Accounting (SEEA EA), the role of accounting and links to policy. This section provides an overview of the NCAVES project and the approach to national implementation in India.

Section 2: Extent accounts focus on the ecosystem extent accounts, which organize information on the extent of different ecosystem types (e.g. forests, wetlands, agricultural areas and marine areas) within a country in terms of area. The section also discusses a concordance of the nationally available ecosystem classification systems and the IUCN Global Ecosystem Typology that are recommended internationally. Results are presented for: Change Matrix of Land Use – Land Cover (LULC); Asset Account for Land Use Land Cover (LULC); Land Degradation Account; and Wetlands Extent Account.

Section 3: Ecosystem condition covers accounts which measure the overall quality of an ecosystem asset and captures, in a set of key indicators, the state or functioning of the ecosystem in relation to both its naturalness and its potential to supply ecosystem services. This section presents and discusses results for soil nutrient indices, water quality accounts, a coastal water quality index, a forest condition account and a cropland condition account.

Section 4: Ecosystem services provide results of accounts for the supply of selected ecosystem services. The section considers the following ecosystem services: crop provisioning, provisioning of timber and non-timber forest products, carbon retention (from forests), nature-based tourism and soil erosion prevention service. Carbon retention is expressed in both physical and monetary terms. Soil retention is expressed in physical terms only. Other services are expressed in monetary terms only.

Section 5: Thematic accounts cover stand-alone accounts on topics of importance in their own right for policy and analysis. This section provides: national floral and faunal species accounts (measuring diversity and endemism); national floral and faunal species asset accounts; biodiversity accounts for four biodiversity hotspots (Himalaya, Indo-Burma, Western Ghats and Sundaland); and information on keystone species, red list species richness, protected areas and biodiversity expenditure. A cross-mapping of the indicators within Biodiversity Indicators Partnership to the proposed Post-2020 global biodiversity framework goals/targets and SEEA is also provided.

Section 6: Accounts for individual environmental assets describes accounts for both forest and water that have been compiled, following the specification of the SEEA Central Framework. A physical asset account, the amount of carbon stored and change in growing stock are provided for forests. For water, measures of inland water resources, river basin water availability, rainfall and groundwater resources availability and extraction are provided.

Section 7: Indicators and analysis – SDG indicators provides an assessment of the use of SEEA accounts to inform indicators used to measure progress against the Sustainable Development Goals (SDGs). A mapping of India's national indicator framework to the SEEA is given. In addition, results of testing the calculation of the following SDG indicators using the SEEA are shown: 15.1.1 – Forest area as a proportion of total land area; 6.6.1 – Change in the extent of water-related ecosystems over time; 15.3.1 - Proportion of land that is degraded over total land area; and 11.3.1 – Ratio of land consumption rate to population growth rate.

Section 8: Discussion and conclusion provides an assessment of the potential policy uses of the accounts and summarizes a road map advancing natural capital accounting and mainstreaming accounts into policymaking in India.

Section 1:
Introduction

Natural capital refers to all types of environmental assets that exist in the environment. It also includes ecosystem services that are often "invisible" to most people, such as air and water filtration and purification, flood protection, carbon storage, pollination of crops and habitats for wildlife. Natural capital is essential for economic growth, employment, and, ultimately, prosperity. Gross Domestic Product (GDP), the way it is constructed, looks at economic performance and has a limited representation of the natural capital that underlie this income.

A major drawback of GDP is its restricted or limited representation of natural capital. Depletion and degradation of natural capital of assets, like forest, water and biodiversity, to name but a few, not only decreases a country's resources and wealth but also poses a challenge to poverty alleviation, economic growth and achievement of sustainable development objectives. Thus, measuring and valuing the environment, via natural capital accounting, leads to better decision-making for development of an economy.

Natural capital accounting (NCA) is a tool that can help measure the full extent of a country's natural assets. It also provides a perspective on the link between the economy, ecology and environment, which can subsequently help to better manage natural resources that contribute to economic development. NCA uses an accounting framework to provide a systematic way to measure and report on stocks and flows of natural capital. It covers accounting for individual environmental assets or resources, both biotic and abiotic (such as water, minerals, energy, timber and fish), as well as accounting for ecosystem assets (e.g. forests and wetlands), biodiversity and ecosystem services.

The System of Environmental-Economic Accounting (SEEA), the accepted international standard for environmental-economic accounting, provides a framework for organizing and presenting statistics on the environment and its relationship with the economy. The SEEA is a statistical system that brings together economic and environmental information into a common framework to measure the condition of the environment, the contribution of the environment to the economy and the impact of the economy on the environment. SEEA consists of three parts:

1. **The SEEA Central Framework (SEEA-CF**) was adopted by the UN Statistical Commission as the first international standard for environmental-economic accounting in 2012. The Central Framework looks at "individual environmental assets", such as water resources, energy resources etc. and how those assets move between the environment and the economy.
2. **The SEEA Ecosystem Accounting (SEEA EA)** offers a synthesis of current knowledge in ecosystem accounting. It takes the perspective of ecosystems and considers how individual environmental assets interact as part of natural processes within a given spatial area.

3. **The SEEA Applications and Extensions** illustrates to compilers and users of SEEA Central Framework based accounts how the information can be used in decision-making, policy review and formulation, analysis and research.

1.1 The Importance of SEEA in a Policy Context

Environmental economics and accounting have a substantial opportunity to enhance policy-making. Thus, SEEA, which underpins environmental accounting, helps to facilitate better and informed decision-making process. It offers a means of monitoring the pressure that can be exerted by the economy on the environment by capturing the abstraction of natural resources and emissions, changes in condition and how the economy responds in terms of expenditure on environmental protection and resource management. It provides a system that can help in generating a wide range of indicators and statistics with different applications in decision-making. Due to its integrated approach, the SEEA is well positioned to support progress on a range of critical global initiatives, notably Agenda 2030, the post2020- biodiversity agenda and the Paris Agreement to the United Nations Framework Convention on Climate Change (UNFCCC). SEEA is an ideal framework for directly measuring some of the Sustainable Development Goals (SDGs) and provides supplemental information for various other goals such as those that are related to livelihood and economic growth. So, SEEA allows for the development of indicators to enable the analysis of the economy-environment nexus. This has been discussed further in Section 7 of the report.

1.2 The SEEA Ecosystem Accounting

The System of Environmental-Economic Accounting Ecosystem Accounting (SEEA EA) is a coherent framework for integrating measures of ecosystems and their flows of services with measures of economic and other human activities. Ecosystem accounting complements, and builds on, the accounting for environmental assets as described in the System of Environmental-Economic Accounting 2012 Central Framework (SEEA-CF).

The SEEA EA framework provides an integrated information system on (a) ecosystem assets, encompassing ecosystem extent, ecosystem condition, ecosystem services, ecosystem capacity and relevant monetary values; and (b) economic and other human activities and the associated beneficiaries (households, businesses and governments). The integration of ecosystem and economic information is intended to mainstream information on ecosystems in decision-making.

The ecosystem accounting framework was intended for application at the national level to enable the integration of information on multiple ecosystem types and multiple ecosystem services with macro-level economic information (e.g. measures of national income, value-added, production, consumption and wealth). However, since the release of SEEA EA, the application of the framework has proved relevant at sub-national scales, encompassing, for example, individual administrative areas such as provinces, protected areas and cities; and environmentally defined areas, such as water catchments. This report covers the application of both SEEA-CF and SEEA EA both at national and sub-national level.

1.2.1 Why the need for accounting

The essence of ecosystem accounting lies in the potential to represent the biophysical environment in terms of distinct spatial areas that each represent different ecosystem assets, such as forests, wetlands, agricultural areas, rivers and coral reefs. While focus

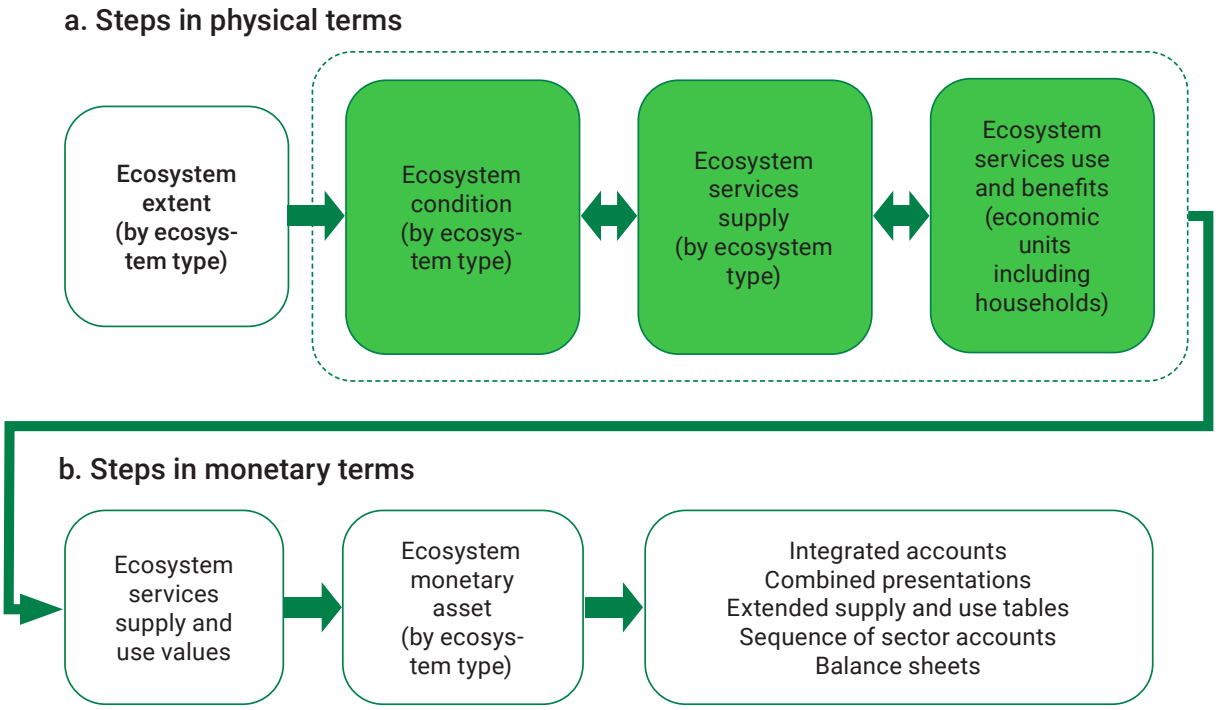
is commonly on accounting for land areas, including inland waters, ecosystem accounting is also applicable to coastal and marine ecosystems.

Following an accounting logic, each ecosystem asset supplies a stream (bundle) of ecosystem services. The flows of services in any period are related to the extent (i.e. size) and condition of the asset. The intent in ecosystem accounting is to record the supply of all ecosystem services over an accounting period for each ecosystem asset within an ecosystem accounting area, as well as the users of ecosystem services.

Flows of ecosystem services are distinguished from flows of benefits. The term "benefits", as used in SEEA EA, encompasses: (a) System of National Accounts (SNA) benefits, that is, the products (goods and services) produced by economic units as recorded in the standard national accounts; and (b) the non-SNA benefits that are generated by ecosystems and consumed directly by individuals and societies. The measurement of well-being is not the focus of ecosystem accounting, although the data that are integrated through the ecosystem accounting framework can support such measurements.

The broad steps in ecosystem accounting are shown in Figure 1 below.

Figure 1: Broad steps in ecosystem accounting



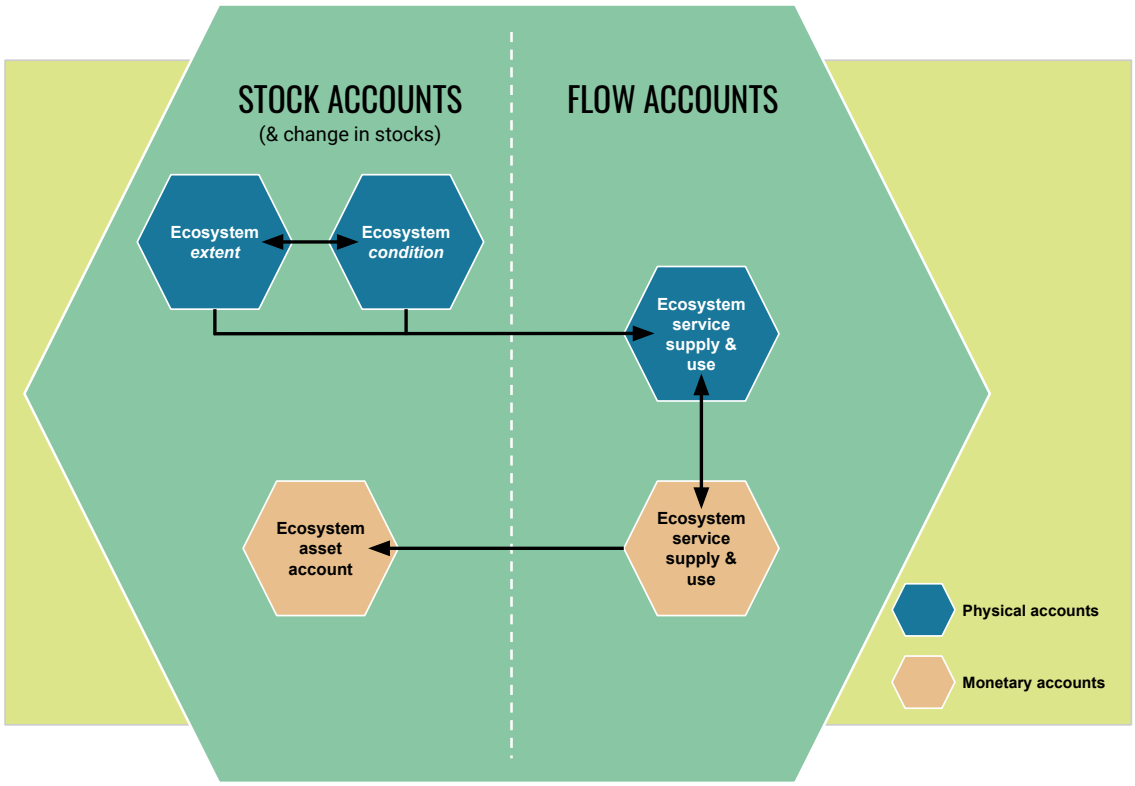
Note: The dotted line surrounding the boxes for ecosystem condition, ecosystem services supply and ecosystem services use and benefits signifies that measurement of these concepts may often be completed concurrently, and iteration between them is appropriate in developing a single best picture. Also, while the figure portrays a progression from physical to monetary terms, for some provisioning services direct estimation of monetary values may be undertaken, or estimates for the accounts may be taken from existing studies.

Source: UN (2019)

1.2.2 Ecosystem accounts

Ecosystem accounting can produce information on the extent of ecosystems, their condition based on selected indicators and the flow of ecosystem services. Because of the spatial nature of ecosystem accounting, maps are a common method of presenting information. The links between an ecosystem and the economy can be presented in both physical and monetary terms. Figure 2 summarizes the main types of ecosystem accounts. These accounts will also provide the main structure for this report, namely the: extent account; condition account; supply and use of ecosystem services (in physical and monetary terms); and the monetary ecosystem asset account. This set of ecosystem accounts, as illustrated by Figure 2, collectively presents a coherent and comprehensive view of ecosystems.

Figure 2: Types of ecosystem accounts



- **Ecosystem extent account:** This account serves as a common starting point for ecosystem accounting. It organizes information on the extent of different ecosystem types (e.g. forests, wetlands, agricultural areas and marine areas) within a country in terms of area.
- **Ecosystem condition account:** This account measures the overall quality of an ecosystem asset and captures, in a set of key indicators, the state or functioning of the ecosystem in relation to both its naturalness and its potential to supply ecosystem services.
- **Ecosystem services accounts:** This set of ecosystem accounts measures the supply of ecosystem services as well as their corresponding users and beneficiaries, classified by broad national accounting categories or other groupings of economic units.
- **Monetary asset account:** This account records the monetary value of opening and closing stocks of all ecosystem assets

within an ecosystem accounting area and additions and reduction to those stocks.

- **Thematic accounts:** This set of accounts, which cover accounts for land, water, carbon and biodiversity, are stand-alone accounts on topics that are important for policy analysis but are also of direct relevance in the compilation of ecosystem accounts.

Ecosystem services can be described in physical terms or be valued in monetary units. Valuation requires the use of a valuation concept that is aligned to the SNA. On the basis of the estimates of ecosystem services in monetary terms, the value of the underlying ecosystem assets can be estimated using net present value techniques whereby the value of the asset is estimated as the discounted stream of income arising from the supply of a basket of ecosystem services that is attributable to an asset.

1.2.3 Indicators from ecosystem accounts

The ecosystem accounts can be used to derive a range of aggregates and indicators. The integration with standard economic accounting data enables the derivation of, for example, measures of GDP adjusted for ecosystem degradation, extended measures of production and consumption and the estimation of extended measures of national wealth.

The physical accounts on extent, condition and ecosystem services allow for multiple indicators to be derived for monitoring and reporting on global indicators (e.g. SDGs, biodiversity targets) as well as national indicators (e.g. sectoral plans, development reports), which will be further described in Chapter 7 of this report.

1.3 About the NCAVES Project

The United Nations Statistics Division (UNSD), the United Nations Environment Programme (UNEP), the Secretariat of the Convention on Biological Diversity (CBD) and the European Union (EU) launched, in 2017, the project "Natural Capital Accounting and Valuation of Ecosystem Services" (NCAVES).

The project funded by the EU, through its Partnership Instrument, aims to assist the five participating partner countries, namely Brazil, China, India, Mexico and South Africa, to advance the knowledge agenda on environmental-economic accounting, in particular ecosystem accounting. It has initiated pilot testing of SEEA Ecosystem Accounting (SEEA EA) with a view to:

- Improving the measurement of ecosystems and their services (both in physical and monetary terms) at the (sub)national level;
- Mainstreaming biodiversity and ecosystems at (sub)national level policy planning and implementation;
- Contribute to the development of internationally agreed methodology and its use in partner countries.

1.3.1 Global work streams

The project was organized along several work streams. These include:

- **Compiling ecosystem accounts** in physical and monetary terms in the project countries;
- Applying the accounts in **scenario analysis**, based on national policy priorities;
- Development of **guidelines and methodology** that contribute to national and global implementation of NCA;
- Development and testing of a set of **indicators** in the context of the post2020-Biodiversity Agenda and other international initiatives;

- **Business accounts** that contribute to the alignment between SEEA and corporate sustainability reporting;
- **Communications** that increase awareness of natural capital accounting both in project countries and beyond through developing a range of products;
- Enhanced **capacity building and knowledge sharing** that help to grow the community of practitioners on natural capital accounting by way of e-learnings and training workshops (in country and regional).

In parallel, within project countries, inter-institutional mechanisms around NCA will be established or strengthened, through a country assessment that feeds into the development of national roadmaps.

1.3.2 National implementation

In India, the NCAVES project is being implemented by the National Statistical Office (NSO) of the Ministry of Statistics and Programme Implementation (MoSPI) in close collaboration with the Ministry of Environment, Forest and Climate Change (MoEF&CC), the National Remote Sensing Centre (NRSC), the Soil and Land Use Survey of India (SLUSI) and the Indian Institute of Science (IISc) - Centre for Ecological Sciences. MoSPI has coordinated with all the stakeholders through a consultative process by setting in place a mechanism for linking the diverse stakeholders concerned – namely producers and the policymakers – using the environmental accounts.

To make a gradual progression towards the compilation of the environmental accounts, the supplement on "Environment Accounts" of the annual publication "EnviStats-India" has been initiated to present the environmental accounts for India (MoSPI, 2020 ,2019 ,2018). Under the NCAVES project, MoSPI has focused primarily on compiling ecosystem extent, ecosystem condition and an ecosystem services accounts (for selected ecosystem services), along with a focus on biodiversity and the derivation of SDGs based on the SEEA.

In parallel, in the State of Karnataka, the Indian Institute of Science is leading the development of a suite of ecosystem accounts for assessing a range of ecosystem services. The State of Karnataka was shortlisted for the pilot studies through a landscape assessment[1] due to the availability of good data, a strong technical capacity within local research institutes and a strong policy interest in using an accounting approach. These accounts will be applied in subsequent scenario analyses and also in the assessment of conservation and afforestation policies. The results of the pilot are reported in separate publications.

This current publication summarizes the main results that were achieved during the period 2020-2017 under some of the work streams of the project. The results of other work streams are reported the project site: https://seea.un.org/home/Natural-Capital-Accounting-Project

[1] See: https://seea.un.org/sites/seea.un.org/files/india_assessment_2019.pdf

Section 2: Extent Accounts

2.1 Introduction

Ecosystem assets are measured in terms of their extent, condition and flows of ecosystem services. Understanding ecosystem extent is generally the starting point of ecosystem accounting.

The extent account organizes information on the extent of different ecosystem assets within a country or other ecosystem accounting areas and how that extent changes over time.

Accounting for ecosystem extent is relevant for several reasons. An ecosystem extent account provides a common basis for discussion among stakeholders of the composition of, and changes in, ecosystem types within a country. Thus, an extent account supports the derivation of coherent indicators of deforestation, desertification, agricultural conversion, urbanisation and other forms of ecosystem change. Extent accounts also support the measurement of ecosystem diversity, fragmentation and the derivation of indicators of changes in biodiversity. Furthermore, the spatial data required to compile an ecosystem extent account provides an underlying structure for the measurement of ecosystem condition and modelling of many ecosystem services, which is a key requirement for formulation of environmental policies and decision making.

In concept, at the national level, the ecosystem accounting area covers all terrestrial, freshwater and marine ecosystems with a boundary set by the country's border with other countries and its exclusive economic zone (EEZ). Compilers may choose to use an ecosystem accounting area of smaller scope – say, states or provinces. Ecosystem classifications that are suitable for formulating ecosystem accounts are required to account for both ecosystem extent and condition. As a first step towards arriving at the most suitable classification for India, the IUCN Global Ecosystem Typology (IUCN GET) was assessed vis-à-vis the major national classification systems used in India. This assessment, referred to as the "Cross-walking of ecosystem classification", was accomplished by creating a concordance between the IUCN GET with the classification systems being presently used in the country.

2.2 Cross-Walking of Ecosystem Classification

2.2.1 The IUCN Global Ecosystem Typology

The IUCN Global Ecosystem Typology (GET) is a classification that distinguishes between ecologically important land, water and bioclimatic niches.[2] It comprises of a nested hierarchy of units at each level and more detailed classified niches nested within broader units at higher levels. The three upper levels classify ecosystems based on their functional characteristics, irrespective of species composition. The three lower levels of classification distinguish functionally similar ecosystems from one another based on compositional resemblance and enable

[2] See: https://iucnrle.org/about-rle/ongoing-initiatives/global-ecosystem-typology/

integration of established classifications already in use and incorporated into policy infrastructure at national levels. This is crucial, as important conservation actions occur at local levels, where most expertise resides. The six different hierarchical levels (see Figure 3 below) are:

1) **Realm:** One of five major components of the biosphere that differ fundamentally in ecosystem organization and function: terrestrial, freshwater, marine, subterranean and atmospheric.

2) **Biome:** A component of a realm united by one or a few common major ecological drivers that regulate major ecological functions, derived from the top-down by the subdivision of realms.

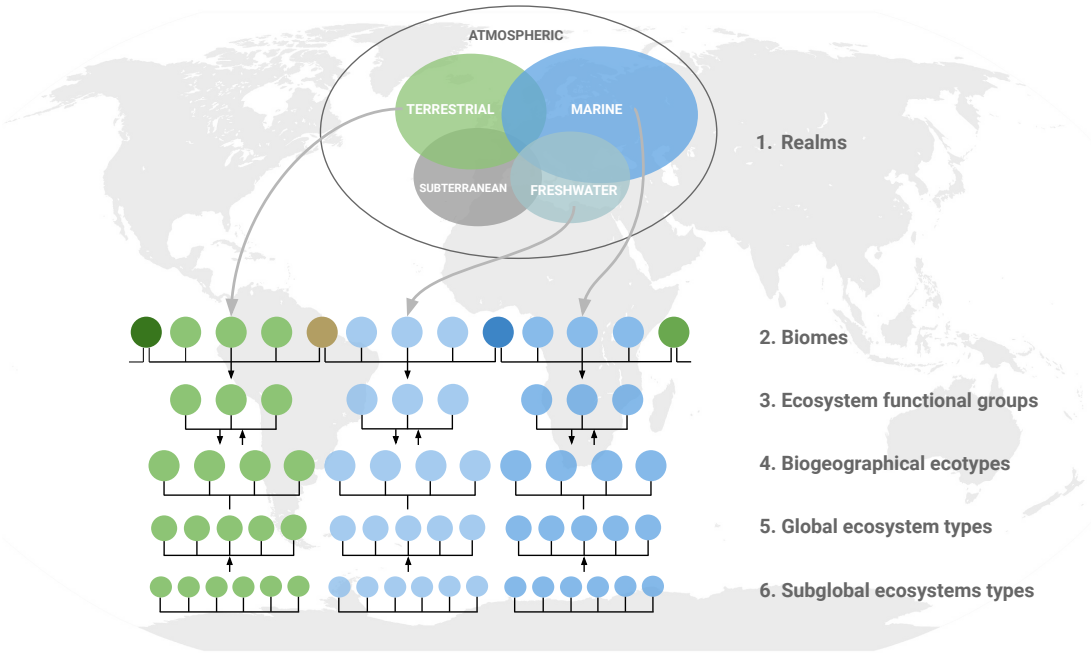
3) **Ecosystem Functional Group (EFG):** A group of related ecosystems within a biome that share common ecological drivers promoting the convergence of biotic traits that characterise the group. Derived from a top-down approach subdividing lower biomes into this order.

4) **Biogeographic ecotype:** An eco-regional expression of an ecosystem functional group derived from the top-down by a subdivision of ecosystem functional groups (level 3). They are proxies for compositionally distinctive geographic variants that occupy different areas within the distribution of a functional group.

5) **Global ecosystem type:** A complex of organisms and their associated physical environment within an area occupied by an ecosystem functional group. Global ecosystem types grouped into the same ecosystem functional group share similar ecological processes but exhibit substantial difference in biotic composition. They are derived from the bottom-up, either directly from ground observations or by aggregation of sub-global types (level 6).

6) **Sub-global ecosystem type:** A subunit or nested group of sub-units within a global ecosystem type which exhibit a greater degree of compositional homogeneity and resemblance to one another than global ecosystem types (level 5). These represent units of established classifications, in some cases arranged in a sub-hierarchy of multiple levels, derived directly from ground observations.

Figure 3: A hierarchical structure of the Global Ecosystem Typology



Source: The IUCN Global Ecosystem Typology v1.01: Descriptive profiles for Biomes and Ecosystem Functional Groups, Keith et al. (2020).

2.2.1.1 Relevance of the IUCN GET

The IUCN GET unifies the global classification of ecosystems which allows for various researchers across the world to support consistent policies by 1) following the same procedure for ecosystem assessment and by 2) providing the systematic and consistent definitions of assessment units. The IUCN GET, thus, provides a standardised typology for ecosystems which can be used by various initiatives focusing on ecosystem assessment directly or indirectly (see Figure 4) such as the CBD Aichi targets, UN SDGs, NCA and Key Biodiversity Areas, that revolve around managing world ecosystems and their services.

Figure 4: The Global Ecosystem Typology uses

Source: IUCN [3]

The IUCN GET can be used to assess different ecosystems. However, care should be taken while delineating ecosystem assets for the purpose of ecosystem accounting in that ecosystem assets should be mutually exclusive, both conceptually and geographically. This implies that any area on the land or the seafloor, or any horizontal depth layer in the ocean, should be occupied by one, and only one, ecosystem type. As long as the ecosystem assets are mutually exclusive, there can be no "double-counting" of the same space.

2.2.2 National classification

India covers a land area of 3.28 million km2 that is only 2.4 per cent of the total land area in the world; but exhibits immense diversity, in terms of its climate, physio-geography and ecological regime. India is called a "land of diversity" as it has immense biodiversity wealth - not only in terms of the number of floral and faunal species but also thanks to its diverse range of ecological landscapes, from mountains, plains, plateaus to coasts, islands and deserts that are represented in as many as ten unique biogeographic zones.

[3] See: https://iucnrle.org/about-rle/ongoing-initiatives/global-ecosystem-typology/

Administratively, India is composed of 28 states and 8 union territories (including a national capital territory) (see Annexure 10.1.1). There are different classifications in India which are being followed for different purposes. Some of the most cited classifications are:

1. National land use/land cover classification;

2. Biogeographic classification;

3. Forest type classification; and

4. Agro-ecological regions.

Each of these are described in the following paragraphs.

2.2.2.1 National land use/land cover classification

In India, land cover statistics are maintained by the National Remote Sensing Centre (NRSC), the Department of Space, the Government of India, and through a component of the National Land Use/ Land Cover (LULC) mapping of the Natural Resources Census (NRC) Project of the National Natural Resources Repository Program. The LULC database is prepared with 54 classes of LULC Classification Schema and are harmonised to 24 classes (given in Table 1) for dissemination through Bhuvan[4] geoportal by emphasising more on land lover (see the LULC Map for the year 2015-16 given in Annexure 10.1.2).

Table 1: A grouping of LULC classes

Sl.	Level I	Level II	Level-III
I.	Built-up	Urban	Built-up – compact (continuous), built-up – sparse (discontinuous), built-up – vegetated/open area, industrial area, ash/cooling pond/effluent and other waste
		Rural	Rural
		Mining	Mining – active, mining – abandoned, quarry
II.	Agriculture	Crop land	Kharif, Rabi, Zaid, cropped in two seasons, cropped in more than two seasons
		Plantation	Agriculture Plantation
		Fallow	Fallow land
		Current shifting cultivation	Shifting cultivation – current
III.	Forest	Evergreen/semi-evergreen	Dense/closed and open category of evergreen/semi-evergreen
		Deciduous	Dense/closed and open category of deciduous and tree clad area
		Forest plantation	Forest plantation
		Scrub forest	Scrub forest, shifting cultivation – abandoned
		Swamp/mangroves	Dense/closed & open mangrove
IV.	Grass/ Grazing	Grass/grazing	Grassland: alpine/sub-alpine, temperate/sub-tropical, tropical/desertic

[4] See: https://bhuvan-app1.nrsc.gov.in/thematic/thematic/index.php

Sl.	Level I	Level II	Level-III
V.	Barren/ unculturable / wasteland	Salt affected land	Salt affected land
		Gullied/ravine landscape	Gullied/ravine landscape
		Scrub land	Dense/closed and open category of scrub land
		Sandy area	Desertic, coastal, riverine sandy area
		Barren rocky	Barren rocky
		Rann	Rann
VI.	Wetlands/water bodies	Inland wetland	Wetland - inland natural (ox-bow lake, cut off meander, waterlogged etc.); Inland man-made (Water logged, saltpans etc.)
		Coastal wetland	Wetland – lagoon, creeks, mudflats, saltpan etc.
		River/stream/canals	Perennial & non-perennial river, canal/drain
		Water bodies	Aquaculture, permanent & seasonal lake/ponds, reservoir/tanks
VII.	Snow and glacier	Snow and glacier	Snow and glacier

2.2.2.2 Biogeographical classification

A biogeographic classification is the division according to biogeographic characteristics – i.e. the distribution of species (biology), organisms and ecosystems in geographic space and through geological time. Rodgers and Panwar (1998) outlined a scheme to divide India zoogeographically while planning a protected area network for India. Biogeographic Zones of India as per Rodgers and Panwar (1998) are given in Table 2 (see the map in Annexure 10.1.3).

Table 2: The biogeographic zones of India

Biogeographic zones of India	Biogeographic provinces of India	Biogeographic zones of India	Biogeographic provinces of India	Biogeographic zones of India
Trans Himalaya	1A: Himalaya – Ladakh Mountains 1B: Himalaya – Tibetan Plateau 1C: Trans – Himalaya Sikkim	**Trans Himalaya**	1A: Himalaya – Ladakh Mountains 1B: Himalaya – Tibetan Plateau 1C: Trans – Himalaya Sikkim	**Trans Himalaya**
The Himalaya	2A: Himalaya – North West Himalaya 2B: Himalaya – West Himalaya 2C: Himalaya – Central Himalaya 2D: Himalaya – East Himalaya	**The Himalaya**	2A: Himalaya – North West Himalaya 2B: Himalaya – West Himalaya 2C: Himalaya – Central Himalaya 2D: Himalaya – East Himalaya	**The Himalaya**
The Indian Desert	3A: Desert – Thar 3B: Desert – Katchchh	**The Indian Desert**	3A: Desert – Thar 3B: Desert – Katchchh	**The Indian Desert**
The Semi-Arid	4A: Semi-arid – Punjab Plains 4B: Semi-arid – Gujarat Rajputana	**The Semi-Arid**	4A: Semi-arid – Punjab Plains 4B: Semi-arid – Gujarat Rajputana	**The Semi-Arid**
The Western Ghats	5A: Western Ghats – Malabar Plains 5B: Western Ghats – Western Ghats Mountains	**The Western Ghats**	5A: Western Ghats – Malabar Plains 5B: Western Ghats – Western Ghats Mountains	**The Western Ghats**
The Deccan Peninsula	6A: Deccan Peninsular – Central Highlands 6B: Deccan Peninsular – Chotta Nagpur 6C: Deccan Peninsular – Eastern Highland 6D: Deccan Peninsular – Central Plateau 6E: Deccan Peninsular – Deccan South	**The Deccan Peninsula**	6A: Deccan Peninsular – Central Highlands 6B: Deccan Peninsular – Chotta Nagpur 6C: Deccan Peninsular – Eastern Highland 6D: Deccan Peninsular – Central Plateau 6E: Deccan Peninsular – Deccan South	**The Deccan Peninsula**
The Gangetic Plains	7A: Gangetic Plain – Upper Gangetic Plains 7B: Gangetic Plain – Lower Gangetic Plains	**The Gangetic Plains**	7A: Gangetic Plain – Upper Gangetic Plains 7B: Gangetic Plain – Lower Gangetic Plains	**The Gangetic Plains**
The Coasts	8A: Coasts – West Coast 8B: Coasts – East Coast 8C: Coasts – Lakshadweep	**The Coasts**	8A: Coasts – West Coast 8B: Coasts – East Coast 8C: Coasts – Lakshadweep	**The Coasts**
North-East India	9A: North-East – East – Brahmaputra Valley 9B: North-East – North – East Hills	**North-East India**	9A: North-East – East – Brahmaputra Valley 9B: North-East – North – East Hills	**North-East India**

2.2.2.3 Classification of forest types

As per Champion and Seth (1968), Indian forests can be classified into four major classes, namely tropical, subtropical, temperate and alpine. These major classes are further divided into 16 type groups (see Annexure 10.1.4). So, the Forest Survey of India (FSI) gives 16 forest type groups as given in Table 3 below. These 16 forest classes can be nested in the national LULC classification, providing an alternative disaggregation of the Level 1 category Forest for the purpose of the cross-walking exercise.

Table 3: The different forest type groups of India

S. No.	Type Group
1	Group 1 – Tropical wet evergreen forests
2	Group 2 – Tropical semi-evergreen forests
3	Group 3 – Tropical moist deciduous forests
4	Group 4 – Littoral and swamp forests
5	Group 5 – Tropical dry deciduous forests
6	Group 6 – Tropical thorn forests
7	Group 7 – Tropical dry evergreen forests
8	Group 8 – Subtropical broadleaved hill forests
9	Group 9 – Subtropical pine forests
10	Group 10 – Subtropical dry evergreen forests
11	Group 11 – Montane wet temperate forests
12	Group 12 – Himalayan moist temperate forests
13	Group 13 – Himalayan dry temperate forests
14	Group 14 – Sub-alpine forests
15	Group 15 – Moist alpine scrub
16	Group 16 – Dry alpine scrub

2.2.2.4 Agro-ecological regions

The National Bureau of Soil Survey and Land Use Planning (NBSSLUP) came up with 20 agro-ecological zones, based on the length of growing period (LGP), as an integrated criteria of effective rainfall, soil groups, delineated boundaries which are adjusted to district boundaries with a minimal number of regions. The length of the growing period refers to number of days in a year during which the rainfall and moisture that are stored in the soil exceeds half of the potential evapotranspiration. Agro-ecological zones of India (Mandal et.al., 2016) are given in following Table 4 (see the map in Annexure 10.1.5).

Table 4: The agro-ecological zones of India

S.No.	Zone
1	Western Himalayas
2	Western Plain, Kachchh and part of Kathiawar Peninsula
3	Deccan Plateau
4	Northern Plain and Central Highlands including Aravallis
5	Central Malwa Highlands, Gujarat Plains and Kathiawar Peninsula
6	Deccan Plateau, hot semi-arid eco-region
7	Deccan (Telangana) Plateau and Eastern Ghats
8	Eastern Ghats, Tamil Nadu Plateau and Deccan (Karnataka)
9	Northern Plain, hot sub-humid (dry) eco-region
10	Central Highlands (Malwas, Bundelkhand and Eastern Satpura)
11	Eastern Plateau (Chhattisgarh), hot sub-humid eco-region
12	Eastern (Chotanagpur) Plateau and Eastern Ghats
13	Eastern Plain
14	Western Himalayas
15	Bengal and Assam plains
16	Eastern Himalayas
17	North Eastern Hills (Purvanchal)
18	Eastern Coastal Plain
19	Western Ghats and Coastal Plain
20	Island of Andaman Nicobar and Lakshadweep

2.2.3 Cross-walking: Setting up a concordance of the IUCN GET with the National Ecosystem Classification

As seen in the previous section, forests are better classified under the Forest Type Classification of India, as adopted by the Forest Survey of India, as this provides additional detail of forest class. Therefore, for the purpose of this exercise, a "National Ecosystem Classification" was drafted by using the NRSC's LULC classes in conjunction with the Forest Type Classification as being used for the National Forest Inventory. The biogeographic classification or the agro-ecological regions are very appropriate for adoption as a base for ecosystem typology, but due to lack of further detailing, this classification was not considered for the cross-walking exercise.

The following steps were taken for preparing the concordance/cross-walk between the IUCN GET and the drafted National Ecosystem Classification, to deduce the best fit:

- National classification, at the most detailed available level, was taken in rows;
- Level 3 GET classes (the EFGs) from reference classification were taken in the columns;
- An entry into the cells of the concordance table indicate that the national ecosystem type seems to match with GET classes (one-to-one or one-to-many correspondence).

The numbers represented in Table 3 gives correspondence between the two classifications where '1' represents a one-to-one match and a value less than 1, represents a partial match;

- To identify the presence or quantitative split of national class across the IUCN GET classes, the following information was used:
  - o IUCN global maps were compared to land use/land cover map of India for 2015-16 and forest type mapping carried out by the Forest Survey of India for 2019;
  - o Also, the description of various EFGs and the descriptions of the national ecosystem class, as provided by NRSC or FSI, as the case may be, were compared and a suitable fit was deduced;
  - o Along with this, some of the other resources used for comparing the two sets are as under:
    - Ecology and Management of Grassland Habitats in India[5] (Rawat, G.S. and Adhikari, B.S., 2015);
    - India Water Portal;[6]
    - Land Use Statistics;[7]
    - India State of Forest Report 2019 (ISFR 2019, Forest Survey of India (MOEF&CC);
    - National Wetland Atlas;[8] and
    - Marine Ecosystems and Marine Protected Areas of India.[9]

It should be noted that although care has been taken while assigning the shares of a particular National Ecosystem Class under the different IUCN GETs, these shares may need to be deliberated further to present a more accurate description of the concordance.

The concordance between the National Ecosystem Classification and the IUCN EFGs, as derived above, is presented in Annexure 10.2.1 with the different ecosystems given in different subparts.

2.2.4 Observations

Some of the observations with respect to the cross-walking exercise are as follows:

- Some national land use land cover classes could not be mapped to any of the IUCN EFGs such as:
  - o Built-up: Rural, Quarry
  - o Barren/unculturable/wasteland: Gullied/ravine landscape, dense/closed and open category of scrubland and barren rocky
- Ambiguity in some of the cases which are not shown in India in the IUCN global maps, but they could be classified as being present in India:
  - o F 1.1 Permanent upland streams
    - Example-Ganga River
  - o F 2.1 Large permanent freshwater lakes
    - Example-Wular Lake
  - o F2.7 Ephemeral salt lakes
    - Example-Sambhar Salt Lake
  - o MFT 1.3 Coastal saltmarshes
    - Example-Little Rann

5 See: http://wiienvis.nic.in/WriteReadData/Publication/19_Grassland20%Habitat_2016.pdf

6 See: https://www.indiawaterportal.org/

7 See: https://eands.dacnet.nic.in/LUS_1999_2004.htm

8 See: SAC (2011)

9 See: Venkataraman, K. et.al. (2012)

- There were a few ecosystems like Aerobic Caves, which are known to be present in India but because of lack of delineation in LULC, the mapping could not be done.
- Also, an area of Rann can be classified to some class similar to seasonal salt marsh but due to lack of any such appropriate class, the 'seasonal salt marsh' has for now been included in coastal salt marsh since part of the area is a coastal salt marsh.

This concordance between IUCN EFGs and national classes provides a link as to how national classes are linked to the international classification. Although at present, the national classification are being used for developing the national extent accounts, the concordance of the national classification with IUCN GET will make international comparisons much easier by linking national classes to a global reference classification i.e. IUCN EFGs.

Owing to the widespread use of the LULC classification in India and the existence of nested classifications that allow for further disaggregation (e.g. as for forest, but also for wetlands and water resources that will be discussed in the later sections), the LULC classes have been used as the basis for the ecosystem extent account. The LULC classes can also be aggregated to the SEEA-CF classes, see Annexure 10.2.2. As the extent account is based on land cover classes as a proxy for ecosystems, it is described here as a land account.

2.3 Extent Results

Land is a ubiquitous but limited resource. It is subject to competing pressures from urbanisation, infrastructure, increased food, feed, fibres and fuel production and the provision of key ecosystem services. Land-use change has broad lines of impact, influencing economic growth, quality of life, management of environmental resources and national food supply. Given the finite supply of land resources, it is imperative that diversification and urbanisation are planned in a manner that while responding to the market needs, it keeps sustainability at the core of these decisions. The challenge here is that given the variedness of its characteristics, different types of land and locations are not equally suitable for different purposes. Hence, the need arises for appropriate land-use planning – including land monitoring and management – for sustainable development.

The two main characteristics on the basis of which land is classified are land use (LU) and land cover (LC). Land cover can be defined as observed physical features on the Earth's surface, which transforms to land use when a socio-economic function is added to it.

Given the fact that increasing anthropogenic activities around the biosphere are causing large-scale alterations of the Earth's land surface, land-use and land-cover (LULC) change is an important indicator for monitoring environmental changes and a vital input for informed decision-making in the context of land management. Land accounts register both the state of land cover and use at a certain time, which can be termed as land stocks and include the extent (area), type (which can be further related to indicators on condition) and other properties (e.g. ownership); and also the changes between two periods of time (or flows). It may be useful to distinguish in these accounts, the 'naturally-driven' changes and those driven by human actions.

2.3.1 Methodology/data-source

NRSC has produced the LULC datasets for the years 2005-06, 2011-12 and 2015-16 on a 1:50,000 scale and these have been disseminated through the Bhuvan website.

2.3.2 Result: Land asset account

The all-India change matrix of LULC from 2011-12 to 2015-16, as provided by NRSC, is given in Table 5. Based on this change matrix, the asset account for land-use land-cover is given in Table 6. The state-wise asset account for land use land cover and the corresponding change-matrices for 2005-06 to 2011-12 and from 2011-12 to 2015-16can be seen in EnviStats India 2018 and EnviStats India 2020 (MoSPI, 2018 and MoSPI, 2020a, respectively).

Table 5: A change matrix of land use – land cover (LULC) from 2011-12 to 2015-16 (area in km2)

LULC_CLASSES		ALL INDIA : 2015-2016															
		1: Agriculture		2: Barren		3: Built-up		4: Forest		5: Grass/grazing		6: Snow and glacier		7: Wetlands/water bodies		Grand total	
		Area in km²	Percentage of geographic area (%)	Area in km²	Percentage of geographic area (%)	Area in km²	Percentage of geographic area (%)	Area in km²	Percentage of geographic area (%)	Area in km²	Percentage of geographic area (%)	Area in km²	Percentage of geographic area (%)	Area in km²	Percentage of geographic area (%)	Area in km²	Percentage of geographic area (%)
2011-12	1: Agriculture	1,809,033	55.03	5,103	0.16	2,648	0.08	2,299	0.07	94	0.00	8	0.00	2,547	0.08	1,821,732	55.41
	2: Barren / unculturable / wastelands	4,237	0.13	348,460	10.60	589	0.02	2,285	0.07	61	0.00	68,471	2.08	614	0.02	424,717	12.92
	3: Built-up	238	0.01	442	0.01	118,239	3.60	48	0.00	2	0.00	0	0.00	29	0.00	118,998	3.62
	4: Forest	5,085	0.15	6,838	0.21	205	0.01	712,342	21.67	207	0.01	637	0.02	230	0.01	725,543	22.07
	5: Grass / grazing	147	0.00	408	0.01	118	0.00	368	0.01	22,502	0.68	1,333	0.04	521	0.02	25,397	0.77
	6: Snow and glacier	0	0.00	1,643	0.05	0	0.00	131	0.00	7	0.00	30,799	0.94	1	0.00	32,581	0.99
	7: Wetlands / water bodies	2,536	0.08	966	0.03	49	0.00	155	0.00	679	0.02	77	0.00	133,833	4.07	138,294	4.21
	Grand total	1,821,276	55.40	363,860	11.07	121,848	3.71	717,629	21.83	23,551	0.72	101,325	3.08	137,774	4.19	3,287,263	99.99

Note: Totals may not match due to rounding off

Table 6: An asset account for land use - land cover (LULC) in India (area in km2)

Level-1	Level-2	INDIA				
		Opening stock (2011-12)	Addition to stock	Reduction in stock	Closing stock (2015-16)	Net change (in %) from 2011-12 to 2015-16
Agriculture	Crop land	1,553,007	41,056	90,107	1,503,956	-3.16
	Current shifting cultivation	3,743	2,633	2,353	4,023	7.48
	Fallow	181,469	79,956	33,247	228,179	25.74
	Plantation	83,514	4,346	2,742	85,118	1.92
	Sub Total 1	**1,821,732**	**127,991**	**128,448**	**1,821,276**	**-0.03**
Barren/ unculturable/ wastelands	Barren rocky	173,986	3,540	72,371	105,154	-39.56
	Gullied/ravine landscape	7,511	2,898	468	9,941	32.35
	Rann	18,822	0	132	18,690	-0.70
	Salt affected land	9,610	372	228	9,754	1.50
	Sandy area	30,644	3,471	680	33,436	9.11
	Scrub land	184,144	12,602	9,862	186,885	1.49
	Sub Total 2	**424,717**	**22,883**	**83,740**	**363,860**	**-14.33**
Built-up	Mining	6,024	907	310	6,620	9.89
	Rural	74,653	658	233	75,079	0.57
	Urban	38,321	2,201	372	40,150	4.77
	Sub Total 3	**118,998**	**3,766**	**916**	**121,848**	**2.39**

Level-1	Level-2	INDIA				
		Opening stock (2011-12)	Addition to stock	Reduction in stock	Closing stock (2015-16)	Net change (in %) from 2011-12 to 2015-16
Forest	Deciduous	444,433	3,753	11,300	436,886	-1.70
	Evergreen/semi-evergreen	156,105	1,134	4,194	153,045	-1.96
	Forest plantation	23,895	330	871	23,355	-2.26
	Scrub forest	96,406	11,466	8,252	99,620	3.33
	Swamp/mangroves	4,704	66	47	4,723	0.40
	Sub Total 4	**725,543**	**16,749**	**24,663**	**717,629**	**-1.09**
Grass/grazing	Grass/grazing	25,397	1,049	2,894	23,551	-7.27
	Sub Total 5	**25,397**	**1,049**	**2,894**	**23,551**	**-7.27**
Snow and glacier	Snow and glacier	32,581	70,525	1,782	101,325	210.99
	Sub Total 6	**32,581**	**70,525**	**1,782**	**101,325**	**210.99**
Wetlands/ water bodies	Inland wetland	8,175	458	1,027	7,606	-6.96
	Coastal wetland	10,719	189	121	10,787	0.63
	River/stream/canals	61,032	2,130	2,333	60,829	-0.33
	Water bodies	58,367	1,478	1,293	58,552	0.32
	Sub Total 7	**138,294**	**4,254**	**4,775**	**137,774**	**-0.38**
Grand Total		**3,287,263**	**247,218**	**247,218**	**3,287,263**	**0.00**

2.4 Land Degradation

Land degradation is the loss of biodiversity and productivity that arises from the physical, chemical and biological degradation of the land. It affects the entire natural environment, resulting in losses of ecosystem services. Degraded land is a threat multiplier for communities, as it reduces people's ability to use their land and limits their access to resources. The main anthropogenic factors contributing to land degradation include: deforestation and land clearing for economic use and to cope with increasing urbanisation. These practices are focused on short-term production and profitability in order to meet the demand of growing populations. There is an urgent need to stop and reverse the process of land degradation for ensuring food, water and environment security as well as to improve the living conditions of population residing in such areas.

2.4.1 Methodology/data-source

The spatial distribution of various types of land degradation is important for planning reclamation activities and increasing the agricultural production of the country. National level land degradation mapping is taken up by the Indian Space Research Organisation (ISRO) along with partner institutions, under its Natural Resources Census (NRC) mission, towards generating information on land degradation at 1:50,000 scale.

Two cycles of land degradation mapping at a 1:50,000 scale, for the timeframe 2005-06 and 2015-16, have been accomplished by the NRSC. The Land Degradation (LD) classification scheme of the second cycle was slightly modified based on the experiences gained from the first cycle of land degradation mapping. The major classification scheme was the same as that used in the first cycle, but the land use and landform attributes in the classification scheme of the first cycle were dropped in the second cycle. The classification system broadly consists of eight land degradation processes and 36 land degradation classes. The land degradation classification scheme of second cycle, the results of which were published in the Status of Land Degradation in India 2015-16 (NRSC 2019), is given in the Table 7 below.

Table 7: A classification scheme for Land Degradation (LD)

LD Process	LD Code	LD Class
Water erosion	A1	Sheet – slight
	A2	Sheet – moderate
	A3	Sheet – severe
	A4	Rills
	A5	Gullies
	A6	Ravines – shallow
	A7	Ravines – moderately deep to deep
Wind erosion	B1	Sheet – slight
	B2	Sheet – moderate
	B3	Sheet – severe
	B4	Stabilized dunes
	B5	Partially – stabilised dunes
	B6	Unstabilised dunes
Water logging	C1	Surface ponding – seasonal
	C2	Surface ponding –permanent
	C3	Sub – surface waterlogging
Salinisation/ alkalization	D1	Saline – slight
	D2	Saline – moderate
	D3	Saline – severe
	D4	Sodic – slight
	D5	Sodic - Moderate
	D6	Sodic – severe
	D7	Saline sodic – slight
	D8	Saline Sodic – moderate
	D9	Saline Sodic – severe
	D10	Rann
Acidification	E1	Acidity – moderate
	E2	Acidity – severe
Glacial	F1	Frost heaving
	F2	Frost shattering
Anthropogenic	G1	Industrial-effluent affected areas
	G2	Mining and dump areas
	G3	Brick kiln areas
Others	H1	Mass movement/mass wastage
	H2	Barren rocky/stony waste
	H3	Miscellaneous – riverine sands/sea ingress areas
Normal	N	Normal

2.4.2 Result: Land Degradation account

Based on the change matrices of each of the states for the year 2005-06 and 2015-16, as given in the NRSC report on land degradation cited previously, the Opening Stock, Addition to Stock, Reduction in Stock and Closing Stock have been obtained for all the states. The The Land Degradation account for all the states can be seen in EnviStats India 2020 (MoSPI, 2020a). However, the Land Degradation account for the country is given in Table 8 below which shows that 27.74 per cent of the country's land is degraded.

Table 8: Land Degradation (LD) account (area in km2)

S. No.	Category	Opening Stock (2005-06)	Addition to Stock	Reduction in Stock	Closing Stock (2015-16)
1	A1	90,213	4,733	2,505	92,440
2	A2	240,978	6,782	7,743	240,017
3	A3	142,083	4,076	5,518	140,641
4	A4	11,467	5	13	11,459
5	A5	18,214	4	34	18,184
6	A6	4,196	0	2	4,194
7	A7	3,028	0	0	3,028
8	B1	55,554	11	5	55,560
9	B2	10,691	149	147	10,692
10	B3	10,502	0	39	10,463
11	B4	21,629	4,392	115	25,906
12	B5	41,306	11	5,213	36,103
13	B6	4,318	2	246	4,073
14	C1	16,004	736	1,023	15,717
15	C2	1,209	160	194	1,175
16	C3	1,291	78	43	1,326
17	D1	14,366	315	417	14,264
18	D2	17,347	0	0	17,347
19	D3	9,886	221	528	9,579
20	D4	2,932	151	240	2,843
21	D5	6,635	25	43	6,618
22	D6	3,530	12	41	3,501
23	D7	732	11	7	736
24	D8	4,075	51	23	4,103
25	D9	3,465	49	43	3,471
26	D10	2,225	7	48	2,184
27	E1	28,369	68	53	28,384
28	E2	2,086	14	68	2,031
29	F1	3,251	0	0	3,251
30	F2	25,587	0	0	25,587
31	G1	390	122	0	511
32	G2	3,864	1,326	10	5,180
33	G3	634	302	79	856
34	H1	4,699	55	2	4,752
35	H2	101,402	0	257	101,145
36	H3	4,826	97	180	4,744
37	N	4,417	5,327	4,417	5,327
Total		**917,399**	**29,288**	**29,294**	**917,393**
Land degradation total		912,982	23,961	24,877	912,067
Land degradation as a percentage of geographic area		**27.77**	**0.73**	**0.76**	**27.74**

Note: Calculations made based on the change matrices given by NRSC.

2.5 Wetlands

Wetlands are areas of land that are either seasonally or permanently covered by water, or nearly saturated by water. This means that a wetland is neither truly aquatic nor terrestrial; although in some cases, wetlands can switch between being aquatic or terrestrial for periods of time depending on seasonal variability. Thus, wetlands exhibit enormous diversity according to their genesis, geographical location, water regime and chemistry, dominant plants and soil or sediment characteristics.

Utility wise, wetlands directly and indirectly support millions of people in providing services such as food, fibre and raw materials, storm and flood control, clean water supply, scenic beauty and educational and recreational benefits. Recognising the importance of wetlands, the oldest conservation convention, the 1971 Ramsar Convention on Wetlands of International Importance provides a framework for the conservation and 'wise use' of wetland biomes. The Ramsar Convention is the first modern global intergovernmental treaty on conservation and wise use of natural resources.[10]

Wetlands in India, estimated to occupy less than five per cent of the geographical area of the country, support about one fifth of the known biodiversity. Wetlands of India have been classified into 19 classes. River/ stream reservoir/barrage, inter-tidal mud flat and natural lake/pond are some of the major wetland types of India. Lagoon, mangrove, coral, riverine wetland and high-altitude lake (>3000 m elevation) are some of the unique wetland types of the country. Each wetland type also exhibits a wide diversity in terms of shape, size, water quality, aquatic vegetation etc. The classes of wetlands are listed below:

i. Lake/pond
ii. Ox-bow lake/cut-off meander
iii. High altitude wetland
iv. Riverine wetland
v. Waterlogged (natural)
vi. River/stream
vii. Reservoir/barrage
viii. Tank/pond
ix. Waterlogged (man-made)
x. Salt pan
i. Lagoon
ii. Creek
iii. Sand/beach
iv. Intertidal mud flat
v. Salt Marsh
vi. Mangrove
vii. Coral Reef
viii. Salt pan
ix. Aquaculture pond

The National Wetland Inventory and Assessment (NWIA) project, therefore, was initiated in 2007 as a joint programme of the MoEF&CC and the Space Applications Centre, ISRO, to provide a geospatial database of the wetlands of the country. Under the NWIA Project, the entire country, including the island territories, was considered for an inventory and assessment of its wetlands. Mapping was carried out on a 1:50,000 scale. Area estimates of various wetland categories for India were compiled using GIS layers of wetland boundary, water-spread, aquatic vegetation and turbidity. A total of 201,503 wetlands have been mapped at a 1:50,000 scale in the country. In addition, 555,557 wetlands of less than 2.25 hectares have also been identified. The total wetland area is estimated to be 15.26 million hectares (Mha), which is around 4.63 per cent of the geographic area of the country.

[10] See: www.ramsar.org

2.5.1 Result: Wetlands extent account

Wetlands were categorised in to two major categories, four sub-categories and 19 classes. The area of inland wetlands was estimated as 10.56 Mha and the area of coastal wetlands as 4.14 Mha. Category-wise distribution of wetlands in the country are shown in Table 9.

Table 9: Area of wetlands in India, 2006-07 (area in km^2)

S. No.	Wetland category	Number of wetlands	Total wetland area	% of Wetland area	Open water	
					Post-monsoon area	Pre-monsoon area
1a	Inland wetlands – natural	45,658	66,231	43	41,008	31,157
1b	Inland Wetlands – man-made	142,812	39,418	26	32,676	16,542
1	**Total - inland**	**188,470**	**105,649**	**69**	**73,684**	**47,699**
2a	Coastal wetlands - natural	10,204	37,040	24	9,307	7,503
2b	Coastal wetlands – man-made	2,829	4,361	3	3,018	2,810
2	**Total - coastal**	**13,033**	**41,401**	**27**	**12,324**	**10,313**
	Sub-total	**201,503**	**147,050**	**96**	**86,008**	**58,012**
3	Wetlands (<2.25 ha)	555,557	5,556	4	-	-
	Total	**757,060**	**152,606**	**100**	**86,008**	**58,012**

Area under aquatic vegetation	**13,228**	**20,651**
Area under turbidity levels		
Low	32,060	18,885
Moderate	41,684	29,675
High	12,264	9,452

An analysis of wetland status in terms of open water shows that out of the total wetland area, the extent of open water is 58.5 per cent in post-monsoon and 39.4 per cent in pre-monsoon. There is a significant reduction in the extent of open water (about 32.5 per cent) from post-monsoon to pre-monsoon conditions (8.60 Mha to 5.80 Mha). It is reflected in all the inland wetland types. The aquatic vegetation in India accounts for about 9 and 14 per cent of total wetland area in post-monsoon (1.32 Mha) and pre-monsoon (2.06 Mha) respectively. State-wise details on the extent of wetlands is given in Table 10. State-wise and class-wise details on extent of Wetlands can be seen in EnviStats India 2020 (MoSPI 2020a).

Table 10: State-wise wetland distribution in India (area in km^2) - Year 2006-07

State/UT	Wetland area	% of total wetland area	Open water		Aquatic vegetation		Turbidity (post-monsoon)			Turbidity (pre-monsoon)		
			Post-monsoon	Pre-monsoon	Post-monsoon	Pre-monsoon	Low	Moderate	High	Low	Moderate	High
Andhra Pradesh	14,471	9.48	8,871	6,107	1,262	2,683	2,956	5,313	603	2,279	3,508	320
Arunachal Pradesh	1,557	1.02	662	575	60	59	565	80	18	458	95	22
Assam	7,644	5.01	4,231	3,902	368	760	641	3,584	5	228	3,667	7
Bihar	4,032	2.64	2,247	1,484	252	174	1,323	753	170	3	1,463	18
Chhattisgarh	3,380	2.21	2,438	1,737	21	196	290	1,830	318	791	858	87
Delhi	28	0.02	13	15	7	8	12	0	-	15	1	-
Goa	213	0.14	189	189	18	18	24	103	63	24	103	63
Gujarat	34,750	22.77	11,508	7,325	1,523	2,052	3,311	1,361	6,835	1,453	840	5,032
Haryana	425	0.28	142	189	22	15	70	33	40	64	95	30
Himachal Pradesh	985	0.65	691	492	-	53	469	222	-	339	153	-
Jammu & Kashmir	3,915	2.57	3,018	3,142	198	154	3,005	13	0	3,062	16	64
Jharkhand	1,701	1.11	1,529	1,032	34	72	210	884	435	128	641	263
Karnataka	6,436	4.22	4,279	2,630	808	1,073	655	3,262	362	601	1,784	244
Kerala	1,606	1.05	1,390	1,305	134	89	1,020	365	4	947	351	6
Madhya Pradesh	8,182	5.36	5,720	2,453	134	628	28	5,327	364	7	2,138	308
Maharashtra	10,145	6.65	7,968	3,704	476	847	6,331	1,398	239	2,026	1,599	79
Manipur	636	0.42	453	394	168	235	179	269	5	173	218	3
Meghalaya	300	0.2	279	274	8	9	249	19	11	247	12	16
Mizoram	140	0.09	138	138	0	0	138	0	-	137	1	-
Nagaland	215	0.14	209	207	0	6	22	81	106	11	79	117
Odisha	6,909	4.53	5,083	4,193	627	1,426	1,164	3,781	138	1,389	2,640	164
Punjab	863	0.57	363	244	159	172	309	51	3	205	36	3
Rajasthan	7,823	5.13	3,681	1,587	41	52	2,943	409	329	1,076	74	438
Sikkim	75	0.05	72	50	0	0	24	48	-	9	42	-
Tamil Nadu	9,025	5.91	6,579	2,963	1,673	5,316	3,143	2,477	959	702	1,592	669
Tripura	175	0.11	98	70	18	52	27	71	0	6	63	1
Uttar Pradesh	12,425	8.14	6,902	4,950	2,193	1,292	2,125	4,157	620	1,910	2,166	874
Uttarakhand	1,039	0.68	542	462	53	117	229	313	-	112	350	-
West Bengal	11,079	7.26	6,325	5,836	2,282	2,391	324	5,371	629	212	5,005	619
Andaman & Nicobar Islands*	1,528	1	83	86	683	684	10	67	6	19	60	7
Chandigarh*	4	0	2	2	0	0	1	2	-	1	2	-
Dadra & Nagar Haveli*	21	0.01	19	11	-	1	13	6	-	8	3	-
Daman & Diu*	21	0.01	6	3	1	1	3	3	0	1	1	0
Lakshadweep*	796	0.52	237	237	-	-	237	-	-	237	-	-
Puducherry*	63	0.04	40	25	6	18	12	27	1	5	20	1
Total	**152,606**	**100**	**86,008**	**58,012**	**13,228**	**20,651**	**32,060**	**41,684**	**12,264**	**18,885**	**29,675**	**9,452**

*- Union Territories

Section 3:
Ecosystem Condition

3.1 Introduction

The ecosystem condition account provides insight about the characteristics and quality of ecosystem assets and how they have changed during the accounting period. Measurement of ecosystem condition is of significant interest when it comes to supporting environmental policy and decision-making that is commonly focused on protecting, maintaining and restoring ecosystem condition.

Ecosystem condition accounts complement environmental monitoring systems by using data from different monitoring systems for biodiversity, water quality and soil properties. The intention of the ecosystem condition account is to build upon, rather than replace, existing monitoring systems. Ecosystem condition accounts provide a means to mainstreaming a wide range of ecological data into economic and development planning processes.

Ecosystem condition accounts record data on the state and functioning of ecosystem assets within an ecosystem accounting area using a combination of relevant variables and indicators. The selected variables and indicators reflect changes over time in the key characteristics of each ecosystem asset. Ecosystem condition accounts are compiled in biophysical terms and the accounting structure provides the basis for organizing the data, aggregating across both ecosystem assets of the same ecosystem type and across ecosystem types within an ecosystem accounting area, and measuring change over time between the opening and closing points of accounting periods.

The SEEA ecosystem condition typology (SECT) is a hierarchical typology for organizing data on ecosystem condition characteristics (Table 11). By describing a meaningful ordering and coverage of characteristics, it can be used as a template for variable and indicator selection and it provides a structure for aggregation. The SECT also establishes a common language to support increased comparability among different ecosystem condition studies.

Table 11: Proposed SEEA EA ecosystem condition typology (SECT) for ecosystem accounting

Ecosystem condition	SECT Superclass	SECT class
	Abiotic ecosystem characteristics	1. Physical state characteristics (including soil structure, water availability)
		2. Chemical state characteristics (including soil nutrient levels, water quality, air pollutant concentrations)
	Biotic ecosystem characteristics	3. Compositional state characteristics (including species-based indicators)
		4. Structural state characteristics (including vegetation, biomass, food chains)
		5. Functional state characteristics (including ecosystem processes, disturbance regimes)
	Landscape level Characteristics	6. Landscape and seascape characteristics (including landscape diversity, connectivity, fragmentation, embedded semi-natural elements in farmland)

The typology describes a set of groups and classes with the common aim of being exhaustive (i.e. broad and inclusive enough to be able to host all variables and indicators that meet relevant selection criteria (described below)) and mutually exclusive (i.e. each variable and indicator can be assigned to a unique class). Ecosystem condition accounts are commonly compiled by ecosystem type because each type has distinct characteristics. For example, the characteristics of forests may include tree density and age, while for wetlands, characteristics concerning water quality and riparian zones will be relevant. However, some characteristics may be common across a number of ecosystem types, for example, species richness, and some other characteristics will be relevant to a combination of ecosystem types within a landscape, for example, the diversity among different ecosystem type.

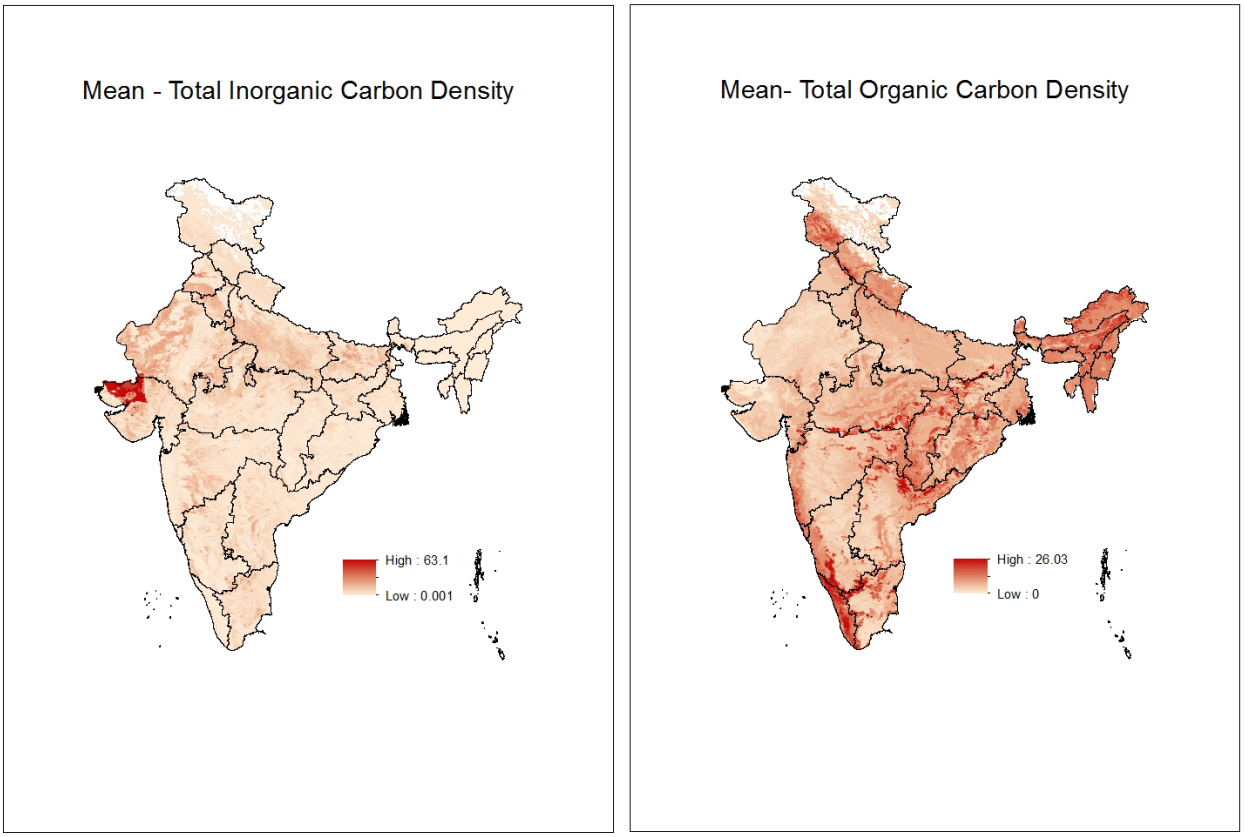
Chapter 5 of the revised SEEA EA contains an initial list of variables that can be included in condition accounts. This chapter describes a range of examples on condition, covering soil, water, forest and cropland.

3.2. Soil Nutrient Indices

Soil is one of the most important natural resources that plays a vital role in the Earth's ecosystem. It is the foundation of all terrestrial ecosystems and also for agricultural and forestry provisioning services, as well as being the structural medium for supporting the terrestrial biosphere and human infrastructure. Soil ecosystem services are diverse, valuable and under-appreciated. It gives plants the necessary medium and nutrients for plant growth, provides a habitat for many insects and other organisms that enhances soil biodiversity, filters rainwater and controls the discharge of excess rainwater along with flooding. Also, it can store large amounts of organic carbon and buffers against pollutants, thus, protecting groundwater quality. In fact, soils are a source of many current medicines, probiotics and antibiotics. Healthy soils increase the capacity of crops to withstand weather variability, including short-term extreme precipitation events and intra-seasonal drought.

Soil carbon is the backbone of soil fertility. Soil carbon includes both inorganic carbon as carbonate minerals and as soil organic matter. Soil organic carbon (SOC) is the engine of any soil and plays an important role in maintaining fertility by holding nitrogen, phosphorous and a range of other nutrients. It helps in improving soil properties such as water-holding capacity that is important for root growth. The loss of SOC indicates a certain degree of soil degradation. Mapping of soil carbon densities across India was carried out by the NRSC using multi-temporal satellite data with an objective to provide important soil properties at 5 km equal area grid (start date: 1-9-2008 to stop date: 31-5-2012). The soil carbon density product consists of mean soil organic and inorganic carbon densities generated at 5000m spatial resolution (Figure 5). These maps provide users with very useful information regarding soil condition and help in making decisions to mitigate and adapt to a changing climate.

Figure 5: Soil carbon density maps (mean 2008-2012)



Source: NRSC [11]

3.2.1 Methodology

Soil fertility, or the soil's reserve of crop nutrients, is broadly equated with soil quality and soil health. Soil health is the capacity of the soil to function as a vital living system, within ecosystem and land-use boundaries, to sustain plant and animal productivity, maintain or enhance water and air quality and promote plant and animal health.

Soil health and quality remain a matter of great concern for the Government of India. Of the several programmes being run by the Government of India for monitoring soil health, some of them dating back to 1955-56, the Soil Health Card scheme is a flagship programme that was launched in February 2015, under which uniform norms are followed across different states for soil analysis for not just diagnosing fertility related constraints but also to make site specific fertiliser recommendations. The scheme is managed by the Integrated Nutrient Management (INM) Division in the Ministry of Agriculture and Farmers Welfare, Government of India. Under this scheme, soil health condition is assessed with respect to 12 important soil parameters namely:

(i) Nitrogen (N), Phosphorus (P), Potassium (K) - the macronutrients;

(ii) Sulphur (S) – the secondary nutrient;

(iii) Zinc (Zn), Iron (Fe), Copper (Cu), Manganese (Mn), Boron (B) - micronutrients;

(iv) pH, Electrical Conductivity (EC), Organic Carbon (OC) - physical parameters.

During both the first cycle (2015-16 to 2016-17) and the second cycle (2017-18 to 2018-

[11] See: https://bhuvan-app3.nrsc.gov.in/data/download/tools/document/soil_nices.pdf

19), more than 20,000 million soil samples were collected and more than 100,000 million soil health cards were distributed to farmers. A Soil Health Card is a printed report that farmers are handed over for each of his holdings. It contains the status of the tested soil with respect to 12 parameters, namely N, P, K (macronutrients); S (secondary nutrient); Zn, Fe, Cu, Mn, Bo (micronutrients); and pH, EC, OC (physical parameters). Based on this, the Soil Health Card also indicates fertilizer recommendations and soil amendment required for the farm.

To compare the levels of soil fertility of one area with those of another, it was necessary to obtain a single value for each nutrient. Nutrient index (N.I.) value is a measure of nutrient supplying capacity of soil to plants (Singh et al., 2016). The nutrient index approach introduced by Parker et al. (1951) has been adopted and modified by several researchers such as Shetty et al. (2008); Pathak, H. (2010), Sidharam, P. et al. (2017), Chase, P. & Singh, O. P. (2014), Amara, D. M. K. et al. (2017) and national /international organizations such as ICAR - NBSSLUP, Ministry of Agriculture (Government of India), Food and Agriculture Organization (FAO, 1980) etc.

This index can be used to evaluate the fertility status of soils based on the samples in each of the three classes, i.e., low, medium and high. The states/UT's wise nutrient index was evaluated for the soil samples analysed using the following formula:

$$\text{Nutrient Index (N.I.)} = (N_L \times 1 + N_M \times 2 + N_H \times 3) / N_T$$

Where:

N_L: Indicates number of samples falling in low class of nutrient status

N_M: Indicates number of samples falling in medium class of nutrient status

N_H: Indicates number of samples falling in high class of nutrient status

N_T: Indicates total number of samples analysed for a given area

In an effort to put together the existing status of macro and micronutrients of soil in different states/UT's and analyse the trend in fertility status of Indian soils, the information on the soil samples collected under the Soil Health Card Scheme for cycle I (2015-16 to 2016-17) and cycle II (2017-18 to 2018-19) as on September 5, 2019, has been used. As per the data available for Cycle I & II at the Soil Health Card website, the status of the macronutrients has been categorised under five categories i.e. very low, low, medium, high, very high and the status of micronutrients has been categorised into two categories i.e. sufficient and deficient. For the sake of convenience, in the case of macronutrients, "Very low" and "Low" category samples are taken under "Low class of nutrient status" and "High" and "Very high" category samples are taken under "High class of nutrient status". Similarly, in case of micronutrients, "Deficient" category samples are taken under "Low class of nutrient status" and "Sufficient" category samples are taken under "Medium class of nutrient status".

3.2.2 Results: Soil nutrient indices

Interpretation of the different values of the Soil Nutrient Index are given in Table 12.

Table 12: A rating chart of nutrient index

S.No.	Nutrient Index	Value	Interpretation
1	Low	<1.67	Low fertility status of the area
2	Medium	1.67-2.33	Medium fertility status of the area
3	High	>2.33	High fertility status of the area

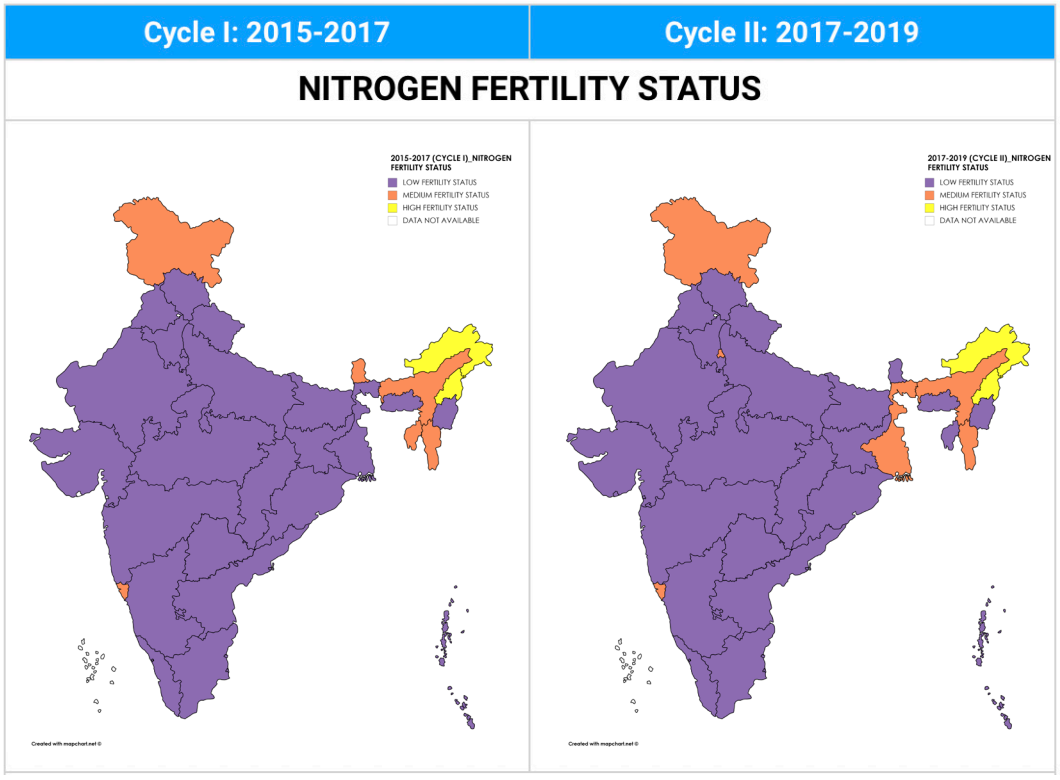
The state-wise Soil Nutrient Index, classified by each of the macro and micronutrients, for Cycle I and Cycle I, is given in the Annexure 10.3.1. Some inferences that can be made from these indices are:

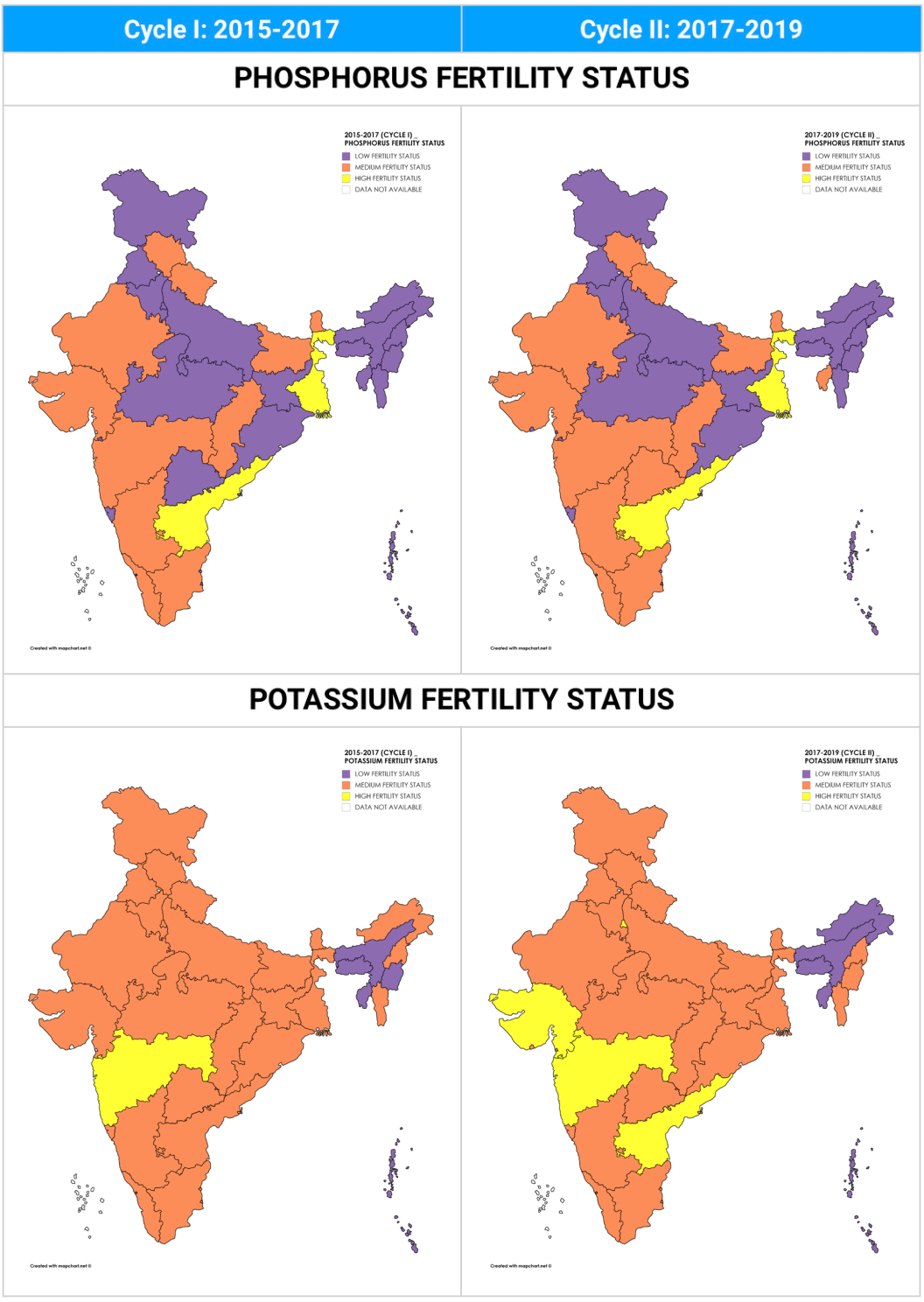
- Nitrogen fertility status in both cycles has been generally low, except in the case of Arunachal Pradesh and Nagaland;
- Phosphorus fertility status has either been low or medium in the majority of states for both cycles;
- Potassium fertility status has been medium in most of the states for both cycles;
- Even during this short period between the two cycles, the status of some soil nutrients from Cycle I to Cycle II has become better in the States of Andhra Pradesh, Bihar, Delhi, Gujarat, Jharkhand, Manipur, Telangana and West Bengal. However, for many of the other States like Assam, Himachal Pradesh, Karnataka, Kerala, Madhya Pradesh, Odisha, Punjab, Tamil Nadu, Uttar Pradesh and Uttarakhand, there has been no major change in the status of nutrients.

Maps on the fertility status in respect to the macronutrients - Nitrogen, Phosphorus and Potassium – are given in Figure 6.

Figure 6: Status of macronutrients, Cycle I and Cycle II

Rating chart of nutrient index			
Legend	**Nutrient Index**	**Value**	**Interpretation**
	Low	<1.67	Low fertility status of the area
	Medium	1.67-2.33	Medium fertility status of the area
	High	>2.33	High fertility status of the area





Source: MoSPI (2019)

3.3 Water Quality Accounts

Water quality can be assessed using physical, chemical and biological parameters. Water can be harmful for health when the values of these parameters are outside the defined limits. Water quality accounts are one of the most effective ways to describe the quality of water and to assist in the formulation of appropriate policies by various environmental agencies. In general, water quality can be assessed based on (actual or desired) water uses/functions or against general standards.

Considering the importance of water quality, the Inter-Ministerial Group (IMG) on Environmental Economic Accounting in India constituted a Sub-Group on the compilation of indices relating to water quality - under the Chairpersonship of the Additional Secretary, Department of Water Resources, the River Development & Ganga Rejuvenation, the Ministry of Jal Shakti with the experts from the Central Water Commission (CWC), the Central Ground Water Board (CGWB), the Central Pollution Control Board (CPCB), the National Centre for Coastal Research (NCCR) and the MoEF&CC - to work out the methodology for the development of the Water Quality Index (WQI) for surface/ground/marine water along with parameters, their weights and standards/ permissible limits. It was envisaged that these indices/accounts will provide the linkage between environment and economy, enable an assessment of the impact of the economy on the environment, in terms of degradation, and also help in identifying the areas warranting focused interventions for taking remedial measures and evaluation. In addition, it was also envisaged that these accounts/indices would also help in aggregating the detailed statistics on water quality being released by the concerned agencies in a manner to reflect the direction of combined fluctuations in the different variables/monitoring stations.

3.3.1 Methodology

Based on the discussions in the Sub-Group, the methodology, as recommended by SEEA-Water, has been adapted to compile water quality accounts based on designated best use quality classes for surface and groundwater. The limits for various water quality parameters for these designated best-use quality classes for surface and groundwater, as suggested by Sub-Group, is given at Annexure 10.3.2 and Annexure 10.3.3. In short, the quality classes have been categorised in accordance with the uses for which the water is fit for. The "designated best-use classes of water" as used in the water accounts are mentioned below in Table 13.

Table 13: Designated best use classes of water

Quality classes for surface water	Quality classes for groundwater
Class A: Drinking water source without conventional treatment but after disinfection	***Class A:*** Drinking water source – Class I
Class B: Outdoor bathing (organized)	***Class C:*** Drinking water source – Class II
Class C: Drinking water source after conventional treatment and disinfection	***Class E:*** Irrigation
Class D: Propagation of wildlife and fisheries	***Class U:*** Unclassified – not classified as 'A' to 'E' or inadequate information
Class E: Irrigation, industrial cooling, controlled waste Disposal	
Class U: Unclassified – not classified as 'A' to 'E' or inadequate information	

Category "Unclassified" refers to any measurement point where the parameters do not fulfil criteria for quality classes "A" to "E" or the information is insufficient to classify the data point under any of the specified quality classes. In the water quality accounts for the surface and groundwater, for a given geographic area, each entry in the table represents the amount of water of a certain quality measured in the volume of the water. In the case of rivers, and owing to the flowing nature of the water, the volume of the river is approximated by a specific unit of the account, otherwise called the "standard river unit" (SRU). The value, in SRU of a stretch of river of length (L) and of flow (q) is the product of L multiplied by q (assuming that the stretch between two monitoring stations is uniform in quality and flow, the standard river units can be allocated to the corresponding quality-class). Quality accounts for rivers can be compiled by assessing the quality class for each stretch, by computing the SRU value for each stretch and by summing the corresponding SRU per quality class to populate the quality accounts. The different quality classes can then be aggregated without double counting. It may be noted that volumes corresponding to stretches of river water where the riverbed is dry and does not allow for the collection of samples will be 'zero'.

In the case of ground water, in respect to the volume, the SRU's are replaced by Net Annual Groundwater Resources which are available block-wise and are assumed to be equally distributed across locations within the block. Thus, quality accounts for groundwater can be compiled by assessing the quality class for each location, by aggregating the Net Annual Groundwater Resources for the different monitoring locations as per the corresponding quality classes.

3.3.2 Results: Water quality accounts

3.3.2.1 Surface water quality accounts

The water quality accounts have been compiled for the Godavari River Basin for the year 2015-16 with 12 data points, one for each month, using the data on quality parameters as furnished by Central Water Commission (CWC) for 26 monitoring stations across the basin. The detailed site-wise, month-wise quality accounts of Godavari River Basin for the year 2015-16can be seen in EnviStats India 2019 (MoSPI 2019). The percentage distribution of summary of site-wise and month-wise quality accounts of Godavari River Basin are given in the Table 14 and Table 15 below. A map depicting the month-wise changes in water quality across the basin is given in Figure 7.

Table 14: Site-wise distribution of water quality in Godavari River Basin, 2015-16 (in %)

Sites	Designated best use class					Grand total	Share in total volume
	B	C	D	E	U		
Ashti	6.25	0.22	92.85		0.69	100	5.95
Bamni	17.90	3.13	75.06	2.49	1.42	100	2.73
Bhadrachalam			1.90	97.55	0.55	100	13.34
Bhatpalli	50.53		38.85		10.62	100	0.08
Hivra	38.42		28.40		33.18	100	0.42
Jagdalpur				100		100	2.63
Keolori	20.13	3.78	76.08			100	0.27

Sites	Designated best use class					Grand total	Share in total volume
	B	C	D	E	U		
Konta		2.94	15.37	77.92	3.77	100	5.02
Kopergaon				100		100	5.32
Kumhari	17.44		82.56			100	0.79
Mancherial				79.54	20.46	100	1.13
Nandgaon	2.62		20.21	77.17		100	0.76
Nowrangpur			5.08	93.50	1.42	100	0.25
P.G.Bridge	32.09	0.13	11.29		56.49	100	0.32
Pachegaon				100		100	0.46
Pathagudem		0.12	0.12	99.01	0.75	100	3.98
Pauni	12.54		87.46			100	0.55
Perur			2.12	97.24	0.64	100	22.71
Polavaram			2.11	94.61	3.27	100	20.33
Rajegaon	9.95		90.05			100	1.18
Ramakona	4.05	0.29	95.65			100	0.21
Sakmur	35.10		61.42		3.47	100	1.49
Sangam			2.71	97.01	0.28	100	0.15
Satrapur	6.69		83.57		9.74	100	0.20
Tekra	45.36		54.02		0.62	100	9.64
Wairagarh	5.89		94.11			100	0.11
Grand total	**6.48**	**0.26**	**18.86**	**72.53**	**1.87**	**100**	**100**

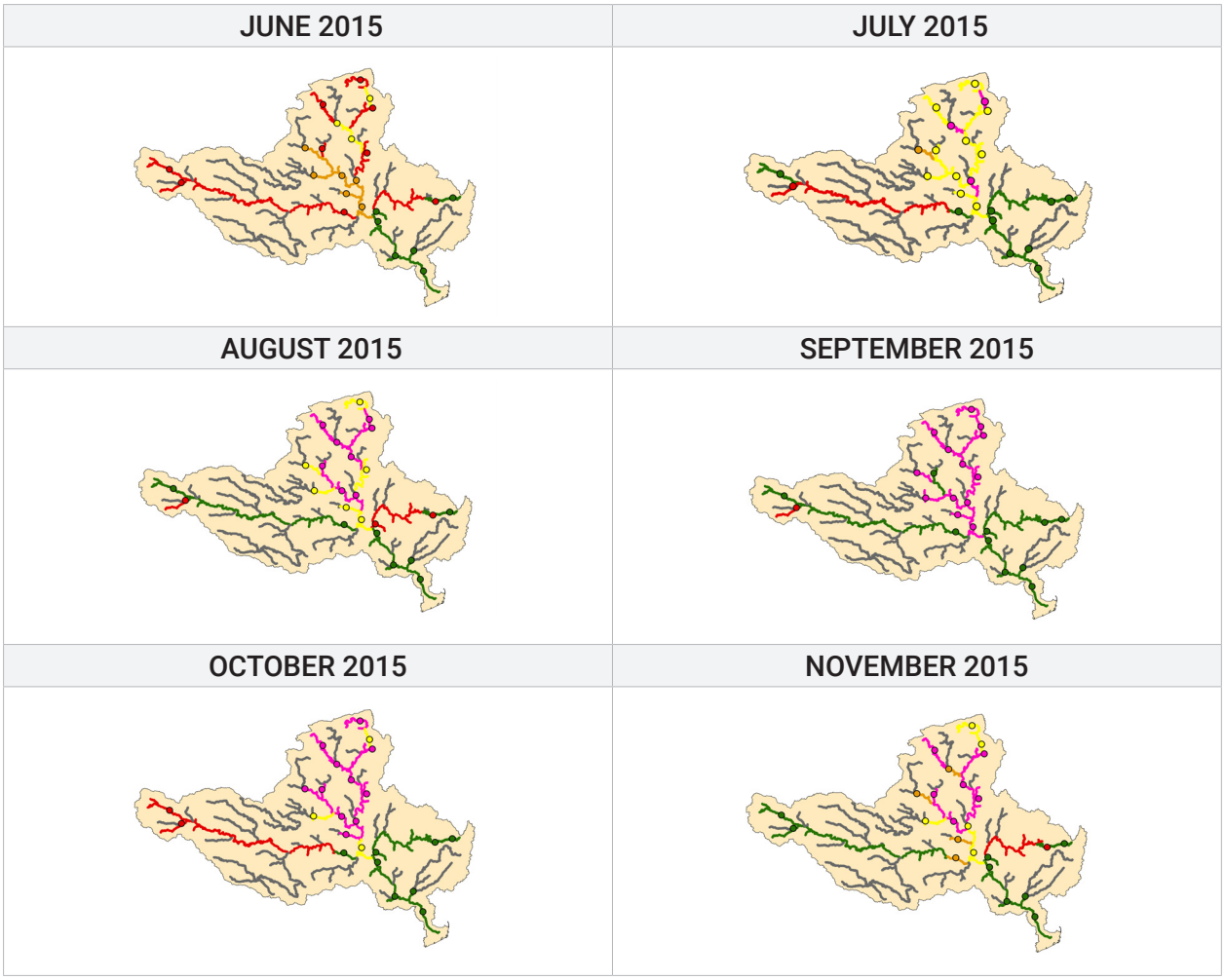
Table 15: Month-wise distribution of water quality in Godavari River Basin, 2015-16 (In %)

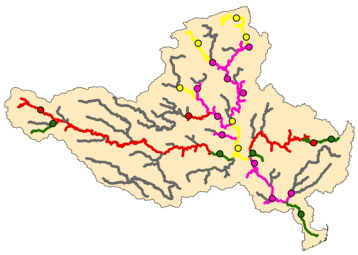
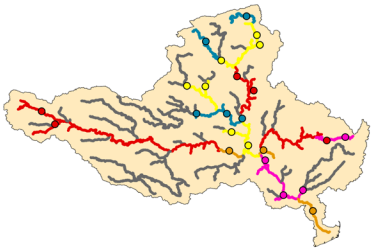
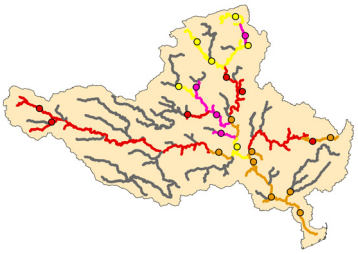
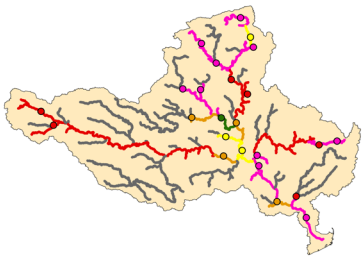
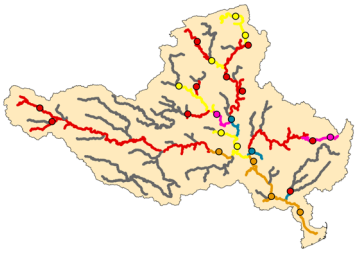
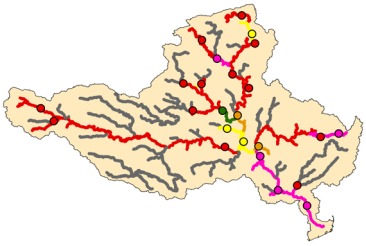
Godavari Basin	Designated based use class					Grand total
	B	C	D	E	U	
June	1.05			62.25	36.70	100.00
July	21.75		3.51	74.24	0.50	100.00
August	10.44		11.57	77.99		100.00
September			25.23	74.77		100.00
October	7.36		10.90	81.73		100.00
November	15.32		5.07	77.55	2.07	100.00
December	18.74		46.04	35.22		100.00
January	17.65	9.68	39.44		33.23	100.00
February	16.58		15.82		67.61	100.00
March	9.13		76.44	7.54	6.89	100.00
April	13.64	35.51	2.96		47.89	100.00
May	5.90		91.15	1.10	1.85	100.00
Total	**6.48**	**0.26**	**18.86**	**72.53**	**1.87**	**100.00**

Some findings from the quality accounts of Godavari River Basin during 2015-16 are:

- No stretch of water under Godavari River Basin was found to be of Class A. Further, only about 0.3% of water was found to be of Class C, i.e. water that could be used for drinking after treatment and disinfection.
- 73% of water of the Godavari Basin falls under the "Class E: Irrigation, Industrial Cooling, Controlled Waste Disposal" followed by 19% of water that falls under the "Class D: Propagation of Wildlife and Fisheries".
- More than 90% of water is suitable only for "Class E: Irrigation, Industrial Cooling, Controlled Waste Disposal" in several monitoring sites - Bhadrachalam, Jagdalpur, Kopergoan, Nowrangpur, Pachegaon, Pathagudem, Perur, Polavaram and Sangam.
- More than 80% of water of monitoring sites namely Asthi, Kumhari, Pauni, Rajegaon, Ramakona, Satrapur and Wairagarh is not fit for human use, but could be used for "Propagation of Wildlife and Fisheries".
- During the months of July to November 2015, more than 70% of water of Godavari Basin falls under the "Class E: Irrigation, Industrial Cooling, Controlled Waste Disposal".

Figure 7: Water quality of Godavari River Basin, 2015-16



DECEMBER 2015	JANUARY 2016
	
FEBRUARY 2016	**MARCH 2016**
	
APRIL 2016	**MAY 2016**
	

- **B:** Outdoor Bathing (Organised)
- **D:** Propogation of Wild life and Fisheries
- **E:** Irrigation, Industrial Cooling, Controlled Waste Disposal
- **U:** Unclassified - Not Classified as 'A' to 'E' or inadequate information
- Discharge = **0** (River dry)

Source: MoSPI (2019)

3.3.2.2 Ground water quality accounts: Punjab

The groundwater quality accounts for the State of Punjab for the year 2015 have been compiled based on the data on groundwater quality parameters provided by CGWB for 291 sites across 119 blocks in 22 districts of the state, along with data on block-wise Net Annual Groundwater Resources for the year 2013. The quality accounts, district-wise and block-wise, for the year 2015 can be seen in EnviStats India 2019 (MoSPI 2019), depiction of which can be seen in Figure 8. Table 16 gives the percentage distribution of quality of water across districts of Punjab.

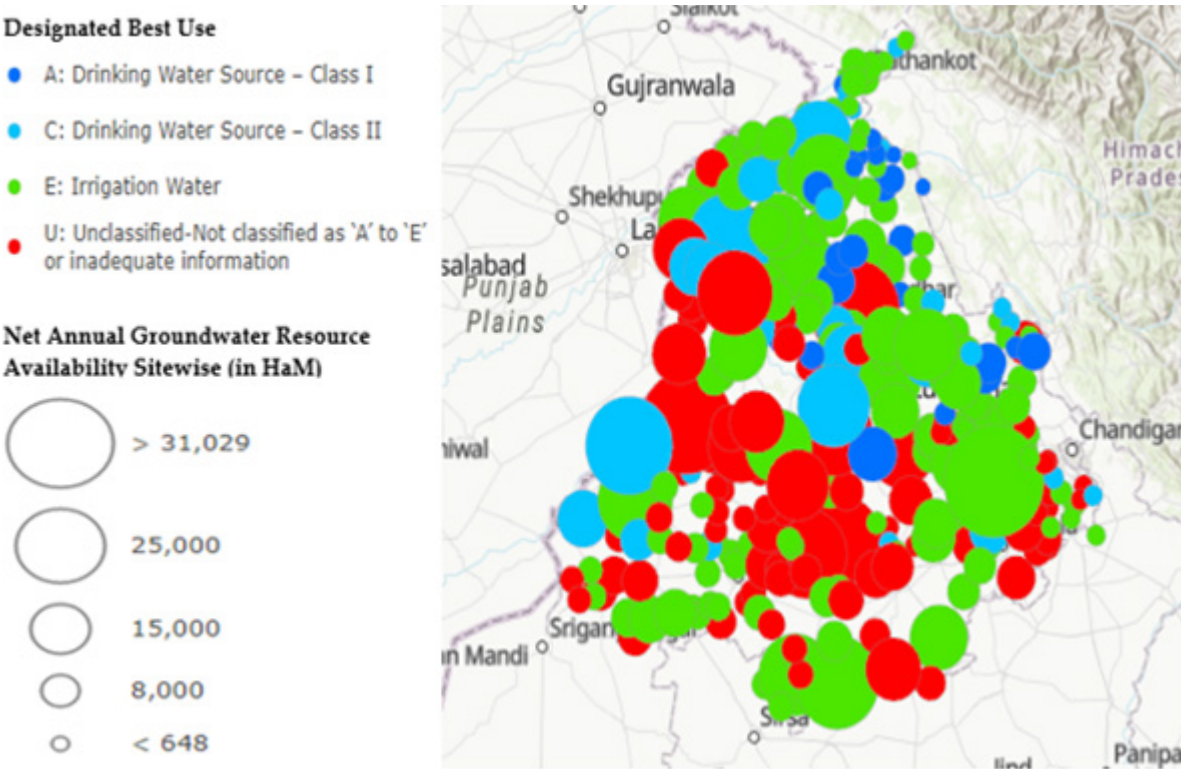
Table 16: The distribution of groundwater quality in districts of Punjab (in %)

Districts	A	C	E	U	Grand Total
Amritsar		29.40	52.47	18.13	100.00
Barnala		0.00	12.03	87.97	100.00
Bathinda		3.27	46.38	50.35	100.00
Faridkot		3.76	20.48	75.76	100.00
Fatehgarh Sahib		0.00	80.31	19.69	100.00
Fazilka		14.33	39.51	46.16	100.00
Firozpur		0.00	34.41	65.59	100.00
Gurdaspur	4.08	29.21	66.71	0.00	100.00
Hoshiarpur	31.34	9.40	59.26	0.00	100.00
Jalandhar	8.77	20.49	45.92	24.83	100.00
Kapurthala	30.24	0.00	47.85	21.91	100.00
Ludhiana	9.04	12.64	48.27	30.05	100.00
Mansa		0.00	77.46	22.54	100.00
Moga		22.57	24.71	52.72	100.00
Muktsar		13.57	57.29	29.14	100.00
Nawanshahr	27.93	30.65	41.42	0.00	100.00
Pathankot	4.55	13.71	81.75	0.00	100.00
Patiala		6.98	49.41	43.62	100.00
Ropar	22.55	9.08	61.25	7.12	100.00
Sangrur		1.67	53.33	45.00	100.00
Sas Nagar		18.71	43.88	37.42	100.00
Tarn Taran		37.53	23.85	38.63	100.00
Grand total	**5.08**	**13.96**	**47.32**	**33.64**	**100.00**

Some findings from the of groundwater quality accounts of Punjab for the year 2015 are:

- At state level, 47 per cent of groundwater in the State of Punjab is only fit for irrigation.
- 3 per cent of the states' resources could not be classified specifically into Class A to Class E, meaning thereby that the resources cannot be used even for irrigation.
- In the districts of Barnala, Fatehgarh Sahib, Firozpur and Mansa, no samples of groundwater could be classified under the two classes of drinking water.
- Some samples of Class A of drinking water could be detected in only 8 of the 22 districts, viz. Gurdaspur, Hoshiarpur, Jalandhar, Kapurthala, Ludhiana, Nawanshahr, Pathankot and Ropar.

Figure 8: Groundwater quality of Punjab, 2015



Source: MoSPI (2019)

The groundwater quality accounts for the State of Haryana for the year 2015 have also been compiled (refer to EnviStats India, 2019: Vol. II – Environment Accounts for details (MoSPI, 2019).

3.4 Coastal Water Quality Index

India has national and international obligations to prevent adverse effects to marine ecosystems caused by various anthropogenic activities. To help monitor long-term trends along the coastal waters of the country, the Ministry of Earth Sciences (MoES) has been implementing a nationally coordinated research programme on, "Coastal Ocean Monitoring and Prediction System (COMAPS)" since 1990. Under this programme, long-term data was being collected at regular intervals using consistent methods that could be used to generate valuable knowledge about the ecosystem processes and could help environmental managers develop effective management plans. In 2010, a review of the programme by an expert panel was undertaken and the COMAPS programme was renamed as "Seawater Quality Monitoring (SWQM)". The primary objective of SWQM programme is systematic monitoring of seawater quality along Indian coast at 24 selected locations, identified based on the sources of marine pollutants. To achieve this objective, the National Centre for Coastal Research (NCCR) coordinates the monitoring activities with the participation of national institutes and academia. Under the programme – COMAPS/ SWQM - data on more than 25 parameters on physico-chemical, biological and microbiological characteristics of seawater and sediment are being seasonally collected and analysed using standard protocols. Water (surface, mid-depth and bottom) and sediment samples are being collected in each location at 0/0.5 km (shore), 2/3 km (near shore) and 5 km (offshore) distance from the shore.

3.4.1 Methodology

The coastal monitoring programme developed indices using several parameters based on the following categories:

Category I: degree of nutrient enrichment

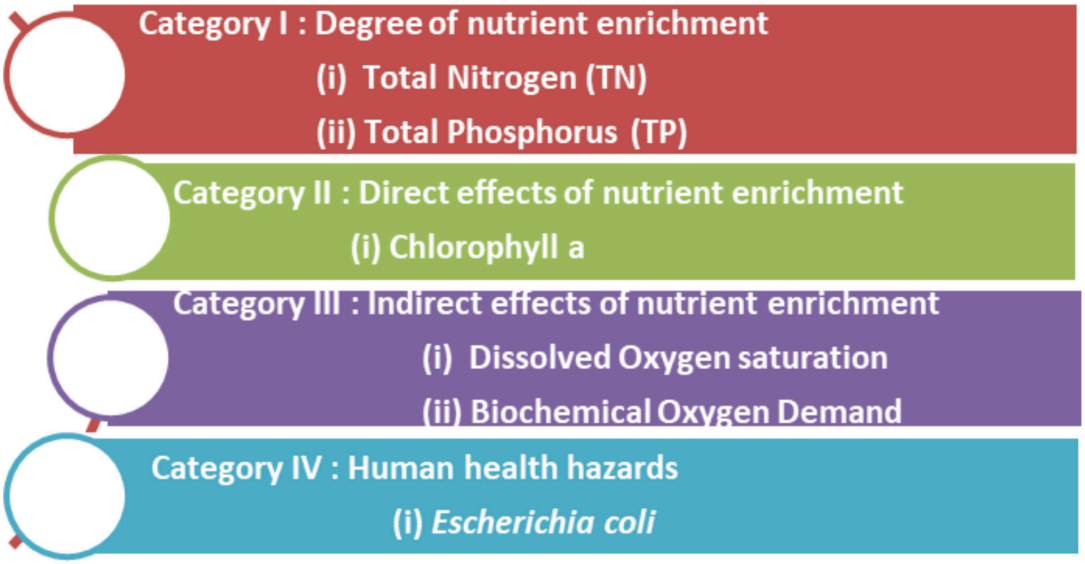
Category II: direct effects of nutrient enrichment

Category III: indirect effects of nutrient enrichment

Developing a simple water quality index requires selecting one or two parameters from each category as indicators. Globally, Dissolved Inorganic Nitrogen (DIN) and Dissolved Inorganic Phosphorus (DIP) are the potential parameters identified for the assessment of eutrophication from Category I, surface Chlorophyll-a (Chl-a) as an indicator from Category II as it reflects the immediate response for enrichment of nutrients and bottom DO as an indicator from Category III because it is a critical parameter for sustenance of ecosystem diversity. In the Indian context, disposal of sewage is the major threat to the coastal waters. The major fraction of sewage in India is released untreated or with minimal treatment (CPCB, 2016), consequently bringing enormous loads of organic matter along with pathogenic microbial population to the coastal waters. In the recent years, organic forms of nutrients were found to contribute more than 70 per cent of total nutrient pools in the coastal waters. Hence, pollution-monitoring programmes in India provide wider attention to total or organic form of nutrients rather than the inorganic forms i.e. DIN & DIP.

An index developed for the Indian coastal waters without considering total nitrogen (TN), total phosphorus (TP) and bacterial loads (in particular faecal coliforms) would be an underestimation of the water quality. For this reason, along with the above listed categories, faecal coliforms were considered as an indicator under Category IV: Human Health Hazards to the index calculation. Figure 9 gives the parameters used by the NCCR for compiling water quality indices for the sites.

Figure 9: Parameters considered for calculating WQI

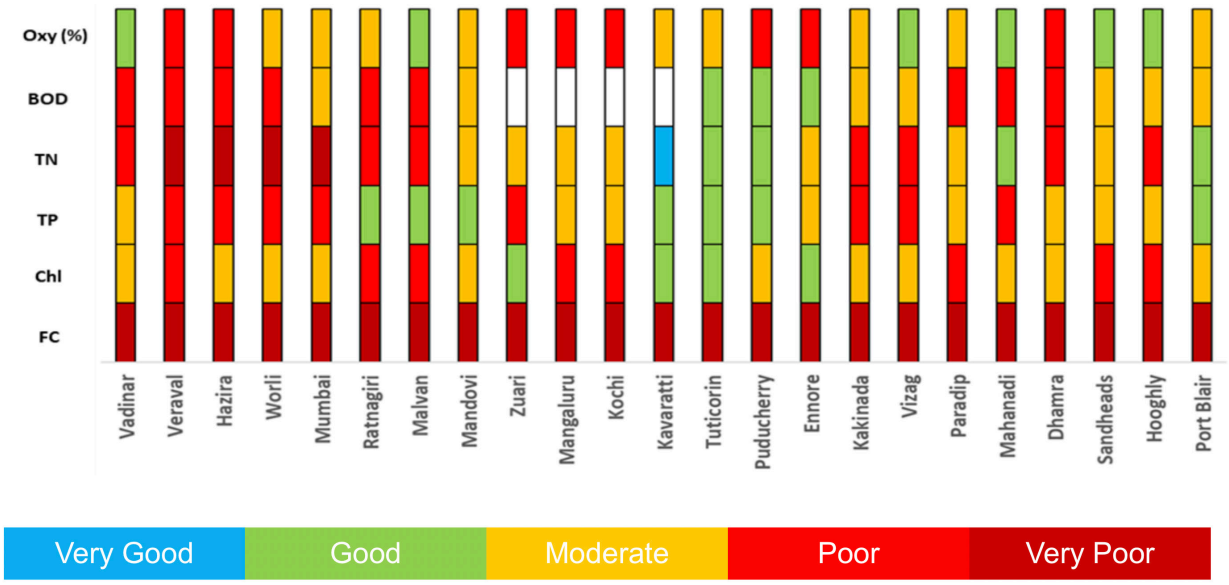


Source: MOES (2018)

3.4.2 Results: Coastal water quality index

Based on threshold value, Figure 10 below gives the grades of the different indicators at different monitoring locations.

Figure 10: Grade of different indicators at different monitoring location



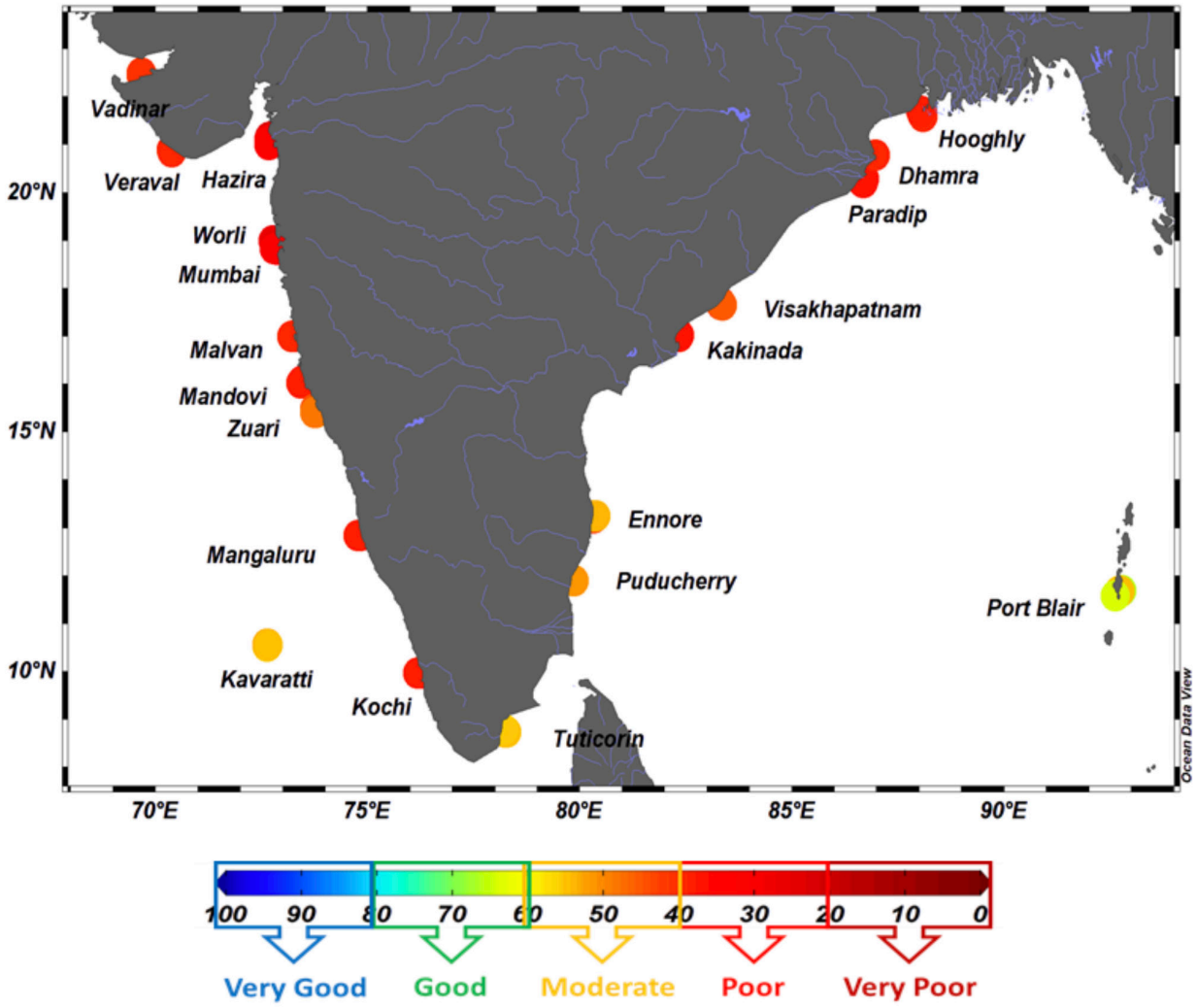
Source: MOES (2018)

The quality or accuracy of any water quality index (WQI) method relies on the definition of thresholds for selected indicators. Thus, the establishment of thresholds for each indicator should be robust and logical. For compiling the WQI for seawater, the NCCR has adopted the methodologies of the Integration and Application Network, University of Maryland Center for Environmental Science, which were used for the development of Eco Health Report Cards.[12] The main objective for deriving the WQI, using the SWQM data was to find out the spatial extent of anthropogenic impacts (i.e. sewage and domestic discharges) on the coastal water quality, hence COMAPS/SWQM dataset of all the stations (ranging from hotspots, 0.5 km, 2.0 km and 5.0 km) from each monitoring location collected during the recent years (2011-2015) were considered to derive thresholds for each indicator. Multiple thresholds were used to score indicators based on a gradient of healthy to unhealthy conditions by diving the data in equal percentiles. Cumulative scores for each parameter were converted to 0-100 per cent grading scale and reported as WQI.

In respect of the aggregate index, WQI at Vadinar, Veraval, Hazira, Worli, Mumbai, Malvan, Mangaluru and Kochi along west coast; Kakinada, Paradip and Dhamra along the east coast obtained "Poor" status. Stations viz. Zuari, Tuticorin, Puducherry, Ennore were found to be in "Moderate" condition. In general, based on the WQI, 11 out of 21 locations were found to be in "Poor" condition and the remaining locations were in "Moderate" condition. Locations at Port Blair and Kavaratti were found to be in "Moderate" and "Good" condition. WQI were developed for each station and five years' average index for each station were used for the preparation of location wise WQI maps (Figure 11).

[12] See: https://ecoreportcard.org/

Figure 11: Water quality index map for the period 2011-2015



Source: MOES (2018)

3.5 Forest Condition Accounts

Ecosystem assets are measured in terms of ecosystem extent, ecosystem condition and ecosystem services flow. Forests provide various forms of ecosystem services. The ability of forests to provide these services is dependent on the health or condition of the forest. In other words, the condition of forests influences the extent to which these services can be provided, although it is not necessarily the case that ecosystems with relatively lower condition will generate fewer ecosystem services. However, there is likely to be a close relationship between reductions in the condition and the capacity of an ecosystem to generate ecosystem services sustainably. Thus, the prevailing cross-sectoral linkages present in forest ecosystems and the importance of services provided by forests highlight the importance of monitoring, not just the quantity, but also the quality of forest ecosystems.

The SEEA prescribes the compilation of extent and condition accounts to comprehend the quality and quantity of the forest, with "ecosystem condition" representing both quality and biophysical state measures that are required to understand the capacity of the ecosystem to generate services. A format for ecosystem extent and condition account is given in Table 17, which has been prepared based on a review of available datasets for selected variables in required format.

Table 17: A format for extent and condition accounts for forests

Indicator
Extent
Recorded forest area (RFA), by type of protection – reserved, protected or unclassed
Condition accounts
Volume of growing stock
Carbon stock, by type of carbon pool – above ground biomass (AGB), below ground biomass (BGB), soil organic carbon (SOC), dead wood and litter
Carbon stock per hectare, by type of carbon pool
Number and area of wetlands within RFA
Biodiversity assessment
Total number of species of herbs, shrubs and trees
Shannon-Wiener Index of herbs, shrubs and trees
Effective number of species (ENS) of herbs, shrubs and trees
Average patch size, number of patches in different patch size classes, proportion of small patches (of less than 1 km^2)

3.5.1 Methodology

Some of the important indicators for the extent and condition of forest ecosystems contained in the format above are the carbon stock, forest fragmentation and effective number of species (ENS) which is calculated from the Shannon-Wiener Index of biodiversity evaluated for different forest types. These concepts are explained in the following paragraphs:

- Forest fragmentation is the breaking up of large, contiguous forested areas into smaller parts of forest, which are mostly separated by roads, utility corridors, agriculture, other subdivisions, or human developments. With time, the patches that separate the different pieces of forest tend to multiply and expand, which affects the health, value and functioning of the forest and the ecosystems within forests. Fragmentation generally leads to a loss of biodiversity, an increase in invasive plants, pests and pathogens, and a reduction in water quality.
    - Average forest patch size is one of the indicators that can summarize the data on different patch sizes:

$$\text{Average Forest Patch size} = \frac{Total\,forest\,Area}{Total\,number\,of\,forest\,patches}$$

    - Similarly, the proportion of small forest patches is also a relevant indicator summarizing the data of forest fragmentation. It will indicate the relative number of patches in the category of patch size greater than equal to 0.01 km2 and less than equal to 1 km2 in comparison to the total number of patches.

$$\text{Proportion of small patches}\left(\geq 0.01\text{km}^2 \text{ to} \leq 1\ \text{km}^2\right)[\%] = \left(\frac{Number\ of\ patches\ in\ Patch\ size\ range\ of\ \geq 0.01\text{km}^2 \text{ to} \leq 1\ \text{km}^2}{Total\ number\ of\ forest\ patches}\right)*100$$

The proportion of small patches as per ISFR 2015 was 98.17%, which decreased to 97.4% as per ISFR 2017. Thus, highlighting that most of the patches lie in this range.

- The Shannon-Weiner Index of Biodiversity is a commonly used indicator for comparing diversity between various habitats. It quantifies the diversity of the species by measuring both species abundance and species richness. The Shannon-Wiener index is calculated by the following formula:

$$H' = -\Sigma p_i \ ln \ p_i$$

Where, pi is the proportion of individuals found in species 'i'.

For a well-sampled community, this proportion can be estimated as $p_i = n_i/N$, where ni is the number of individuals in species i and N is the total number of individuals in the community.

By definition, pi will be between zero and one, the natural log makes all the terms of the summation negative, which is why the inverse of the sum is taken.

- Effective number of species (ENS) can be subsequently computed just like effective number of crop species (ENCS) using the following formula:

$$\boldsymbol{ENS/\ ENCS = eSDI}$$

Interpretation: Value signifies the estimate of the number of trees, shrubs etc. dominating production in a county. Thus, low value of ENS means low diversity and high value corresponds to high diversity.

In India, the Forest Survey of India (FSI) is mandated with the Forest Resource Assessment, which it undertakes on a biennial basis. The report of the assessment is published as the India State of Forest Report. All the indicators explained above have been sourced from the India State of Forest Report. FSI has presented an assessment of plant biodiversity in all the forest type groups for the first time in the ISFR report for the year 2019 (assessment year 2017-18).

3.5.2 Results: Forest condition accounts

The extent and condition accounts for the forests of India for the year 2017-18 are given in Table 18 below. Some indicators, including those for biodiversity assessment, have not been shown in this table, as these have been compiled at the state level only. Details are given in Annexure 10.3.4.

Table 18: Forest condition accounts for the year 2017-18

** Information on fragmentation pertains to the year 2015-16 (ISFR, 2017)

Indicator	Unit	Value	
Extent			
Geographical area (GA)	km²	3,287,469	
	% of Total GA	100.00	
Type of protection			
Recorded forest area (RFA)	km²	767,419	
% of GA		*23.34*	
Reserved forests (RF)	km²	434,853	
Protected forest (PF)	km²	218,924	
Unclassed forests	km²	113,642	
Growing stock			
Volume of growing stock	million cum	4,273.47	
% of country's growing stock		100.00	
Growing stock in forest	cum/ha	55.69	
Carbon stock			
Total	'000 tonnes	7,124,676	
AGB	'000 tonnes	2,256,533	
BGB	'000 tonnes	700,824	
Dead wood	'000 tonnes	35,842	
Litter	'000 tonnes	127,902	
SOC	'000 tonnes	4,003,575	
Carbon stock per hectare			
Total	per hectare stock in tonnes	100.03	
AGB	per hectare stock in tonnes	31.68	
BGB	per hectare stock in tonnes	9.84	
Dead wood	per hectare stock in tonnes	0.50	
Litter	per hectare stock in tonnes	1.80	
SOC	per hectare stock in tonnes	56.21	
Wetlands within RFA			
	Number	62,466	
	Area (in ha)	2,793,141	
	% of RFA	3.83	
Biodiversity assessment			
	Herbs	***Shrubs***	***Trees***
Total number of species	2,300	3,111	3,794
Forest fragmentation**			
Average patch size	km²	0.95	
Proportion of small patches (≥0.01 km² to ≤1 km²)	%	97.45	
Patch size range (in km²)	**No. of Patches**	**Area (km²)**	**Percentage**
>=0.01 to <=1.0	727,380	54,082	7.64
>1.0 to <=10	16,444	43,639	6.16
>10 to <=100	2,183	58,052	8.20
>100 to <=500	257	51,298	7.24
>500 to <=1000	57	39,628	5.59

3.6 Cropland Condition Accounts

Agricultural land/cropland is the land area under temporary crops, such as cereals, temporary meadows for mowing, market or kitchen gardens, land that is temporarily fallow or land that is under permanent crop. In other words, cropland is a main food production area which can also be considered an important ecosystem as it contributes to air filtration and carbon sequestration. This type of land is in good condition when it can support biodiversity and when the abiotic resources (soil-air-water) are not depleted, thus providing a balanced supply of ecosystem services. Due to the intensity of use, cropland, as a land resource, has a major impact on the environment, soil, water and aquifers, which further highlights its eminence. The key dimensions of the condition of cropland, like soil quality, soil pH, soil nutrients, water quality and crop diversity, have a direct bearing on the condition of cropland, and consequently on cropping pattern and productivity. It is, therefore, vital that while taking measures to improve the efficiency of farmland so as to meet the growing consumption demand, adequate care is taken to ensure that the croplands are in good condition.

3.6.1 Methodology

Within this context, extent and condition accounts have been compiled, drawing from the SEEA framework, for the States of India, along with the physical flows of soil regulation services provided by the croplands. The format of the accounts is given in Table 19 below.

Table 19: A format for extent and condition account of cropland ecosystem

Extent Accounts for Croplands
1. Net area sown
2. Total cropped area
3. Area sown more than once
4. Cultivable land
5. Cultivated land
6. Unculturable land
7. Uncultivated land
Condition Accounts for Croplands
1. Depicting intensification and irrigation
2. Depicting fragmentation: Gini Coefficient of Land Concentration
3. Depicting crop diversification: Effective number of crop species

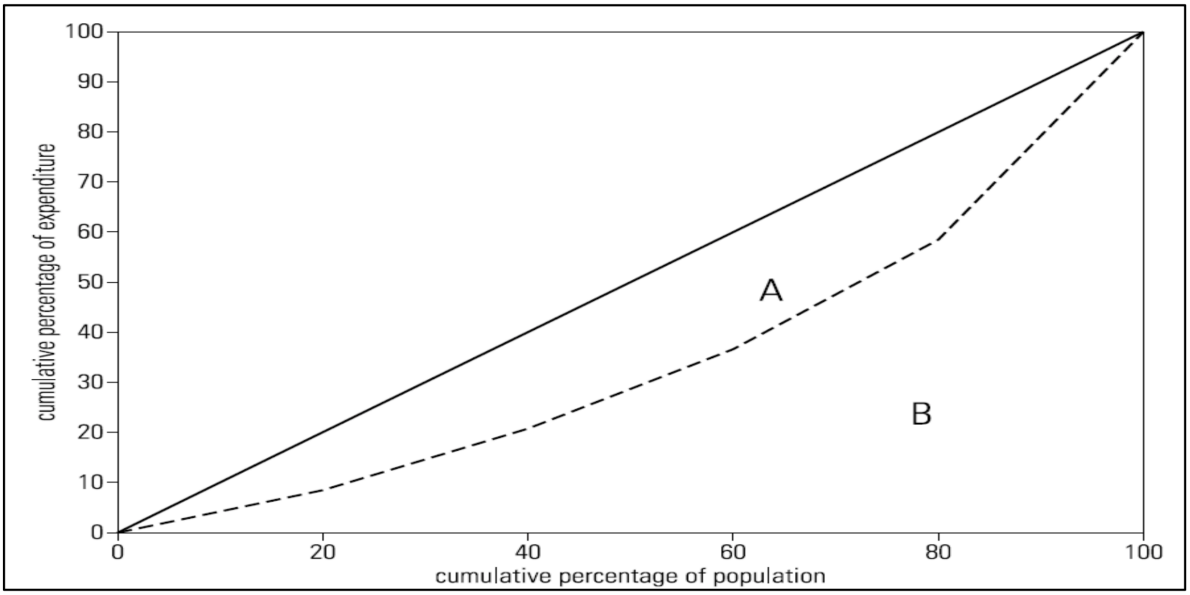
In India, increasing fragmentation of land-holdings is being observed, just as in the case of forests. Medium holdings are getting converted into small and marginal holdings and the average size of land holding, which in 2015-16 was 1.08 hectare, is likely to be reduced further in future. Fragmentation in the cropland can be measured using the Gini Coefficient of Inequality/Gini Coefficient of Land Concentration. The Gini Index, a common indicator of inequality, is based on the Lorenz curve, which is a cumulative frequency curve that compares the present distribution with the uniform distribution that represents equality. Figure 12 gives the Lorenz curve for expenditure and here, the Gini coefficient is A/

(A+B) where the diagonal represents perfect equality. Formally, let x_i be a point on the x-axis, and y_i a point on the y-axis. Then:

$$Gini = 1 - \sum_{i=1}^{N} (x_i - x_{i-1}) * (y_i + y_{i-1})$$

The Gini coefficient, when equal to zero, means perfect equality and when equalling one means complete inequality.

Figure 12:The Lorenz Curve



FAO collates and releases estimates of the Gini Index of Land Concentration using information from agriculture censuses conducted by different countries. The Gini Index of Land Concentration can be compiled by taking the cumulative percentage of holdings (from small to large) on the horizontal axis and the cumulative percentage of area of holdings on the vertical axis. Using the same method, these indices have been compiled for the States of India by using the reports of Agriculture Census conducted during 2005-06, 2010-11 and 2015-16 (MOAFW, 2012, 2015, 2019).

Crop diversification is a vital means for economic growth. It is an inevitable step to safeguard productivity, profitability and sustainability. Food and nutrition security, growth of income and employment, poverty alleviation, judicious use of land, water and other resources, sustainable agricultural progress as well as for sustainable environmental management are some of the benefits that accrue as a result of diversity, thus, one needs to compute a diversity index. Aguilar et.al (2015) suggests compiling the effective number of crop species (ENCS) using the following:

$$ENCS = e^{-SDI}$$

Where, SDI is the Shannon Diversity Index and is computed as follows:

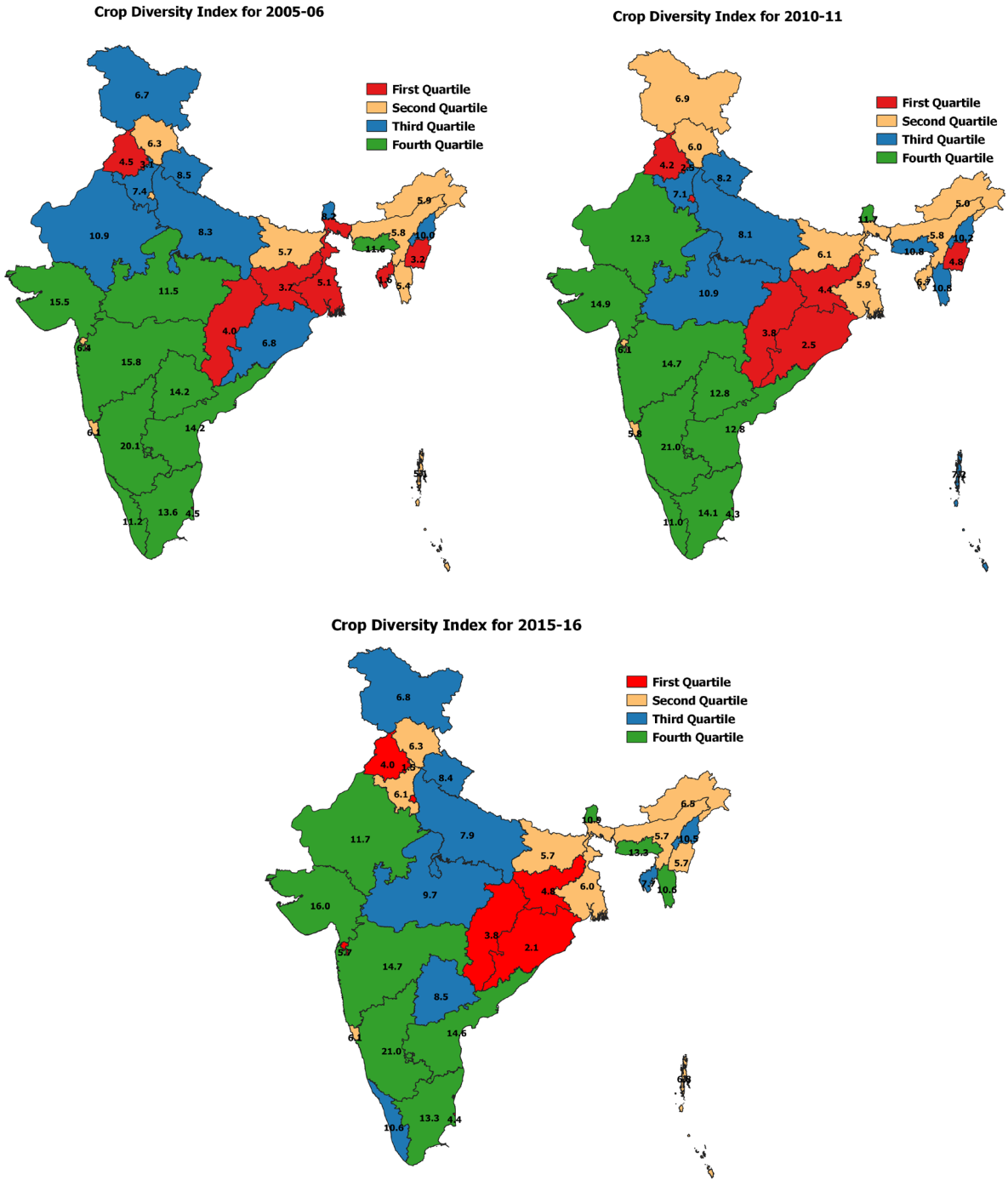
$$SDI = \Sigma\, p_i \ln p_i$$

Where, pi is the proportions of the harvested area for crop i, or the crop group i.

Interpretation: The value of ENCS signifies the estimate of the number of crops dominating production in a particular country.

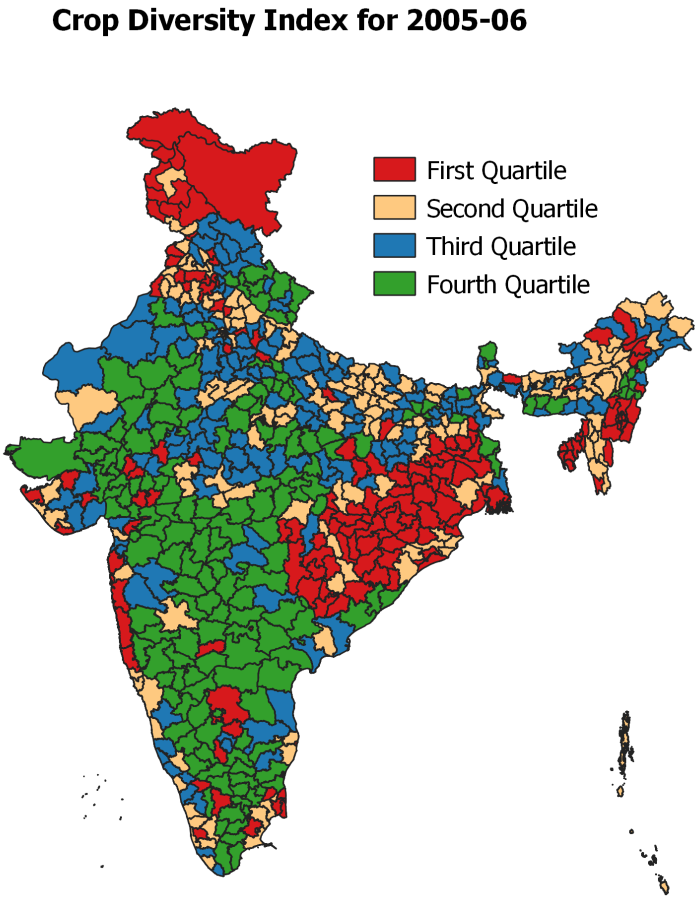
ENCS for the States/Districts of India have been compiled using the crop area statistics as available in the Land Use Statistics (Figure 13 and 14) where the colour depicts the following:

Figure 13: A map depicting effective number of crop species (ENCS) across the years



Source: MoSPI

Figure 14: A map depicting effective number of crop species (ENCS) for 2005-06



Source: MoSPI

3.6.1 Results: Cropland condition accounts

Accounts using the datasets and methods prescribed in the previous paragraphs have been compiled at state and national level for India for three years – 2005-06, 2010-11 and 2015-16, synchronous with the agriculture census. Table 20 below gives the cropland ecosystem accounts at the national level.

Table 20: Cropland ecosystem accounts for India

Indicator	Unit	Value		
		2005-06	2010-11	2015-16
Extent				
Net area sown	'000 Hectares	141,162	141,563	139,506
Total cropped area	'000 Hectares	192,737	197,683	197,054
Total cultivable land	'000 Hectares	182,686	182,010	181,603
Cultivated land	'000 Hectares	155,375	155,840	154,916
Unculturable land	'000 Hectares	124,198	125,473	126,149
Uncultivated land	'000 Hectares	151,510	151,643	152,835

Indicator	Unit	Value		
		2005-06	2010-11	2015-16
Intensification				
Area sown more than once	'000 Hectares	51,575	56,120	57,548
Cropping intensity	%	136.5	139.6	141.3
Fragmentation of operational holdings				
Gini Index of Land Concentration		0.59	0.58	0.57
Number in '000		129,222	138,348	146,454
Area in '000 hectares		158,323	159,592	157,817
Percentage distribution of area operated by operational holdings				
Marginal	%	20.2	22.5	24.0
Small	%	20.9	22.1	22.9
Semi-medium	%	23.9	23.6	23.8
Medium	%	23.1	21.2	20.2
Large	%	11.8	10.6	9.1
Status of Irrigation				
Percentage of gross irrigated area to	%	43.7	45.0	49.0
Area Irrigated more than once	'000 Hectares	23,442	25,275	29,321
Crop diversity				
Effective number of crop species	*Number*	18.7	18.6	18.1

During the period of 2005-06 to 2015-16, the Gini Index of Land Concentration, which is a measure of fragmentation, has decreased marginally from 0.59 to 0.57. As described earlier, the Gini coefficient, when equal to zero, means perfect equality and when it equals one it means perfect inequality. The level of inequality is also reflected in the fact that small and marginal holdings taken together (0.00-2.00 ha.) constituted 86.08% of the total holdings in 2015-16 against 85.01% in 2010-11 while their share in the operated area stood at 46.9% in 2015-16 as against 44.6% in 2010-11. Further, the average size of operational holding has declined to 1.08 ha in 2015-16 as compared to 1.15 in 2010-11. With higher fragmentation, it becomes difficult to employ effective and efficient irrigation and optimum usage of fertilisers and, therefore, in some states, the individual State Governments have enacted land consolidation policies to tackle the challenge of the low average size of holdings. These measures need to be expanded further so that farmers can voluntarily come together and pool land to reap the economies of scale.

More than 100 food and non-food crops are grown in India, representing a range of crop groups - cereals, pulses, fruits, vegetables, spices, oil seeds, fibres, drugs and narcotics, to name a few. However, the ENCS in the country is just around 18. At the state level, several variations are observed (Annexure 10.3.5). Among those states having a "net area sown" of more than 1000 hectares, the States of Assam, Bihar, Chhattisgarh, Haryana, Jharkhand, Odisha, Punjab, West

Bengal have an ENCS of about 7, while the States of Andhra Pradesh, Gujarat, Karnataka, Maharashtra and Tamil Nadu have a number of more than 14 species. Crop diversification reduces the need for and associated risk of application of harmful chemicals, like pesticides and herbicides, due to the presence of a variety of crops that are resistant to pests, weeds and diseases. The Government of India is already promoting crop-diversification under its schemes for doubling farmers' income. As these schemes take root, crop diversification may prove to be one of the most cost-effective solutions that can help address the downgrading ecological situation, the depletion of groundwater levels and the declining fertility of soil, as well as help reduce the environmental fluctuations in outcomes that can often occur in agriculture and to also increase resilience against these fluctuations.

Section 4:
Ecosystem Services

4.1 Introduction

Ecosystem services are defined in the SEEA EA as the contributions of ecosystems to benefits used in economic and other human activities, and these are categorised into provisioning, regulating and cultural services. The measurement focus lies on so-called "final ecosystem services" i.e. flows of ecosystem services between ecosystem assets and economic units. The ecosystem accounting framework also supports the recording of flows of intermediate ecosystem services, which are flows of services between ecosystem assets, such as nursery services or pollination.

For accounting purposes, it is assumed that it is possible to attribute the supply of ecosystem services to individual ecosystem assets (e.g. timber from a forest) or, where the supply of services is more complex, to estimate a contribution from each ecosystem asset to the total supply. For each recorded supply of ecosystem services, there must be a corresponding use. The attribution of the use of the final ecosystem services to different economic units is a fundamental element of accounting. Depending on the ecosystem service, the user (e.g. a household, business or government) may receive that service while it is located either in the supplying ecosystem asset (e.g. when catching fish from a lake) or elsewhere (e.g. when it is receiving air filtration services from a neighbouring forest). The physical flows of supply and use of ecosystem services are captured in physical supply and use tables.

The core valuation concept applied in the SNA and is also used in ecosystem accounting is that of exchange value, that is, the value at which goods, services, labour or assets are in fact exchanged or else could be exchanged for cash. The valuation approaches adopted for ecosystem accounting exclude the consumer surplus that may be associated with transactions in ecosystem services.
In most circumstances, values for ecosystem services are not revealed because they are not priced and not transacted in markets. A range of techniques have been developed for the valuation of non-market transactions that can be applied for the purpose of providing estimates of the value of the supply and use of ecosystem services in monetary terms. However, it should be noted that there exists a range of challenges with respect to implementation of those techniques and interpretation of the values that they yield, which is why results of valuation of ecosystem services as reported in this report should be considered experimental.

The supply and use of ecosystem services in monetary terms is captured in Monetary Supply and Use Tables (MSUTs).

The report includes experimental ecosystem services supply accounts for India based on the SEEA EA framework. The overarching goal

of measuring and valuing ecosystem services is to use that information to shape policies and incentives for better management of ecosystems and natural resources.

Six ecosystem services, that have been released by MoSPI during the project period, have been considered in this report: crop provisioning, provisioning of timber and non-timber forest products, carbon retention (from forests), nature-based tourism and soil erosion prevention services. For each ecosystem service, data sources and appropriate valuation approaches that are conceptually valid have been used to produce values consistent with the SNA that can facilitate the integration of environmental and economic statistics. There are still several important indicators of ecosystem services which have not been included in this assessment, but are nevertheless, very important.

It can be noted that by using data available in the public domain, physical supply accounts have been compiled for two selected ecosystem services i.e. carbon retention service and soil erosion prevention service. Monetary supply accounts have been compiled for the crop provisioning services, provisioning of timber and non-timber forest products, carbon retention and nature-based tourism service using appropriate valuation techniques.

4.2 Crop Provisioning Services

The agriculture sector is pivotal to the sustainable growth and development of any country, but it is significantly marked in the Indian context. Not only does it meet the food and nutritional requirements of 1.3 billion Indians, agriculture is the primary source of livelihoods for about 58 per cent of India's rural households or 40 per cent of the total households. With a cropland spanning an area of about 156 million hectares (as per the extent account in chapter 2- table 6), India is a vast country with great diversity of physical features, such as dry deserts, evergreen forests, snowy Himalayas, a long coast and fertile plains. Consequently, the agricultural ecosystems in India show tremendous variation, as they are driven by diverse cultures under diverse socioeconomic conditions in diverse climatic regions.

Definition of ecosystem service

The ecosystem service, "crop provisioning service" is defined here as the total and combined result of processes taking place in cropland that support crop production such as infiltration of water, the water holding capacity of the soil, the absorption of plant nutrients by soil particles and the resupply of these particles to plants.

4.2.1 Valuation approach

Methods and data

In this report, district-wise estimates of the value of the crop provisioning service per unit of geographic area of the district have been presented for the years 2005-06, 2011-12 and 2014-15. The estimates have been compiled using the rental price method prescribed by SEEA, where the service value is estimated based upon rents paid for leased-in land and the extent of various types of agricultural land. For owned land, rental prices are imputed.

For estimating the value of this ecosystem service, three sets of information have been used – (i) The information available in the Cost of Cultivation Studies (CCS), conducted by the Ministry of Agriculture and Farmers Welfare; (ii) Land use statistics (LUS); and (iii) the data on area and production of different crops as given in the Area, Production and Yield (APY) statistics, released by the same Ministry. Land use statistics is a comprehensive and systematic account of natural endowment of land spanning over 328 million hectares of geographic space of the country, adopting the uniform concept of nine-fold land use classification. Crop area statistics, given in LUS, broadly covers the utilisation pattern of land with detailed information relating to

land put to agricultural uses. Crop statistics, in the form of APY, assimilate the diverse agro climatically influenced crop acreage and production details of numerous crops, grown over 140 million hectares of net sown area with about 141 per cent cropping intensity. This includes the area sown under different crops in different seasons.

The steps that were followed for estimating the value of the crop provisioning services are as follows:

i) Estimation of rent for CCS states and CCS crops

- Total rent per hectare, as the sum of rent paid for leased in land or rental value of own land, is taken as it is for the state x crop combination that is available in CCS. In the analysed dataset, there were 19 CCS States and 24 CCS Crops.
- Rent per hectare is then imputed for all states and all crops that are available in CCS. For states where CCS in not available for some crops, missing rent is imputed crop wise using rent from the neighbouring state.
- For states where CCS is not available for some crops and CCS of those crops is also not available in neighbouring states, rent is imputed with minimum rent of that state itself.

ii) Imputation for non-CCS states & CCS crops

- For non-CCS states, rent for the CCS crops has been imputed from the nearest CCS neighbour.

iii) Imputation for non-CCS crops

- For crops where CCS is not available for any state, rent has been imputed with positive minimum rent of that state itself.

iv) Since crop-wise information is available for gross area sown and not net area sown, an adjustment factor has been derived from land use statistics.

- Adjustment factor for net area sown = net area sown/gross area sown

v) Estimation of resource rent for a specific state for a specific crop for a year:

$RR(S)_{crop}$ = (rent per hectare (state) x area under crop (state) x adjustment for Net Area Sown)

vi) Estimation of resource rent for a specific state per unit quantity[13] of crop for a year:

$RR(S)_{crop}$ per tonne = $RR(S)_{crop}$ / (Production (state))

vii) Estimation of resource rent for district for a drop for a year:

$RR(D)_{crop}$ = $RR(S)_{crop}$ per tonne x production (district)

viii) Estimation of total resource rent for a district for a year:

RR (D) = total of all crops as given in APY

Valuation of crop provisioning services has been conducted by using a three-year average of resource rent (per tonne) in order to remove volatility in resource rents over time/years. For instance, the average of 2004-05, 2005-06 and 2006-07 has been taken for the year 2005-06. Considering multiple years is expected to negate excessive fluctuations due to contingent events that happened in specific years. The values of crop provisioning services have been compiled for the years

[13] Tonnes for all crops, except coconut, where the production is given in 'nuts' .

2005-06, 2011-12 and 2014-15 and depicted in terms of values per unit of geographic area of the district. This shows the combined contribution of land resources in agriculture, as well as the share of cropland in the district.

Results

The estimated values of crop provisioning services for the three years 2005-06, 2011-12 and 2014-15 are given in Table 21. The district-wise detailed estimates of crop provisioning services per unit geographic area have also been estimated (refer to EnviStats India 2019 Vol. II - Environment Accounts publication).

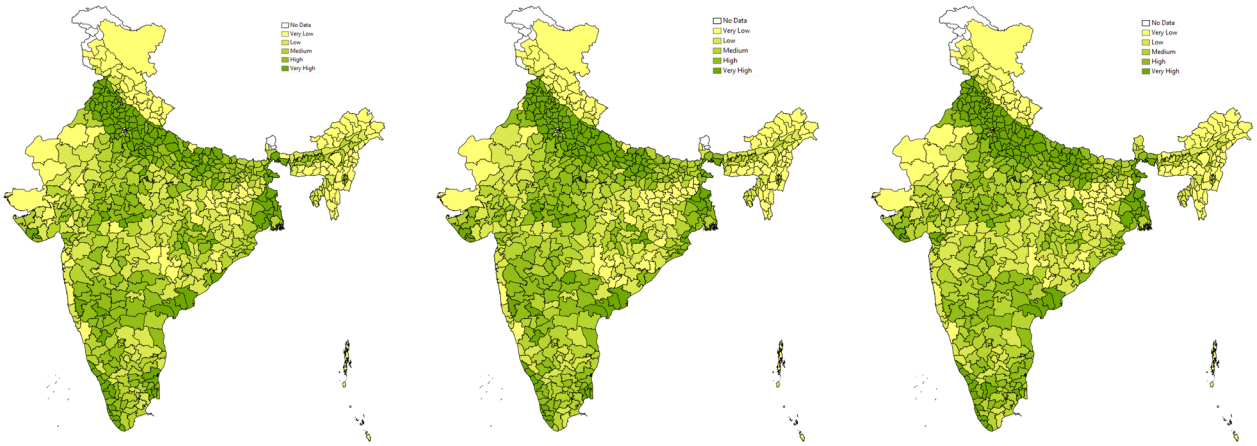
Table 21: Monetary supply table of provisioning of crops ecosystem service, India

	Ecosystem Type			
Ecosystem Service	**Croplands**	**Forests**	**Other ecosystems**	**Total**
Crop Provisioning Services in 2005-06 (INR 000' crores)	58.36			**58.36**
Crop Provisioning Services in 2011-12 (INR 000' crores)	122.10			**122.10**
Crop Provisioning Services in 2014-15 (INR 000' crores)	147.59			**147.59**

The quintile distribution of the districts in respect of resource rent for these three years is depicted in Figure 15.

Figure 15: Maps depicting quintile distribution of Crop Provisioning Services

2005-06 *2011-12* *2014-15*



Source: MoSPI (2019)

Demarcation of classes of quintile distribution of districts in respect of resource rent (in INR)			
Classes	**Year**		
	2005-06	**2011-12**	**2014-15**
No data	-	-	-
Very low	Less than 586	Less than 1033	Less than 1616
Low	586 - 1,339	1,033 - 2,724	1,616 - 3,303
Medium	1,339 - 2,119	2,724 - 4,069	3,303 - 5,192
High	2,119 - 3,643	4,069 - 7,303	5,192 - 8,701
Very high	3,643 - 12,222	7,303 - 34,816	8,701 – 29,260

4.3 Timber Provisioning Services

Forests are one of the multi-functional ecosystems which provide several services on all spatial and temporal levels. Without the ecosystem services emanating from forests, life on Earth would not be possible. The forests of India are rich in biodiversity and form an integral part of the national economy. Timber is the most sought-after product harvested from the forests. However, the source of production of timber is either from forests or from trees outside forests (TOF). FAO (2001) has defined TOF as "Trees on land not defined as forests and other wooded land". In India, FSI 2019 has defined TOF as "all trees growing outside government recorded forest areas (RFAs) irrespective of patch size".

Definition of ecosystem service

The ecosystem service, "timber provisioning service" is defined here as the contribution of ecosystem assets (forest, other wooden areas) to the production of timber by forestry.

4.3.1 Valuation approach

Methods and data

The valuation of timber provisioning service is based on the concept of exchange values. The estimates of gross value added from the forestry and logging sector in India are compiled by the production approach. It aims at estimating the value of output in the first instance and then deducting the value of various inputs at purchaser›s prices. The state-wise estimates of the value of the timber provisioning service are based on these exchange values that are adopted in compilation of the national accounts statistics.

For the compilation of national accounts, the data on production and prices of industrial wood/timber are supplied by State Forest Departments (SFDs) of India. MoSPI prepares the estimates of the value of output at current prices of industrial wood by multiplying the category-wise production figures with their respective average annual prices (at the assembling centres), both of which are supplied by the SFDs. In addition to the production of industrial wood from these Government forests, there would be:

i. Authorised (but unrecorded) and unauthorised removals of timber from reserved/protected forests and;

ii. Unrecorded production from private owned forests and non-traditional forest areas (e.g. trees in village common fields, ridges, canal sides, road sides, fruit trees no longer productive etc.).

Since the value of unrecorded production (i.e. authorised - but unrecorded - removals of timber from reserved/protected forests) is not available, MoSPI uses a norm that 10 per cent of the value of recorded production is taken as the value of unrecorded production. The proportion of 10 per cent has been derived using a set of studies conducted across the country. The estimates of volume of industrial wood from trees outside forests (TOF) (i.e. private owned forests and non-traditional forest areas like village commons, field ridges, canal sides, road sides and fruit trees no longer productive) are provided by the Forest Survey of India (FSI), while the prices are compiled from those made available for industrial wood by the SFDs.

Forest Rent, as a percentage of GDP has been taken from World Bank›s databank. Forest Rent as a percentage of the gross value of output of forestry can then be estimated using the ratios between GVO-Forestry, GVA-Forestry and GDP. This value can be said to be an approximation of the share of 'resource rent' and therefore, has been used to estimate the value of timber provisioning service.

The steps that were followed for estimating the value of timber provisioning services are as follows:

i) Value of output of Industrial wood/timber (at current price) estimates are taken from the State-wise and item-wise value of output from agriculture, forestry and fishing, 2019, National Statistical Office, MoSPI.

ii) Forest Rent as percentage of the gross value of output of forestry is estimated as:

(Forest rent / GVO of forestry) = (Forest rent/GDP) * (GDP/GVA of forestry) * (GVA /GVO of forestry)

(The first factor i.e. 'forest rent/GDP' is taken from the data available at the World Bank databank,[14] the second and third are taken from Indian national accounts).

iii) ***Value of the timber provisioning service = (forest rent/GVO of forestry) * (value of output of timber)***

Results

During the year 2017-18, it was observed that value of the timber provisioning service is INR 16.30 thousand crores which is about 0.10 per cent of India's GDP. The estimated values of timber provisioning services in India during the period 2011-12 to 2017-18 are given in Table 22. State-wise estimates of values of timber provisioning service during the period 2011-12 to 2017-18 can be seen in EnviStats India 2020 (MoSPI 2020a).

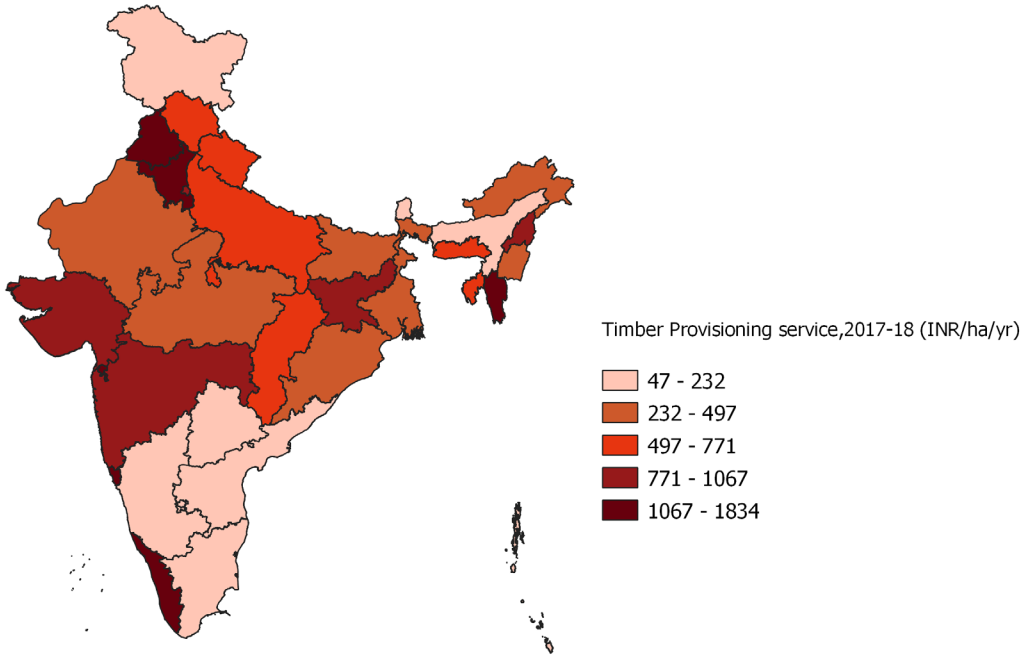
Table 22: Monetary supply table of timber provisioning service, India

	Ecosystem Type			
Ecosystem Service	**Croplands**	**Forests**	**Other ecosystems**	**Total**
Timber provisioning service in 2011-12 (INR 000' crores)		13.41		**13.41**
Timber provisioning service in 2012-13 (INR 000' crores)		13.17		**13.17**
Timber provisioning service in 2013-14 (INR 000' crores)		14.71		**14.71**
Timber provisioning service in 2014-15 (INR 000' crores)		20.66		**20.66**
Timber provisioning service in 2015-16 (INR 000' crores)		24.44		**24.44**
Timber provisioning service in 2016-17 (INR 000' crores)		21.80		**21.80**
Timber provisioning service in 2017-18 (INR 000' crores)		16.30		**16.30**

Value of timber provisioning service per hectare in India during the year 2017-18 is depicted in Figure 16.

[14] See: https://data.worldbank.org/indicator/NY.GDP.FRST.RT.ZS?locations=IN&view=map

Figure 16: A map depicting value of timber provisioning service in India, 2017-18



Source: MoSPI

4.4 Provisioning of Non-Timber Forest Products

Non-timber forest products (NTFPs) constitute an important source of livelihood for millions of people from forest fringe communities across the world. As per FAO, there are at least 150 NTFPs that contribute substantially to international trade, including honey, gum arabic, rattan and bamboo shoots, cork, forest nuts and mushrooms, oleoresins, essential oils, and plant or animal parts for pharmaceutical products. In India, NTFPs are associated with the socio-economic and cultural life of forest dependent communities inhabiting wide variety of ecological and geo-climatic conditions throughout the country.

Definition of ecosystem service

The ecosystem service, "NTFP provisioning service", is defined here as a provisioning service for products other than timber that are produced in forests. NTFPs include plants used for food, beverages, forage, fuel, medicine, fibres and biochemical; animals, birds and fish for food, fur and feathers; as well as their products such as honey, lac and silk. Another term, Non-wood Forest Products (NWFP) differs from the NTFP in that it excludes all wood (including fuelwood) while NTFP includes wood for uses other than for timber.

4.4.1 Valuation approach

Methods and data

The valuation of NTFP provisioning service is based on the concept of exchange values. The state-wise estimates of value of output of NTFPs are available in India's National Accounts Statistics. The items of NTFPs vary from state-to-state. Information is built up on the basis of royalty received (in value terms) from those authorised to extract these from the forests. Value of fodder from forest, as estimated using the 'per animal consumption' norms, is also a component of the estimate of NTFPs, as available in the National Accounts Statistics.

Forest Rent as a percentage of GDP is taken from World Bank›s databank. Forest Rent as percentage of the gross value of output of forestry can then be estimated using the

ratios between GVO-Forestry, GVA-Forestry and GDP. This value can be said to be an approximation of the share of "resource rent" and therefore, has been used to estimate the value of NTFP provisioning service.

The steps that were followed for estimating the value of NTFP provisioning service are as follows:

i) Value of output of non-timber forest products (NTFP) estimates are taken from 'State-wise and item-wise value of output from agriculture, forestry and fishing, 2019, National Statistical Office, MoSPI'.

ii) Forest rent as percentage of the gross value of output of forestry is estimated as:

(Forest rent / GVO of forestry) = (forest rent/ GDP) * (GDP/GVA of forestry) * (GVA /GVO of forestry)

iii) ***Value of NTFP provisioning service = (forest rent / GVO of forestry) * (value of output of NTFPs)***

Results

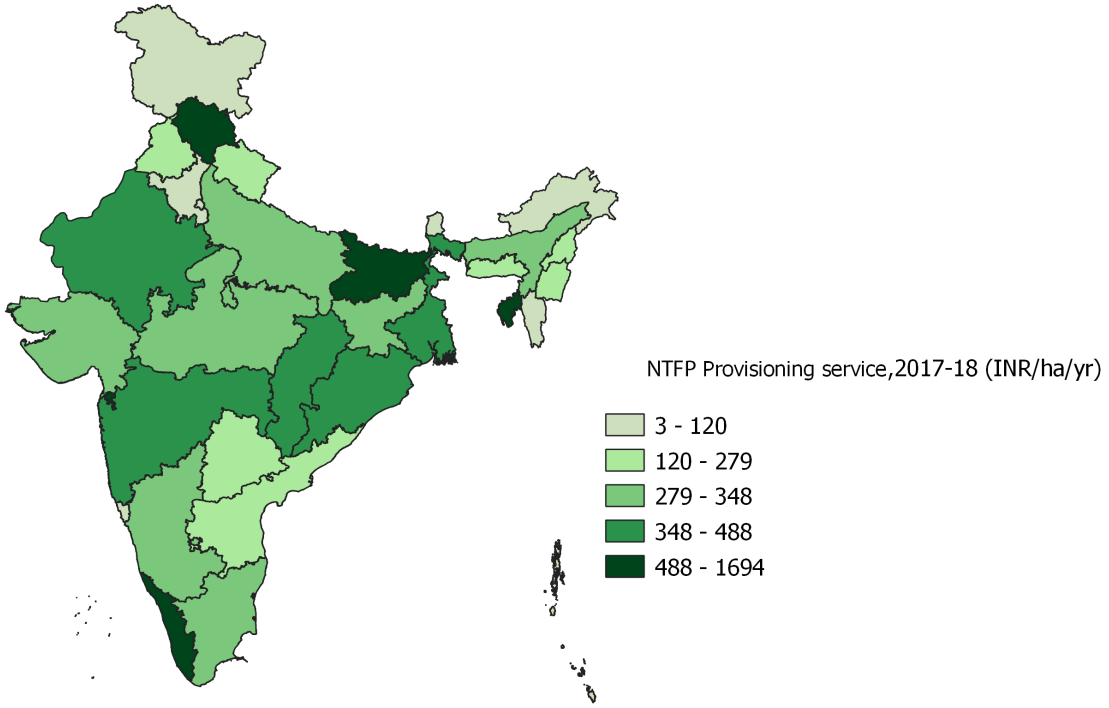
During the year 2017-18, it was observed that value of NTFP provisioning service was INR 10.96 thousand crores which is about 0.06 per cent of India's GDP. The estimated values of NTFP provisioning service in India during the period 2011-12 to 2017-18 are given in Table 23. State-wise estimates of the value of NTFP provisioning service during the period 2011-12 to 2017-18 can be seen in EnviStats India 2020 (MoSPI 2020a).

Table 23: Monetary supply table of NTFP provisioning service, India

	Ecosystem Type			
Ecosystem Service	Croplands	Forests	Other ecosystems	Total
NTFP provisioning service in 2011-12 (INR 000' crores)		13.46		**13.46**
NTFP provisioning service in 2012-13 (INR 000' crores)		14.28		**14.28**
NTFP provisioning service in 2013-14 (INR 000' crores)		15.06		**15.06**
NTFP provisioning service in 2014-15 (INR 000' crores)		17.69		**17.69**
NTFP provisioning service in 2015-16 (INR 000' crores)		20.18		**20.18**
NTFP provisioning service in 2016-17 (INR 000' crores)		15.57		**15.57**
NTFP provisioning service in 2017-18 (INR 000' crores)		10.96		**10.96**

Value of NTFP provisioning service per hectare in India during the year, 2017-18 is depicted in the Figure 17.

Figure 17: Map depicting value of NTFP provisioning service in India, 2017-18



Source: MoSPI

4.5 Carbon Retention

Forests play an important role in climate change mitigation and adaptation. The diversity of India's forests increases the country's resilience to climate change and creates an effective carbon sink. Aside from sequestering carbon, India's forests also act as carbon store, thereby preventing it from being released into the atmosphere and therefore helping to avoid the escalation of the climate change concerns. This carbon storage or retention has an economic value. The social cost of carbon (SCC) represents the economic cost associated with climate damage (or benefit) resulting from the emission of an additional tonne of CO_2 (Ricke et al., 2018). Hence the social cost of carbon is often used as a carbon price estimate.

Definition of ecosystem service

The ecosystem service, "carbon retention service" is defined here as estimates of annual service flow derived from the carbon stocks using a suitable rate of return (to create an annuity).

4.5.1 Physical stocks of carbon

The SEEA EA carbon stock account can be very useful to understand the status of how much carbon is currently 'in stock' in a country and in what form. It can assist in the informing of the implications of policy interventions at any point along the carbon cycle. Carbon stocks are classified into: geocarbon (carbon stored in the geosphere) and biocarbon (carbon stored in the biosphere, in living and dead biomass and in soils). Based on the availability of data, only the biocarbon component has been considered in this report.

The total biocarbon stocked in the forests is divided into five pools by the Intergovernmental Panel for Climate Change (IPCC) Good Practice Guidance (GPG) for Land Use, Land-Use Change and Forestry (IPCC, 2003). The living portion of biomass carbon is classified as "above ground biomass" (AGB) and "below ground biomass" (BGB) and stores significant amounts of carbon. The "dead organic matter" (DOM) is classified as "dead wood" and "litter".

The fifth pool is "soil organic matter" which contains a substantial amount of organic carbon. A description about the classification of different carbon pools is presented in Table 24.

Table 24: A classification of carbon stock in forests under different carbon pools

Pools		Description
Living biomass	**Above ground biomass (AGB)**	All living biomass above the soil including stem, stump, branches, bark, seeds and foliage.
	Below ground biomass (BGB)	All living biomass of live roots. Fine roots of less than 2 mm diameter (country specific) are often excluded because these often cannot be distinguished empirically from soil organic matter or litter.
Dead organic matter	**Dead wood**	Includes all non-living woody biomass not contained in the litter, either standing or lying on the ground. Dead wood also includes dead roots and stumps larger than or equal to 10cm in diameter or any other diameter used by the country.
	Litter	Includes all non-living biomass with a diameter less than a minimum diameter chosen by the country (for FSI 5 cm), lying dead, in various states of decomposition above the mineral or organic soil.
Soil	**Soil organic matter**	Includes organic carbon in mineral and organic soils (including peat) to a specific depth chosen by the country (for FSI 30 cm) and applied consistently through the time series.

Source: IPCC (2003)

The carbon stock account based on the amount of carbon stocked in India's forests under different carbon pools in the years 2017 and 2019 is presented in Table 25.Estimates of carbon stock under different carbon pools in the years 2017 and 2019, for the 16 forest type groups in India are presented in Annexure 10.3.6.

Table 25: Carbon stock (in forests) accounts for India (million tonnes of carbon)

	AGB	BGB	Dead wood	Litter	SOC	Total carbon stock
Carbon stock in 2017 (Opening Stock)	2,237.50	698.70	30.10	136.20	3,979.50	**7,082.00**
Carbon stock in 2019 (Closing Stock)	2,256.50	700.80	35.80	127.90	4,003.60	**7,124.60**
Net change in Carbon stock	19.00	2.10	5.70	-8.30	24.10	**42.60**

Total forest carbon stock of the country in the year 2019 has been estimated to be 7,124.6 million tonnes of carbon. There is an increase of 42.6 million tonnes of forest carbon stock as compared to the estimates of previous assessment i.e. 2017. More than 70 per cent of forest cover in India falls in tropical dry deciduous forests (2,158 million tonnes),

tropical moist deciduous forests (1,320 million tonnes) and tropical semi-evergreen forests (719 million tonnes).

The importance of ecosystems in storing and sequestering carbon is increasingly recognised, given the threat of climate change and the rapid human-induced rise in atmospheric CO_2 concentrations (Portela et al., 2008). Two leading open-source, spatially explicit ecosystem services modelling tools have been applied to understand the carbon-related services: Artificial Intelligence for Ecosystem Services (ARIES) and Integrated Valuation of Ecosystem Services and Tradeoffs (InVEST)[15] to determine the spatial distribution of carbon stored in the state of Andhra Pradesh (India) during the year 2015-16. For one of the services i.e. carbon storage, both the modelling systems had modules for the service, and hence, both the systems were tested.

ARIES underlying software, k.LAB, is designed for integrated socioeconomic environmental modelling, which includes ecosystem services. ARIES can accommodate a range of different users and user needs, including scenarios, spatial assessment and economic valuation of ecosystem services, optimisation of payments for ecosystem services programmes and spatial policy planning. Using ARIES currently requires modelling skills and GIS (Villa, F. et al., 2014). The ARIES global vegetation carbon storage model follows the Tier 1 IPCC methodology and quantifies above- and below-ground carbon storage in vegetation in physical units (tonnes/ha), using a lookup table. The model's lookup table uses five datasets as inputs: a) land cover type b) eco-floristic region according to FAO classification c) continental region d) presence of frontier forests (a proxy for the degree of forest degradation); and e) recent occurrence of fires.

The Tier 1 carbon models currently include:

- Global lookup tables for vegetation carbon storage from Ruesch & Gibbs (2008);[16]
- Spatially explicit global soil carbon storage data by ISRIC-World Soil Information.[17]

InVEST, developed by the Natural Capital Project at Stanford University, is a sophisticated GIS-based tool which incorporates models for ecosystem services. Using land classification data and values of carbon pools for each LULC type, the InVEST model was applied to determine the spatial distribution of carbon stored in the state of Andhra Pradesh (India). The InVEST model defines the total ecosystem carbon storage as *"the sum of the carbon mass stored in above ground and belowground vegetation, plus the amount of carbon stored in the first 200cm of soil"*. The analysis was based on NRSC land use/land cover (LULC) dataset for the year 2015-16 and "Tier 1" method to develop InVEST carbon pools table for India at national scale. The values of carbon pools for each LULC type were filled out using the IPCC guidelines from 2006 and available information from Indian publications and reports.

Results of Assessment of carbon stored in Andhra Pradesh (India) using ARIES and InVEST models

Figure 18 shows the amount of carbon stored in the state of Andhra Pradesh based on ARIES and InVEST modelling respectively in the year 2015-16.

15 See: https://naturalcapitalproject.stanford.edu/software/invest

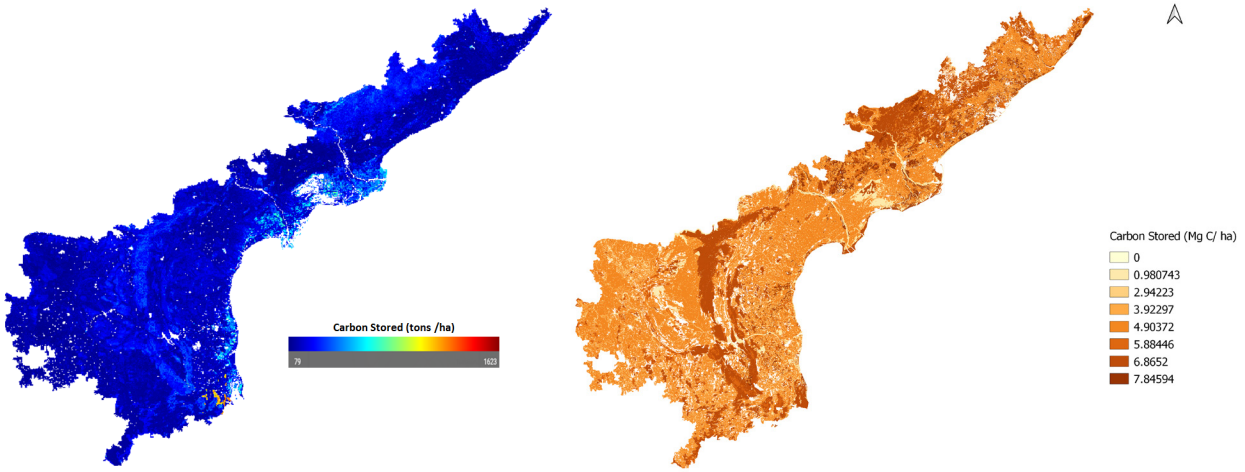
16 See: https://cdiac.ess-dive.lbl.gov/epubs/ndp/global_carbon/carbon_documentation.html

17 See: https://www.isric.org/explore/soilgrids

Figure 18: Maps depicting carbon stored in Andhra Pradesh in 2015-16

Carbon storage based on ARIES model (2015-16)

Carbon storage based on InVEST mode (2015-16)



Source: MoSPI

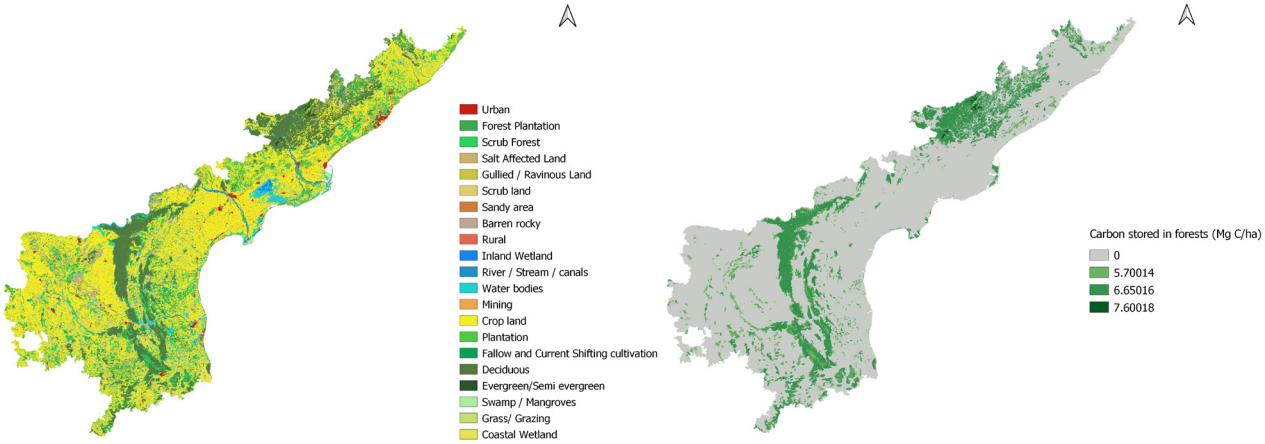
Carbon stored in forests of Andhra Pradesh in 2015-16 based on the InVEST model:

Forest ecosystems are one of the most important carbon sinks of terrestrial ecosystems. An attempt has been made to estimate the carbon stored in the forests of Andhra Pradesh using the InVEST model. Results show that the total carbon stored in Andhra Pradesh is 1225.75 million tonnes of carbon and total carbon stored in forests of Andhra Pradesh is 365.10 million tonnes of carbon in the year 2015-16. This indicates that forests store approximately 30 per cent of the total amount of carbon stored in Andhra Pradesh, while they occupy 22.86 per cent of the extent. In comparison, as per FSI, the total carbon stock of forests in the state is 262.69 million tonnes of carbon in the year 2015-16. The map depicting the carbon stored in forests in Andhra Pradesh based on InVEST is presented in Figure 19 below.

Figure 19: A map depicting carbon stored in forests of Andhra Pradesh in 2015-16

Land Use/Land Cover Map (2015-16)

Carbon stored in forests based on InVEST mode (2015-16)



Source: MoSPI

4.5.2 Valuation approach

Methods and data

With a view to understanding the carbon retention service provided by the forests of India, which also contribute to global climate regulation, estimates for the economic value of carbon retention during the assessment year 2015-16 and 2017-18 were compiled using the social cost of carbon (SCC) approach.

The steps that were followed for estimating the value of carbon retention services are as follows:

i) ***Total Carbon Stock = Above ground biomass + Below ground biomass + Dead wood + Litter + Soil Organic Carbon***

(Estimates of carbon stocks under different carbon pools are taken from the publication 'India State of Forest Report' by the Forest Survey of India.)

ii) ***Carbon stock (CO_2 equivalent) = Carbon content * 3.67***

(Based on default IPCC conventions)[18]

iii) ***Value of carbon stock (CO_2 equivalent) in US$ = carbon dioxide * social cost of tonne of CO_2***

(Using India›s country-level social cost of carbon (CSCC) emission as mentioned in Ricke et al., 2018)

iv) ***Value of carbon stock (CO_2 eq.) in INR = value of carbon stock in US$ * Exchange rate***

(Using the exchange rate of Indian Rupee vis-à-vis the US Dollar (in financial year-annual average.)[19]

v) ***Value of carbon retention service = Value of carbon stock (CO_2 eq.) (as obtained in step iv) * rate of return***

(A %3 rate of return has been assumed, which is equivalent to the discount rate taken for calculating SCC).[20]

The calculation of the state-wise value of the carbon retention service during the year 2015-16 is based on estimates of carbon stock from ISFR 2017, while that for the year 2017-18 is based on ISFR 2019. The corresponding exchange rates were 66 INR per US$ and 65 INR per US$. India›s country-level social cost of a tonne of CO_2 is US$ 86 as per Nature Climate Change article for the year 2017-18. India›s country-level social cost of a tonne of CO_2 for the year 2015-16 has been estimated at US$80 using the GDP deflator.

Results

During the year 2017-18, it was observed that the value of the carbon retention service is INR 438.49 thousand crores. There is an increase in the value as compared to the value obtained for the assessment period 2015-16. The estimated values of the carbon retention service in India during the years 2015-16 and 2017-18 are given in Table 26. The state-wise estimates of the value of the carbon retention service for the year 2015-16 and 2017-18 can be seen in EnviStats India 2020 (MoSPI 2020a).

18 IPCC (2003)

19 Handbook of Statistics on Indian Economy, Reserve Bank of India

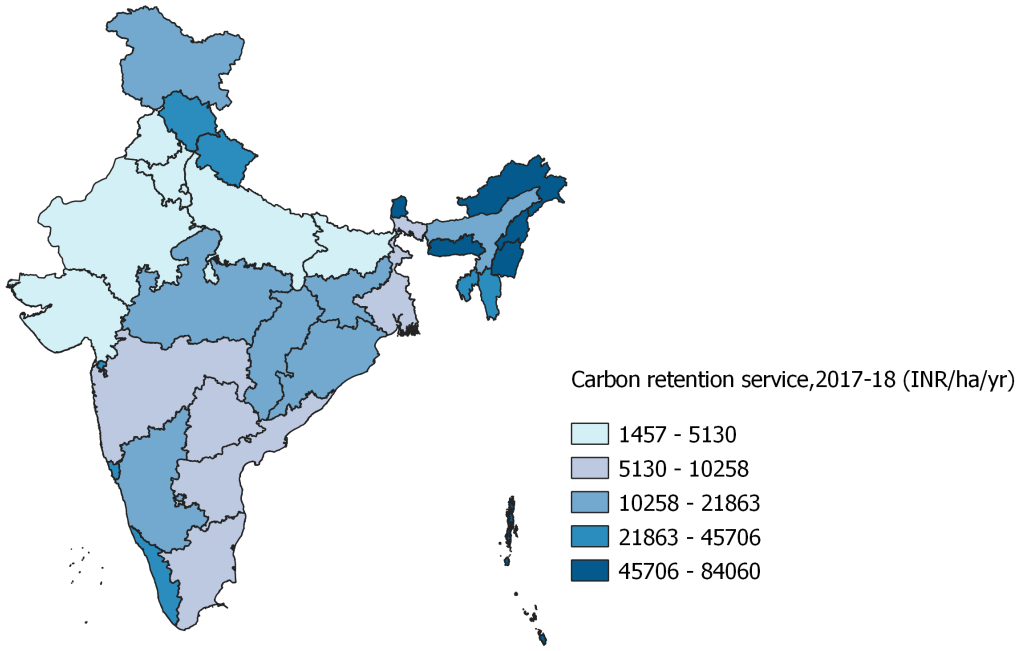
20 Valuing Climate Damages: Updating Estimation of the Social Cost of Carbon Dioxide (2017). See: https://www.nap.edu/read/24651/chapter/9

Table 26: Monetary supply table of carbon retention service, India

Ecosystem Service	Ecosystem Type			
	Croplands	Forests	Other ecosystems	Total
Carbon retention in 2015-16 (INR 000' crores)		411.70		**411.70**
Carbon retention in 2017-18 (INR 000' crores)		438.49		**438.49**

Map depicting economic value of carbon retention service per hectare in India during the year 2017-18 is presented in Figure 20.

Figure 20: Map depicting value of carbon retention service in India, 2017-18



Source: MoSPI

4.6 Nature-Based Tourism

Nature-based tourism is one of India's forte. From its snow-capped mountains to its exquisite backwaters, the country's varied topographical features offer a lifetime's opportunity to not only enjoy its natural splendour but also to indulge in various nature-based or adventure activities such as mountaineering, jungle safaris and fishing. Furthermore, religious tourism, where tourists travel to achieve spiritual fulfilment, usually involves sites that are surrounded by all types of natural features including mountains, hills, forests, groves, rivers, lakes, lagoons, caves, islands and springs. Thus, this type of tourism in India also falls under the gambit of nature-based tourism. This seems to be in line with the fact that most religions have mythology, cosmology, theology or ethics related to earth, nature and land, setting out the relationship to the natural world and the responsibility of human beings towards the planet.

Definition of ecosystem service

The ecosystem service of "nature-based tourism" can be defined as providing opportunities for or enabling nature-related tourism and recreation activities.

4.6.1 Valuation approach

Methods and data

An assessment of the current flow of nature-based tourism services has been made for the States of India, using estimates based on a direct expenditure method, by combining information on average expenditure per person/day on a trip, the duration of stay, number of total visitors, total visitor expenditure (average expenditure per person/day x average length of stay x total visitor numbers) and the attribution factor (expenditure that can be directly attributed to the natural areas). It should be noted that the direct expenditure method provides only a conservative minimum estimate of the total economic contribution of natural areas as it excludes secondary expenditure such as local employment in other sectors and does not include wider values of the benefits obtained from the environment. These benefits, however, could be calculated using the direct expenditure and other relevant indicators through a form of multiplier analysis.

The annual publication, India Tourism Statistics, published by the Ministry of Tourism, Government of India gives the annual number (calendar year-wise) of domestic and foreign travel visits by the state of destination. State-level detailed information on tourism is available in the State Tourism Surveys, which includes information on important tourist destinations and various characteristics of tourists.

MoSPI had conducted two focused household surveys on domestic tourism, one during July 2008 to June 2009 (65th Round) (MoSPI, 2010) and the other during July 2014 to June 2015 (72nd round) (MoSPI, 2017). The surveys provide a detailed insight into several characteristics of domestic tourists - duration of stay, origin and destination, mode of transport, accommodation type, purpose of visit, expenditure on various components of the trip, household income, as well as age and gender of tourists. The survey collected information on both one-day trips and overnight trips.

Since the World Tourism Organization (WTO) (2008) recognises tourism as visits to a recreation site involving at least one overnight stay, only the overnight trips were considered for the purpose of this valuation. An overnight trip is defined in the survey as a movement of not less than two consecutive calendar days and of not more than 6 months, by one or more household members outside their usual environment (which includes the usual place of residence and return to the ***same*** place of residence (a round trip), irrespective of place of stay. The movement should be for any of the following purposes:

- Business;
- Holidaying;
- Leisure and recreation;
- Social;
- Pilgrimage and religion;
- Education and training;
- Health and medical;
- Shopping and;
- Others category (which includes purposes which are not indicated elsewhere).

For compiling the estimates of a nature-based tourism service, only the visits with 'holidaying, leisure and recreation' and 'pilgrimage and religion' as the main purpose of the visit have been considered in this report.

The steps that were followed for estimating the value of nature-based tourism ecosystem services are as follows:

The value of nature-based tourism services has been estimated as the product of:

i) Average expenditure (excluding shopping) incurred per person by tourists who have 'holidaying, leisure and recreation' and 'pilgrimage and religion' as the main purpose of their visit by state of destination as derived from the MoSPI Domestic Tourism Surveys;

ii) The proportion of tourists with 'holidaying, leisure and recreation' and 'pilgrimage and religion' as the main purpose of visit by state of destination as derived from the Domestic Tourism Survey;

iii) Total number of domestic and foreign tourist visits by state of destination as given in the annual publication of the Ministry of Tourism, "Indian Tourism Statistics".[21]

Also to give an idea about the variations across districts, the possibility of using some of the global assessments of this ecosystem service was explored. To quantify the value of the natural environment in tourism, the InVEST recreation model predicts the spread of person-days of recreation, based on the locations of natural habitats and other features that factor into people's decisions about where to recreate. The tool estimates the contribution of each attribute to visitation rate in a simple linear regression. In the absence of empirical data on visitation, the model is parameterised using a proxy for visitation: geotagged photographs posted to the website 'flickr'. Using photo-user-day estimates, the model provides outputs maps showing current patterns of recreational use in absolute terms and as per unit of geographic area. This tool was used to get the district-wise maps for the years 2008-09 and 2014-15.

Results

Estimates of the value of nature-based tourism services have been derived for the years 2008-09 and 2014-15 and are given in Table 27. Since the information in the Indian Tourism Statistics publication is given on a calendar year basis; the average number of visits for the two relevant calendar years has been used for the compilation. State-wise nature-based tourism service estimates can be seen in EnviStats India 2019 (MoSPI 2019).

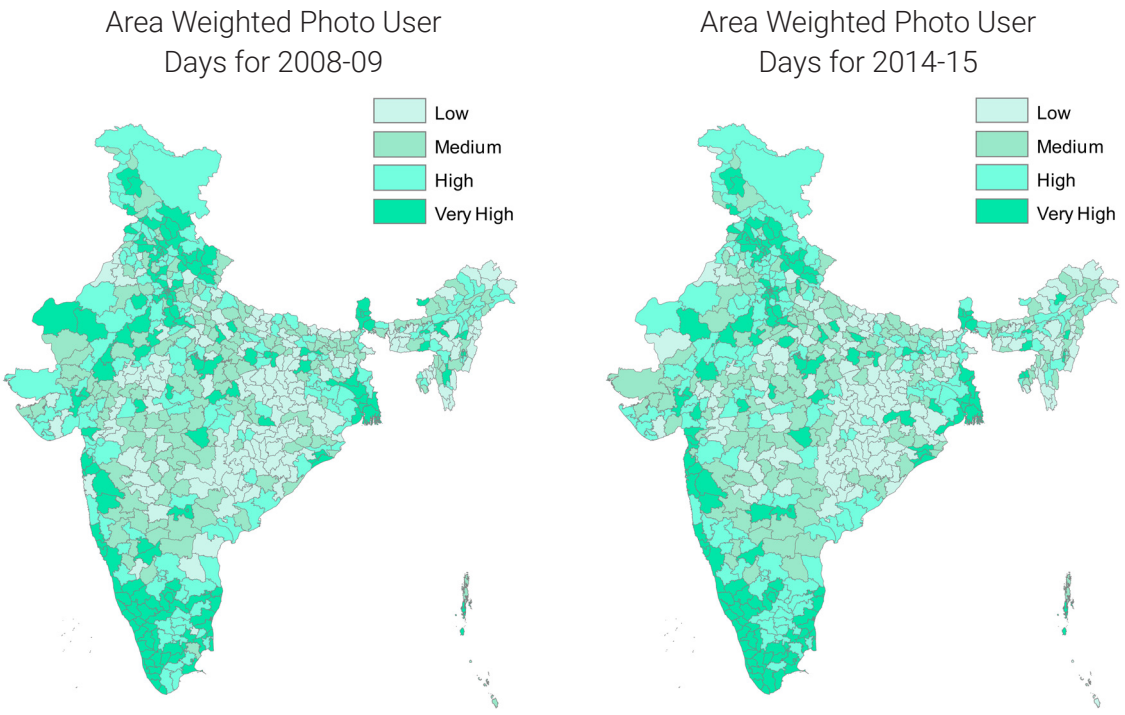
Table 27: Monetary supply table of nature-based tourism ecosystem service, India

	Ecosystem Type			
Ecosystem Service	**Croplands**	**Forests**	**Other ecosystems**	**Total**
Nature-based tourism in 2008-09 (INR 000' crores)				**7.39**
Nature-based tourism in 2014-15 (INR 000' crores)				**18.82**

The district-wise maps depicting value of tourism based on area weighted photo user days for the years 2008-09 and 2014-15 obtained using InVEST model are given in Figure 21.

[21] See: https://tourism.gov.in/market-research-and-statistics

Figure 21: Maps depicting value of tourism based on area weighted photo user days using InVEST model in 2008-09 and 2014-15



Source: MoSPI

4.7 Soil Erosion Prevention

Soil erosion and associated damage to agricultural land over many years have resulted in losses in cropland due to abandonment and reduced productivity of the remaining land. This loss of cropland often results in the creation of new cropland from forests and pastureland and the need to enrich these new croplands with inputs such as nitrogen and phosphate fertilisers. In addition, soil erosion reduces the valuable diversity of plants, animals and soil microorganisms. The main factors influencing the amount of loss due to soil erosion are: soil structure, status of vegetative cover and land topography. An important ecosystem service produced by croplands is the "soil erosion prevention" service, thereby, mitigating several of the negative impacts of soil erosion.

Definition of service

"Soil erosion prevention" can be defined as the difference between the current estimates of loss of soil and the probable loss of soil due to erosion in case the croplands did not exist.

4.7.1 Physical approach

Methods and data

To begin an assessment of the soil erosion prevention services provided by croplands, the first step is to evaluate the erosion that would occur when vegetation is absent and therefore no ecosystem service is provided. The potential soil erosion in a given place and time is related to rainfall erosivity (that is, the erosive potential of rainfall), soil erodibility (as a characteristic of the soil type) and local topography. Although external drivers can have an effect on these variables (for example, climate change), they are less prone to be changed directly by human action. The actual ecosystem service can then be determined by the difference between the potential soil erosion and the impact mitigated by the ecosystem.

Revised Universal Soil Loss Equation (RUSLE)

Owing to the impacts of soil erosion on decline in productivity of arable and non-arable lands, estimation of soil erosion is of utmost importance. Using soil erosion models is seen as a useful first step in identifying the critical areas most vulnerable to soil loss, understanding the spatial distribution of soil loss and studying the drivers and patterns. The empirical soil loss model called the Revised Universal Soil Loss Equation (RUSLE) (Renard, K. G., 1997; Wischmeier, W. H. and Smith, D. D., 1978) designed to predict long-term annual averages of soil loss, has been widely-used and applied around the world due to its relative simplicity and low data requirements compared to more complex soil erosion models (Benavidez, R et al., 2018). It is a multiplicative model that uses information about rainfall, topography, soil, land use and cover, and support practices to estimate terrestrial rill/inter-rill erosion by the equation below:

$$A = R \times K \times LS \times S \times C \times P$$

In the equation given above,

A: Mean annual soil loss (metric tonnes ha^{-1} $year^{-1}$)

R: Rainfall erosivity factor (megajoules millimetre $hectare^{-1}$ $hour^{-1}$ $year^{-1}$)

K: Soil erodibility factor (metric tonnes hectare hour $hectare^{-1}$ $megajoules^{-1}$ $millimetre^{-1}$)

LS: Slope-length factor (unit less)

S: Slope-steepness factor (unit less)

C: Cover and management factor (unit less)

P: Support practice factor (unit less)

Data Processing and Factor Generation

The methodology used in this report is the implementation of the RUSLE equation in a GIS environment for the estimation of different factors and annual soil loss of the croplands in India. To run RUSLE in GIS software (e.g. ArcGIS, QGIS) the raster layers of land structure, land cover, rainfall and soil data are utilized. In this report, some of the global and local datasets have been used to produce soil loss estimates for croplands.

The GeoTIFF rasters of the LS factor and K factor have been prepared with the RUSLE tool in the LUCI for SEEA toolbox[22], which processed these along with the global R factor layer produced by Panagos et al. (2017). LUCI, an acronym for Land Utilisation Capability Indicator, is an ecosystem services modelling tool which illustrates the impacts of land use on various ecosystem services. It runs at fine spatial scales and compares the current services provided by the landscape with estimates of their potential capability. LUCI requires three datasets – Digital Elevation Model (DEM), land cover data and soil data - to run and it can be enhanced with local data. Ecosystem services, like agricultural production, erosion risk and sediment delivery, carbon sequestration, flood mitigation and habitat provision, are included in LUCI tool. For C-factor parameterization, NRSC land cover datasets have been utilized.

Experimental estimates of soil erosion prevention services have been compiled for the years 2005-06, 2011-12 and 2015-16 for the States of India. The summary of datasets used in estimation of soil erosion is in Table 28.

22 Freely accessible through GitHub.

Table 28: A summary of the data sources used for RUSLE

Input	Dataset	Source	Resolution
Digital elevation model	Shuttle Radar Topography Mission 3 Arc-Seconds Global Dataset (SRTM)	NASA	~ 95 metres
Soil data	Harmonised World Soils Database v1.2 (HWSD)	FAO	30 arc-second (~1km at equator)
Rainfall erosivity	Global Rainfall Erosivity Database (GloREDa)	Panagos et al. (2017)	30 arc-second (~1km at equator)
Land cover data	Land Use Land Cover Datasets	NRSC, India	~20-25 metres

In order to make uniform spatial analysis environment, the cell size of the generated raster layer is fixed as ~95m × 95m.

A brief description of each of the factors used in this model for the RUSLE equation is given in the following paragraphs.

Rainfall erosivity factor (R)

The rainfall erosivity factor **(R)** indicates the effect of rainfall intensity on soil erosion. It accounts for the combined effect of rainfall duration, magnitude and intensity (Panagos et al., 2017). For a storm, this is defined as a product of the storm›s total kinetic energy and its maximum 30-min rainfall intensity (Renard, K. G., 1997). In this report, the factor was extracted from the global factor raster layer produced by Panagos et al. (2017) using a relationship between calculated factor, rainfall and other climate covariates.

Soil erodibility factor (K)

The **K** factor represents the influence of different soil properties on the slope's susceptibility to erosion (Renard, K.G., 1997). It is defined as the "mean annual soil loss per unit of rainfall erosivity for a standard condition of bare soil, recently tilled up-and-down slope with no conservation practice" (Morgan, R., 2005). Higher **K**-factor values indicate the soil's higher susceptibility to soil erosion. The soil erodibility factors are estimated using HWSD data and the parameterisation is based on the soil texture class and organic matter content (Stewart, B. et al., 1975).

Slope-length and slope-steepness factor (LS)

The **LS** factor, also referred to as topographic erosivity factor, consists of slope gradient and length of slope which significantly influences the soil erosion. The **LS**-factor dataset was generated using DEM from NASA following the equation that uses slope length steepness only as shown below ((Morgan, R., 2005).

$$\mathbf{LS} = \left(\frac{\mathbf{l}}{22}\right)^{0.5} \times (0.065 + 0.045\mathbf{s} + 0.0065\mathbf{s}^2)$$

Where,
l : Slope length or cell size (m)
s : Slope steepness (%)

This method is widely used, being relatively simple and not computationally expensive and is therefore suitable for very large study areas (e.g. states or countries).

Cover and management factor (C)

The cover and management factor **C** is defined as the ratio of soil loss from a field with a particular cover and management to that of a field under "clean-tilled continuous fallow" (Wischmeier, W. H. and Smith, D. D., 1978). The **C**-factors range between 0 and 1, with areas of tree cover and open water receiving values close to 0 while land classified as bare areas receiving values close to 1. The **C** factor parameterisation requires the extensive knowledge of land cover characteristics of the study area. For this particular study, **C** factor has been fixed as 0.23 drawing from previous

studies in India (Mahapatra, S. K. et al., 2018; Singh, G. et al., 2017; Patil, R. J et al., 2017) that have reported **C**-factor for croplands.

Support practice factor (P)

The support practice factor (**P**-factor) is the soil-loss ratio with a specific support practice to the corresponding soil loss with up and down slope tillage (Renard, K. G.,1997). The values of **P**-factor range from 0 to 1, areas with no conservation practices receive value 1. In many studies, this factor is ignored due the difficulty of accurately mapping support practice factors. In the present report, **P** factor for croplands is taken as 1.

Results

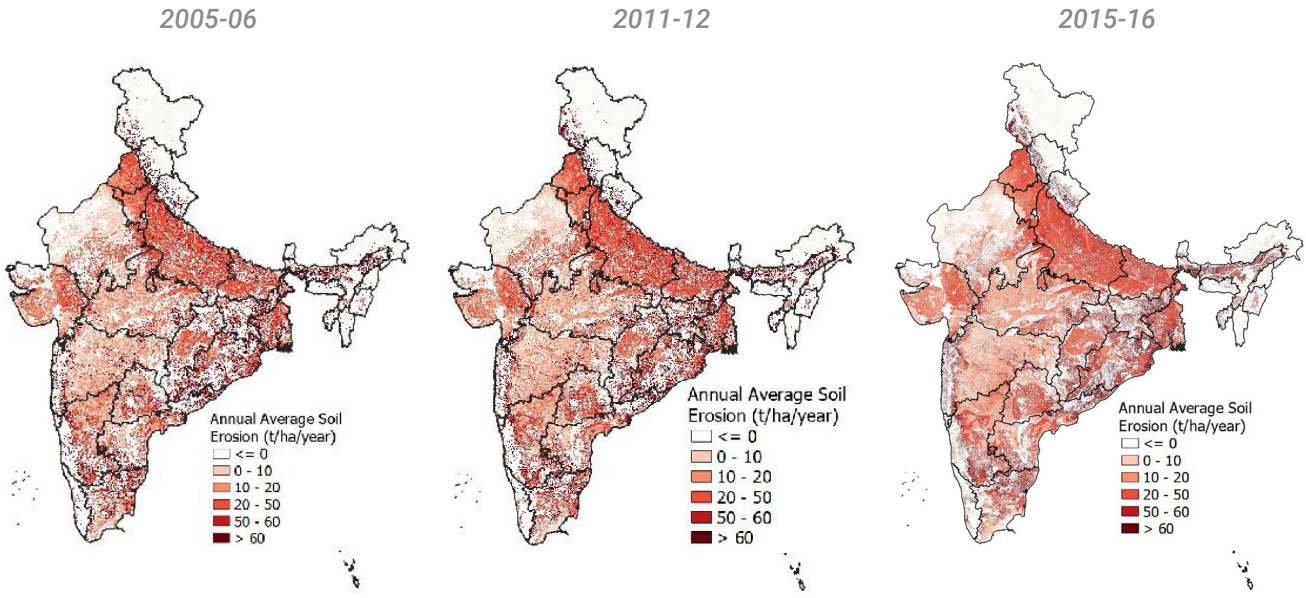
The value of soil erosion prevention services provided by croplands in India is estimated to be 3863.24 million tons in the 2015-16 (Table 29) and state-wise estimates for the years 2005-06, 2011-12 and 2015-16 can be seen in EnviStats India 2020 (MoSPI 2020a). Estimates for the smaller states and Union Territories have not been compiled since the global datasets may not be able to capture enough details for these areas.

Table 29: A physical supply table of soil erosion prevention ecosystem service, India

	Ecosystem Type			
Ecosystem Service	**Croplands**	**Forests**	**Other ecosystems**	**Total**
Soil erosion prevention in 2011-12 (million tonnes)	3,954.01			**3,954.01**
Soil erosion prevention in 2015-16 (million tonnes)	3,863.24			**3,863.24**

Figure 22 shows the spatial and temporal distribution of soil erosion prevention services provided by croplands in India.

Figure 22: Spatial distribution of soil erosion Impact mitigated by croplands, India



Source: MoSPI (2020)

The results show that the amount of soil loss that could be prevented when land cover is comprised of croplands instead of bare soil. The values are observed to be high for hilly states like Uttarakhand, Himachal Pradesh and some of the north-eastern states, which may be attributed to steep slope. The estimates of soil erosion prevention services given here are preliminary and further improvements in parameterisation with expert knowledge and local datasets will enhance these estimates. Also, the future work can involve improving C factor parameterisation for the specific crops and vegetation species present on the agricultural land if such detailed data are available. Another limitation is that this report focuses over mainland India, excluding the Islands due to the coarseness of resolution and difference in the extent of global data for such small areas.

4.8 Integration

The integration of ecosystem accounting information with standard economic data is an important component of work within the context of the SEEA. Table 30 below gives the physical supply account and Table 31 gives the monetary supply table per ecosystem types for India for the services that have been assessed to date. In the future, it will be possible to add more ecosystem services to the table and also construct a time series and further disaggregate the services provided by ecosystem type.

Table 30: Physical supply table of selected ecosystem services per ecosystem type, India

			Ecosystem Type			
Class	**Ecosystem Service**	**Year of assessment**	**Croplands**	**Forests**	**Other ecosystems**	**Total**
Regulating	**Carbon retention** (million tonnes of carbon)	2017-18		7,124		**7,124**
	Soil erosion prevention (million tonnes)	2015-16	3,863			**3,863**

Table 31: Monetary supply table of selected ecosystem services per ecosystem type, India (INR in thousand crores)

			Ecosystem Type			
Class	**Ecosystem Service**	**Year of assessment**	**Croplands**	**Forests**	**Other ecosystems**	**Total**
Provisioning	Crop provisioning	2014-15	147.59			**147.59**
	Timber provisioning	2017-18		16.30		**16.30**
	NTFP provisioning service	2017-18		10.96		**10.96**
Regulating	Carbon retention	2017-18		438.49		**438.49**
Cultural	Nature-based tourism	2014-15	-	-	-	**18.82**

Note: Work is ongoing to spatially allocate nature-based tourism to the ecosystem assets that provide the service.

Section 5:
Thematic Accounts - Biodiversity

5.1 Introduction

The Convention on Biological Diversity (CBD) (1992) defines biodiversity as the "variability among living organisms from all sources including, inter alia, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems". Biological diversity or biodiversity manifests itself at three levels: species diversity which refers to the numbers and kinds of living organisms; genetic diversity which refers to genetic variation within species; and ecosystem diversity which denotes the variety of habitats, biological communities and ecological processes. Biodiversity accounting is one of the main thematic accounting themes in the SEEA EA framework and follows the CBD definition of biodiversity. The SEEA EA addresses two of the three components of biodiversity under the CBD definition of biodiversity - ecosystem diversity and species diversity.

Biodiversity holds both ecological and economic significance. The biodiversity of any given region is not evenly distributed. It varies globally and between and within regions. The various factors that influence biodiversity of a region include temperature, altitude, precipitation, soils and pressures from human activities. Regular monitoring of biodiversity is essential, as it provides a basis for evaluating the integrity of ecosystems, their responses to disturbances and the success of actions taken to conserve or recover biodiversity. Its importance can be assessed by the fact that the UN has designated 2011–2020 as the United Nations Decade on Biodiversity emphasising "living in harmony with nature".

India is one of the recognised mega-diverse countries of the world. Situated at the tri-junction of Afro-tropical, Indo-Malayan and Paleo-Arctic realm, India has a wide array of ecosystems and habitats. The diverse habitats in India are repository of rich biological diversity, providing unparalleled ecological resources. These resources are intricately linked to society through traditional knowledge about medicine and other life support systems. India has only 2.4 per cent of the geographical area of the world, but harbours nearly 7-8 per cent of the recorded species of the world.

This chapter brings together various aspects of India's biodiversity including a set of statistics on flora and fauna in India and biodiversity hotspots, species accounts including a map of species richness, an overview of biodiversity related expenditures and a discussion of the role of SEEA in the post-2020 monitoring framework.

[23] See: https://www.cbd.int/2020-2011/.

5.2 Species Accounts

Nature has endowed India with a wide variety of flora and fauna. The Botanical Survey of India (BSI) and the Zoological Survey of India (ZSI) are the two apex organisations of India that have been actively engaged in the taxonomic study of all major groups of Indian plants and animals, respectively. Every year, these two organisations collate information on the discoveries during the previous year using the research published by scientists on various aspects of taxonomy including species new to science and new records. Table 32 presents India's floral and faunal species status (diversity and endemism) in the year 2019.

Table 32: India's floral and faunal species account (diversity and endemism) – 2019

	No. of species	No. of endemic species	No. of threatened species
FLORA (TOTAL)	**49,441**		
Gymnosperms	82	12	12
Angiosperms	18,666	4,303	416
Bryophytes	2,780	629	7
Pteridophytes	1,302	66	2
Virus & Bacteria	1,223		
Algae	7,411	1,924	
Fungi	15,396	c. 4100	1
Lichens	2,581	c. 520	
FAUNA (TOTAL)	**102,161**	**28,537**	**675**
Protozoans	3,545	640	
Invertebrates	91,800	26,782	135
Chordates	6,816	1,115	540
Of which			
Fish	3,439	482	228
Amphibia	427	287	75
Reptilia	641	220	54
Birds	1,343	81	89
Mammals	429	45	94

Source: Botanical Survey of India (BSI) and Zoological Survey of India (ZSI).
Note: Blank cell doesn't mean 'zero'; it could also mean 'no information'.

Taxonomic diversity of India

The Species Asset Account provides an opening stock and ends with a closing stock for the species. Based on the available data, biodiversity is depicted, showing floral and faunal species number of major taxonomic groups in India. Table 33 outlines the species asset account for India with the opening stock as of the year 2014 and the closing stock as of the year 2019. The fact that all net changes are positive reflects primarily the increasing knowledge of species.

Table 33: Species (faunal + floral) asset account, India

Species asset account (2014 to 2019)					
Taxonomic group			Number of species in India		
			Opening Stock	Closing Stock	Net Change
			Reference year: 2014	Reference year: 2019	
FAUNA	**Protista**		**3,509**	**3,545**	**36**
		Phylum Protozoa	3,509	3,545	36
	Animalia		**93,382**	**98,616**	**5,234**
	INVERTEBRATA	Phylum Mesozoa	10	10	0
		Phylum Porifera	500	550	50
		Phylum Cnidaria	1,052	1,453	401
		Phylum Ctenophora	12	19	7
		Phylum Platyhelminthes	1,653	1,789	136
		Phylum Rotifera	370	467	97
		Phylum Gastrotricha	100	163	63
		Phylum Kinorhyncha	10	10	0
		Phylum Nematoda	2,911	2,984	73
		Phylum Acanthocephala	229	306	77
		Phylum Sipuncula	35	41	6
		Phylum Mollusca	5,178	5,227	49
		Phylum Echiura	43	47	4
		Phylum Annelida	1,002	1,035	33
		Phylum Onychophora	1	1	0
		Phylum Arthropoda	73,439	76,461	3,022
		Phylum Phoronida	3	3	0
		Phylum Bryozoa (Ectoprocta)	200	337	137
		Phylum Entoprocta	10	10	0
		Phylum Brachiopoda	4	8	4
		Phylum Chaetognatha	30	44	14
		Phylum Tardigrada	30	31	1

Species asset account (2014 to 2019)					
Taxonomic group			Number of species in India		
			Opening Stock	Closing Stock	Net Change
			Reference year: 2014	Reference year: 2019	
		Phylum Tardigrada	30	31	1
		Phylum Nemertea		6	6
		Phylum Echinodermata	779	784	5
		Phylum Hemichordata	12	114	2
		Phylum Protochordata	119		
	VERTEBRATA	Phylum Chordata	5,650	6,816	1,166
		Of which			
		Class Pisces	3,092	3,439	347
		Class Amphibia	371	427	56
		Class Reptilia	530	641	111
		Class Aves	1,234	1,343	109
		Class Mammalia	423	429	6
	TOTAL FAUNAL SPECIES		**96,891**	**102,161**	**5,270**
FLORA		Virus/Bacteria	1,071	1,223	152
		Algae	7,309	7,411	102
		Fungi	14,936	15,396	460
		Lichens	2,434	2,581	147
		Bryophytes	2,531	2,780	249
		Pteridophytes	1,274	1,302	28
		Gymnosperms	77	82	5
		Angiosperms	18,159	18,666	507
	TOTAL FLORAL SPECIES		**47,791**	**49,441**	**1,650**
TOTAL (FLORA + FAUNA)			**144,682**	**151,602**	**6,440**

Sources: Botanical Survey of India (BSI) and Zoological Survey of India (ZSI)

Invasive Alien Species

Invasive Alien Species are species whose introduction and/or spread outside their natural past or present distribution threaten biological diversity. Invasive alien species occur in all taxonomic groups, including animals, plants, fungi and microorganisms and can affect all types of ecosystems. As per the latest assessment, there are 168 invasive alien species reported in India, its distribution across ecosystem type is as given in Table 34. Source: National Biodiversity Authority

Table 34: Invasive alien species of India

Category	Number of invasive alien species
Terrestrial plants	54
Aquatic ecosystems	56
Agriculture ecosystems	44
Island ecosystems	14
Total	**168**

Source: National Biodiversity Authority

Key Stone Species – Elephant and Tiger

India has a long-standing and successful track record of protecting its tigers and elephants. Elephants and tigers are the "national heritage" animal of India. For the conservation of key stone species, Project Elephant (initiated in 1991-92) and Project Tiger (initiated in 1973) are being carried out in India. According to all India elephant estimation (2017), the elephant population in the country is estimated to be 29,964. The South Region accounted for 14,612 followed by North East with 10,139 elephants. The state-wise population estimates of elephants in India are given in Table 35.

Table 35: Population estimation of elephants in 2017, India

REGION	STATE	ELEPHANT POPULATION
North-East	Arunachal Pradesh	1,614
	Assam	5,719
	Meghalaya	1,754
	Tripura	102*
	Nagaland	446*
	West Bengal (Northern Region)	488
	Manipur	9
	Mizoram	7
	SUBTOTAL	**10,139**
East Central Region	Odisha	1,976
	Jharkhand	679
	Chhattisgarh	247
	Bihar	25
	Madhya Pradesh	7
	West Bengal (Southern Region)	194
	SUBTOTAL	**3,128**

REGION	STATE	ELEPHANT POPULATION
North Western Region	Uttarakhand	1,839
	Uttar Pradesh	232
	Haryana	7
	Himachal	7
	SUBTOTAL	**2,085**
Southern Region	Karnataka	6,049
	Kerala	5,706*
	Maharashtra	6
	Andhra Pradesh	65
	Andaman & Nicobar Islands	25*
	Tamil Nadu	2,761
	SUBTOTAL	**14,612**

Source: Project Elephant Division, MoEF&CC.
* Results are based on indirect (dung) count method as direct counts could not be carried out as informed by State & UTs like Kerala, Nagaland, Tripura and Andaman & Nicobar Islands.'
# Meghalaya and Uttarakhand had not conducted elephant census in 2012. Therefore, the figure of 2007 has been maintained for 2012 as well.

An estimated 60-70 per cent of the world's wild tigers are found in India, which is the result of India's conservation initiatives. The status of the tiger population and occupancies in landscapes of India are given in Table 36 below.

Table 36: Estimates of tiger population and occupancy in landscapes, India

Landscape	Tiger population 2014	Tiger population 2018	Tiger occupancy 2014	Tiger occupancy 2018
Shivalik	485	646	8,815	8,346
Central India	688	1,033	40,185	47,717
Western Ghats	776	981	27,824	27,297
North East	201	219	9,901	3,312
Sundarban	76	88	1,834	2,313
India	**2,226**	**2,967**	**88,558**	**88,985**

Source: Jhala, Y.V. et.al., (2020)

India's Biodiversity Hotspots

Biodiversity hotspots, as proposed by Norman Mayer in 1988, are the regions characterised by exceptional plant endemism and plagued by serious level of habitat loss. According to Conservation International, who adopted this concept of hotspots for their institutional blueprint in 1989, in order to qualify as a biodiversity hotspot, a region must meet two strict criteria:

a) It must have at least 1500 vascular plants as endemics; and

b) It must have 30 per cent or less of its original natural vegetation. In other words, it must be threatened.

Among the 36 global biodiversity hotspots of the world, four (Himalaya, Indo-Burma, Western Ghats and Sundaland) globally identified biodiversity hotspots are found within India. Encompassing more than 2 million km2 of tropical Asia, Indo-Burma is still revealing its biological treasures. The total protected area in Indo-Burma region is much larger than the remaining vegetation and the area protected in categories I-IV* in Indo-Burma region is 1,32,283 km2 (*Protected area categories, I(a): Strict Nature Reserve, I(b): Wilderness Area, II: National Park, III: Natural Monument or Feature, IV: Habitat/ Species Management Area).

Key statistics of the four biodiversity hotspots in India are given in Table 37 and the species accounts (diversity and endemism) across these four global biodiversity hotspots in India is presented in Table 38.

Table 37: Key statistics of the four biodiversity hotspots in India

	Western Ghats	Sundaland	Indo-Burma Region	The Himalaya
Hotspot original extent (km²)	189,611	1,501,063	2,373,057	741,706
Hotspot vegetation remaining (km²)	43,611	100,571	118,653	185,427
Endemic plant species	3,049	15,000	7,000	3,160
Endemic threatened birds	10	43	18	8
Endemic threatened mammals	14	60	25	4
Endemic threatened amphibians	87	59	35	4
Extinct species†	20	4	1	0
Human population density (people/km²)	261	153	134	123
Area protected (km²)	26,130	179,723	235,758	112,578
Area protected (km²) in categories I-IV*	21,259	77,408	132,283	77,739

†Recorded extinctions since 1500
*Categories I-IV afford higher levels of protection
Source: Website of ENVIS Resource Partner on Biodiversity, BSI, MoEF&CC. See: bsienvis.nic.in

Table 38: Species accounts (diversity and endemism) - global biodiversity hotspots in India

Taxonomic group		Plants	Mammals	Birds	Reptiles	Amphibians	Freshwater fish
Western Ghats	Number of species	5,916	140	458	267	178	191
	Number of endemic species	3,049	18	35	174	130	139
	Endemism (%)	**51.50**	**12.90**	**7.60**	**65.20**	**73.00**	**72.80**
Sundaland	Number of species	25,000	380	769	452	244	950
	Number of endemic species	15,000	172	142	243	196	350
	Endemism (%)	**60.00**	**45.30**	**18.50**	**53.80**	**80.30**	**36.80**
Indo-Burma	Number of species	13,500	433	1,266	522	286	1,262
	Number of endemic species	7,000	73	64	204	154	553
	Endemism (%)	**51.90**	**16.90**	**5.10**	**39.10**	**53.80**	**43.80**
Himalaya	Number of species	10,000	300	977	176	105	269
	Number of endemic species	3,160	12	15	48	42	33
	Endemism (%)	**31.60**	**4.00**	**1.50**	**27.30**	**40.00**	**12.30**

Source: Website of ENVIS Resource Partner on Biodiversity, BSI, MoEF&CC. See: bsienvis.nic.in

Insights into the Red List Species in India

The IUCN Red List of Threatened Species is one of the most well-known objective assessment systems for classifying the status of plants, animals and other organisms threatened with extinction. It contains explicit criteria and categories to classify the conservation status of individual species on the basis of their probability of extinction. It divides species into nine categories: Not Evaluated, Data Deficient, Least Concern, Near Threatened, Vulnerable, Endangered, Critically Endangered, Extinct in the Wild and Extinct. Any species that has been assessed as Critically Endangered, Endangered or Vulnerable are called "threatened species". The IUCN list also includes "Least Concern" Species, which have a lower risk of extinction, but are still important in terms of global biodiversity.

IUCN Red List Spatial Data

The IUCN Red List of Threatened Species contains global assessments for over 120,000 species. The IUCN provides, in the public domain, intercontinental species shape files with the Geographic Coordinate System as *GCS_WGS_1984* and the Unit as Degree *(~100km)*. The IUCN data repository has spatial datasets on mammals, amphibians, birds, reptiles, fishes, plants and other groups. More than 80 per cent of the total red list species (>96,600 species) have spatial data.[25] The data is freely accessible and includes taxonomic information, distribution status, IUCN Red List Category, sources and other relevant details. More information and resources can be found at the IUCN Red List Resources and Publications[26] page. The IUCN spatial datasets can be used to evaluate the species richness of the red list species for any defined region/area. Species richness represents a measure of the variety of species based simply on a count of the number of species in a particular sample and is generally expressed as the number of species per unit area.

In order to facilitate its use, the IUCN Red List Toolbox for ArcMap[27] is available alongside the dataset, which intersects the red list species polygon with a user-specified grid or shape file of polygons, giving the number of species per cell or region polygon. The toolbox also enables preparation of Species Richness Map, which shows the number of IUCN red list species found per pixel having area 0.07 degree^2, or roughly 865 km^2. To understand the distribution of the red listed species in India, an exercise was undertaken using IUCN spatial datasets on mammals, amphibians and reptiles, using the IUCN Red List of Threatened Species, Red List Version 2020-2 downloaded on August 31, 2020. The number of red listed terrestrial species in India under these categories, as available in the IUCN spatial datasets is given in the following Table 39.

25 See: https://www.iucnredlist.org/resources/spatial-data-download

26 See: https://www.iucnredlist.org/resources

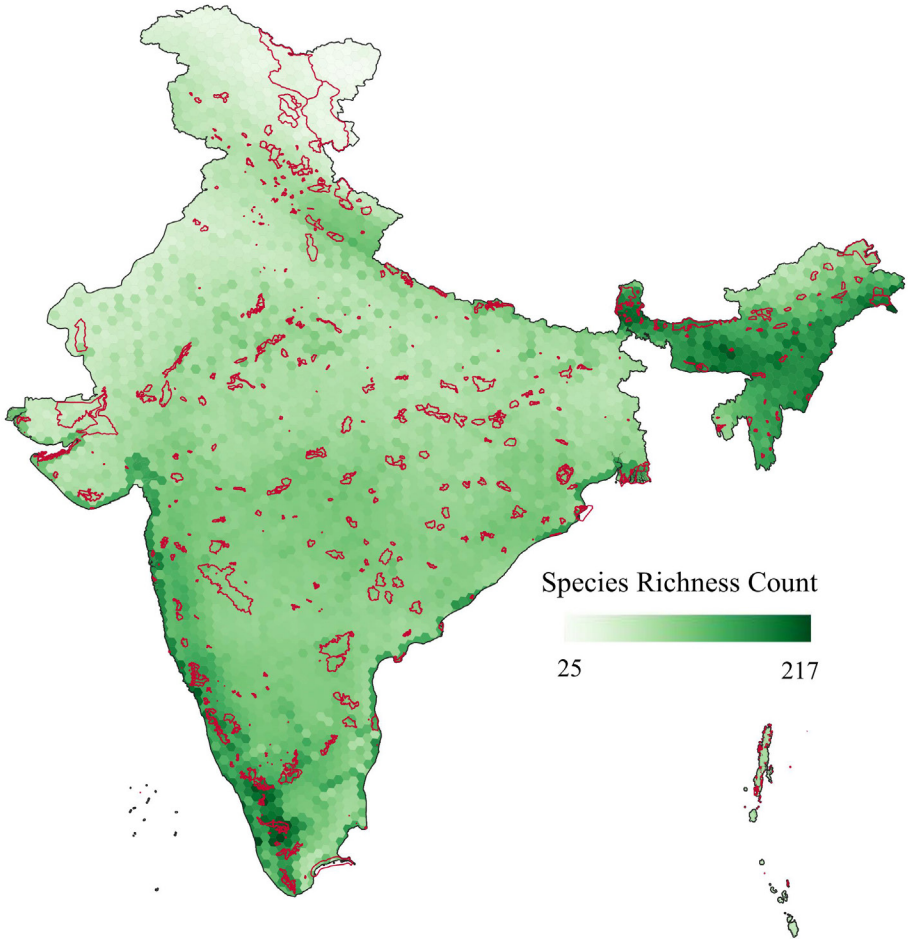
27 See: https://www.iucnredlist.org/resources/spatialtoolsanddata

Table 39: Data availability for India in IUCN Spatial Database as on August 31, 2020

Category	Number of species		
	Mammals	Amphibians	Reptiles
Critically endangered	9	20	10
Endangered	60	36	13
Near threatened	58	13	11
Vulnerable	87	23	23
Least concerned	338	119	199
Data deficient	40	87	66
Grand total	**592**	**298**	**322**

The state level red list species counts, as compiled using the IUCN Red List Toolbox can be seen in EnviStats India 2020 (MoSPI 2020a) and Figure 23 shows the species richness across the country, with the protected areas of India marked on the map.

Figure 23: Species richness map of Red List Species



^ Species includes Mammals, Amphibians, Reptiles; the red polygons indicate the protected areas.
Source: MoSPI, 2020

5.3 Protected Areas

Protected Areas today cover 15.1 per cent of Earth's land surface and 7.9 per cent of the oceans (UNEP-WCMC and IUCN, 2020). In India, the protected areas are declared under the Wildlife (Protection) Act, 1972. The wildlife sanctuaries, biosphere reserves and national parks are designated places for protecting the wild plants, animals and natural habitats. These are established in making efforts to preserve, conserve and manage biodiversity. Presently, there are 18 notified biosphere reserves in India. Amongst the terrestrial protected areas of India, national parks covers 1.23 per cent, wildlife sanctuaries covers 3.64 per cent, community reserves covers 0.02 per cent and conservation reserves cover an area of 0.12 per cent of the total geographical area of the country. Hence, the total terrestrial protected area of India is around 5.02 per cent of the India's total geographical area (as per extent account in chapter 2-table 6). Table 40 shows the status of different categories of protected areas in India.

Table 40: Status of different categories of Protected Areas, India

Categories of Protected Areas		Number	Area (in km²)
Terrestrial Protected Areas	National parks	101	40,564
	Wildlife sanctuaries	553	119,757
	Community reserves	163	833
	Conservation reserves	89	4,128
	Total	**906**	**165,282**
Marine Protected Areas	National parks	13	2,798
	Sanctuaries	116	6,909
	Community/ Conservation reserves	4	272
	Total	**133**	**9,979**

Source: Sivakumar K. (2013)

5.4 Biodiversity Expenditures

In this section, an analysis of India's biodiversity-related expenditure estimates as provided by different sources, is presented. The different sources include: (i) 'Biodiversity Expenditure Review at Central Government Level, India' reported in the Final Report, WII-UNDP Biodiversity Finance Initiative (BIOFIN) Project report (Ansari et.al., 2018); (ii) 'Implementation of India's National Biodiversity Action Plan: An Overview 2019' (MoEF&CC, 2019); and (iii) expenditures estimates according to Classification of the Functions of Government (COFOG) derived from the India's National Accounts Statistics, which are based on the System of National Accounts (SNA) (MoSPI, 2020c).

India has extensive constitutional provisions, laws and policies to promote environmental conservation and sustainable use of natural resources. The first set of the Biodiversity Expenditure Review exercise of the 12th Five Year Plan Period (2012-13 to 2016-17) has estimated the average annual attributable biodiversity expenditure to the tune of INR 20,031.51 crores (USD 2,861.64 million) through an assessment of 116 biodiversity relevant public schemes of 25 ministries in India (Table 41).

Table 41: Average biodiversity expenditure, India

Annual average biodiversity expenditures for the period 2012-13 to 2016-17 in various BIOFIN categories in India (at Central Government level) (INR in crores)	
Access and benefit sharing (ABS) expenditure	233
Natural resource use expenditure	1,961
Protection expenditure	1,102
Restoration expenditure	185
Enhancing implementation expenditure	741
Sectoral mainstreaming expenditure	15,810
Average of attributable expenditure	**20,032**

Source: Ansari N.A. et al. (2018)

The total public finance available for biodiversity relevant programmes consists of biodiversity relevant expenditure of the Central Government and that of all the states put together. Based on scheme-wise analysis of biodiversity, attributable expenditure at the Central and State levels, the year-wise details of total biodiversity attributable expenditure have been worked out for the period 2012-13 to 2016-17. Projections are made for the next five years to provide an estimate of year-wise total biodiversity attributable to public finance likely to be available at the Central and State levels. The national level assessment was projected through extrapolation across all states based on their Gross State Domestic Product (GSDP) estimates. The process also included assessment of biodiversity expenditures under CSR and the Official Development Assistance for the externally aided projects (EAP), other official flows and other flows, such as to NGOs and civil society. Based on the above information, India's domestic biodiversity expenditure covering the period of 2012-13 to 2016-17 was calculated as follows:

India's total domestic biodiversity expenditure = Central government (biodiversity attributable expenditure) + State Governments and UTs (Nominal) + Biodiversity share in corporate social responsibility (CSR) + Expenditure under externally aided projects (grants and loans) (real)

India's domestic biodiversity expenditure covering the period of 2012-13 to 2016-17, as calculated above, is shown in Table 42. It can be seen that the overall total and attributable biodiversity expenditure at Central Government level shows an increasing trend over the period from 2012-13 to 2016-17.

Table 42: India's biodiversity expenditure over the period 2012-13 to 2016-17 (INR in crores)

FINANCIAL YEAR		2012 - 13	2013 - 14	2014 - 15	2015 - 16	2016 - 17
Central Government	Total biodiversity expenditure	89,221	92,480	92,632	12,8891	136,587
	Biodiversity attributable expenditure#	15,195	15,707	16,148	25,390	27,717
State Governments and UTs	Real	28,648	28,160	21,298	23,726	27,040
	Nominal#	30,921	32,275	25,224	28,681	30,142
Corporate social responsibility (CSR)	Potential CSR expenditure	-	15,245	16,412	17,784	18,343
	Biodiversity share in CSR#	-	453	487	528	545
Expenditure under Externally aided projects (grants and loans)	Real#	812	896	875	859	845
	Nominal	1,392	1,642	1,652	1,756	1,831
India's total domestic biodiversity expenditure		**46,928**	**49,331**	**42,734**	**55,458**	**59,249**

Source: MoEF&CC (2019)
Note: # Values counted for computing India's Total Domestic Biodiversity Expenditure

The COFOG classifies government expenditure data from the SNA by the purpose for which the funds are used. In India, aggregated government expenditure on environment protection as per the COFOG is available but further details at disaggregated level (i.e. on second-level COFOG) of waste management, waste water management, pollution abatement, protection of biodiversity & landscape and R&D environmental protection are not available. The estimates of government expenditure on environment protection as per COFOG, as given in India's National Accounts Statistics (MoSPI, 2020c) are as given in Table 43.

Table 43: Expenditures on environment protection as per COFOG, national account statistics, India (INR in crores)

FINANCIAL YEAR	2012 - 13	2013 - 14	2014 - 15	2015 - 16	2016 - 17
Gross Domestic Product (GDP)	9,944,013	11,233,522	12,467,959	13,771,874	15,391,669
Total government expenditure (at current prices)	2,367,444	2,640,163	2,950,715	3,390,734	3,716,655
Total government environment protection expenditure (at current prices)	1,366	2,296	1,656	1,791	1,545

Source: MoSPI, (2020c)

India has done well on raising awareness about biodiversity, which is an important thrust area in several programmes of the Government. By comparing Tables 42 and 43 it can be observed that the estimates of total Government environment protection expenditure as per COFOG, National Accounts Statistics, India are much lower than those reported in the Biodiversity Expenditure Review at Central Government Level, India final report. This is because of a difference in scope. The COFOG is based on the primary purpose criterion, while there are several other expenditures categories in COFOG such as Agriculture expenditure; water related expenditure etc. which are given separately but may have been mapped to the biodiversity related schemes.

5.5 SEEA EA and Post-2020

The Strategic Plan for Biodiversity with 20 global Aichi targets adopted in 2010 has ended in 2020 and all the countries together are in the transitional phase for the start of another new pivotal biodiversity-related decade on ecosystem restoration for the period 2021-2030. The post-2020 global biodiversity framework is likely to build on the Strategic Plan for Biodiversity 2011-2020 to set out a broad-based action for bringing about a transformation in society's relationship with biodiversity and to ensure that, by 2050, the shared vision of living in harmony with nature is fulfilled. SEEA is well positioned to support the post-2020 biodiversity agenda and can provide a consistent monitoring framework that can help make the case for protecting and conserving biodiversity by providing a full picture of its connection to the economy.

Goals and targets cannot be achieved or assessed without information. Indicators are communication tools that summarize data on complex environmental issues and can be used to signal key issues that need to be addressed through policy or management interventions. When used to assess national, regional or global trends, they build a bridge between the different fields of policy-making. Although the indicators cannot cover all aspects of biodiversity, as a suite, they assess key aspects of biodiversity from a number of diverse, complementary angles.

The Biodiversity Indicators Partnership (BIP) is a global initiative to promote and coordinate the development and delivery of biodiversity indicators for use by the CBD and other biodiversity-related conventions, the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES), the SDGs and national and regional agencies. As per the available information about biodiversity indicators for India at BIP dashboard and details about goals/targets included in "Draft monitoring framework for the post-2020 global biodiversity framework for review", cross-mapping of some of the biodiversity indicators to the proposed post-2020 global biodiversity framework goals/targets and possible SEEA account is presented in Table 44 below.

Table 44: Cross-mapping of the indicators (within BIP) to the proposed Post-2020 global biodiversity framework goals/targets and SEEA

BIP indicators	Results - indicator value for India (as per BIP)	Proposed post-2020 global biodiversity framework goals/targets	Relevant SEEA accounts possible
Bioclimatic Ecosystem Resilience Index	The Bioclimatic Ecosystem Resilience Index for India was 0.27 in 2015. During 2005-2015, the index changed at an annual rate of -0.001%.	Target 1	Ecosystem condition accounts
Biodiversity Habitat Index	The Biodiversity Habitat Index for India was 0.471 in 2015. During 2005-2015, the index changed at an annual rate of 0.062%.	Goal A, B and target 1	Biodiversity accounts & ecosystem condition accounts
Biodiversity Intactness Index in tropical and subtropical forest biomes	The Biodiversity Intactness Index in tropical and subtropical forest biomes for India was 0.13 in 2012. During 2001-2012, the index changed at an annual rate of -0.14%.	Goal A	Biodiversity accounts & ecosystem condition accounts
Cumulative human impacts on marine ecosystems	The cumulative human impacts on marine ecosystems (using a full set of 19 input datasets) for India was 4.19 in 2013.	Goal A and target 1	Ecosystem condition accounts
Ecological footprint of consumption	The Ecological Footprint for India was 1,450,832,018 global hectares in 2014.	Target 14,15 (termed as 'ecological footprint')	Pressure Indicators related to Ecosystems
Ecological Footprint of Consumption per Capita	The ecological footprint of consumption per capita for India was 1.1201 global hectares in 2014.		
Ecological footprint (pressure on local bio-capacity)	For the time series (1961-2014) of available data through 2014, the pressure on local bio-capacity changed at an annual rate of 1.276%.		

BIP indicators	Results - indicator value for India (as per BIP)	Proposed post-2020 global biodiversity framework goals/targets	Relevant SEEA accounts possible
Growth in species occurrence records accessible through GBIF	There were 12,161,701 species occurrence records accessible through GBIF for India in 2019.	Target 19	Biodiversity accounts
Local breeds at risk of extinction	As of March 2018, the proportion of local breeds with risk status known for India was 0.004.	Goal A and target 9	Biodiversity accounts
Ocean Health Index	The Ocean Health Index for India was 66.3 in 2016.	Goal A and target 1	Ecosystem condition accounts
Protected Area Connectedness Index	The Protected Area Connectedness Index for India was 0.345 in 2019.	Target 2	Ecosystem condition accounts
Protected area coverage of key biodiversity areas (KBA)	During 1980-2018, the mean percentage of each KBA covered by protected areas changed at an annual rate equivalent to 2.2%.	Goal A and target 2	Ecosystem extent accounts
Protected Area Representativeness Index	The Protected Area Representativeness Index for India was 0.12 in 2016.	Goal A and target 2	Ecosystem condition accounts
Red List Index	India's estimated RLI in the year 2020 is 0.671. During 1993-2020, the Red List Index changed at an annual rate equating to -0.516%.	Goal A and target 1,3	Biodiversity accounts & ecosystem condition accounts

Section 6:
Accounts for Individual Environmental Assets

This section describes accounts for forests and water following the specification of the SEEA-CF.

6.1 Forest

In India, the term 'forest cover' refers to all lands more than one hectare in area with a tree canopy of more than 10 per cent irrespective of land use, ownership and legal status. It may include even orchards, bamboo and palm and is assessed through remote sensing. The Forest Survey of India, under the MOEF&CC, has been bringing out a biennial publication, "India State of Forest Report" (ISFR), since 1987. The report provides state/district-wise forest cover of the country and changes thereon, with respect to the previous assessment and with a specific reference to the forest cover in hill and tribal areas, as also in the north-eastern states. It also provides the estimates of growing stock within and outside the forest areas, carbon stock and tree, bamboo and mangrove cover. In addition, the report includes information on forest fires and on water bodies in the forest.

As per India State of Forest Report 2017, the total forest cover of the country is 708,273 km2, which is 21.54 per cent of the total geographic area of the country. From the distribution of forest cover given in the Table 45, it can be seen that the total forest cover has marginally increased by 0.54 per cent from 2004-05 to 2015-16. This increase is notable since an area of 24187 km2 of forest land had been diverted during the period under the Forest (Conservation) Act 1980 for various developmental works such as road and railway construction, mining activities, power and irrigation projects as also industrial requirements. The state-wise distribution of forest cover of the same period can be seen in EnviStats India 2018 (MoSPI 2018).

Table 45: Forest Cover of India in terms of canopy density cover (km2)

Forest classes	Area (km^2)					
	Assessment period	Assessment period	Assessment period	Assessment period	Assessment period	Assessment period
	(2004-05)	(2008-09)	(2010-11)	(2013-14)	(2015-16)	(2017-18)
	ISFR 2005	ISFR 2011	ISFR 2013	ISFR 2015	ISFR 2017	ISFR 2019
Very dense forest	83,472	83,471	83,502	85,904	98,158	99,278
Moderately dense forest	319,948	320,736	318,745	315,374	308,318	308,472
Open forest	286,751	287,820	295,651	300,395	301,797	304,499
Total	**690,171**	**692,027**	**697,898**	**701,673**	**708,273**	**712,249**
Scrub	41,286	42,176	41,383	41,362	45,979	46,297
Non-forest	2,555,806	2,553,060	2,547,982	2,544,228	2,533,217	2,528,923
Total geographic area	**3,287,263**	**3,287,263**	**3,287,263**	**3,287,263**	**3,287,469**	**3,287,469**

Forest classes	Area (km²)					
	Assessment period	Assessment period	Assessment period	Assessment period	Assessment period	Assessment period
	(2004-05)	(2008-09)	(2010-11)	(2013-14)	(2015-16)	(2017-18)
	ISFR 2005	ISFR 2011	ISFR 2013	ISFR 2015	ISFR 2017	ISFR 2019
Percentage to total geographic area (%)						
Very dense forest	2.54	2.54	2.54	2.61	2.99	3.02
Moderately dense forest	9.73	9.76	9.70	9.59	9.38	9.38
Open forest	8.72	8.76	8.99	9.14	9.18	9.26
Total	**21.00**	**21.05**	**21.23**	**21.35**	**21.54**	**21.67**
Scrub	1.26	1.28	1.26	1.26	1.40	1.41
Non-forest	77.75	77.67	77.51	77.40	77.06	76.93
SDG 15.1.1	***21.00***	***21.05***	***21.23***	***21.35***	***21.54***	***21.67***

The precise information on growing stock, which is a measure of tree wealth and includes distribution of stems in different diameter class, volume, biomass, carbon stock etc. both within and outside forest area, is required for strategic planning of the forestry sector at various levels. Traditionally, the growing stock is considered as an important indicator of forest health and productivity. The growing stock is estimated through forest inventory under which both qualitative and quantitative parameters are recorded. The growing stock at all India level is presented in Table 46 which shows that the total growing stock decreased by 7.22 per cent from 2006-07 to 2010-11 but increased by 2.90 per cent in 2015-16. Similarly, the growing stock within forest decreased by 7.23 per cent from 2006-07 to 2010-11 but later increased by 1.07 per cent in 2015-16. The changes in the growing stocks in the States during 2006-07 to 2015-16 are depicted in the Figure 24.

Table 46: All India growing stock (million cum)

	In Forest	In trees outside forest (TOF)	Total
2006-07 (ISFR 2009)	4,498.66	1,599.57	**6,098.23**
2010-11 (ISFR 2013)	4,173.36	1,484.68	**5,658.05**
2015-16 (ISFR 2017)	4,218.38	1,603.99	**5,822.38**

Figure 24: Change in growing stock from 2006-07 to 2015-16

Increase in Growing Stock

Goa, Jharkhand, Kerala, Madhya Pradesh, Sikkim, Uttar Pradesh

Decrease in Growing stock

Andhra Pradesh, Arunachal Pradesh, Assam, Bihar, Jammu & Kashmir, Maharashtra, Manipur, Meghalaya, Mizoram, Nagaland, Odisha, Tamil Nadu, Tripura, Uttarakhand, West Bengal

Marginal changes in other states

Source: MoSPI (2018)

The parties to the United Nations Framework Convention on Climate Change (UNFCCC) have undertaken a comprehensive exercise to address the issues of climate change adaptation and mitigation, in which forests play an important role. Forests sequester and store more carbon than any other terrestrial ecosystem and are, therefore, an important natural deterrent to climate change. The classification of different carbon pools – AGB, BGB, Dead wood, Litter and Soil Organic Carbon - is described in Table 24. The national level estimates of carbon stocks for 2004-05 and 2015-16 in different pools is given in the Table 47.

Table 47: Carbon Stock in forests between 2004-05 and 2015-16 (million tonnes)

Component	Carbon stock in forests in 2004-05	Carbon stock in forests in 2015-16	Net change in carbon stock
Above ground biomass	2,101	2,238	137
Below ground biomass	663	699	36
Dead wood	25	30	5
Litter	121	136	15
Soil organic carbon	3,753	3,979	226
Total	**6,663**	**7,082**	**419**

There is an increase of 419 million tonnes of the carbon stock in 2015-16 as compared to the estimates of 2004-05, with an average annual increase of the carbon stock of about 34.91 million tonnes. Soil organic carbon is the largest pool of carbon followed by AGB, BGB, litter and dead wood. State-wise estimate of carbon stock for the years 2004-05 and 2015-16 can be seen in EnviStats India 2018 (MoSPI 2018).

6.1.1 Physical Asset Account for Forests

The framework suggested in the SEEA-CF for the preparation of physical asset account for forests requires detailed information on the sources of "addition in stock" and "reduction in stock". In view of the limited availability of such details, an abridged version of the asset account is given in Table 48.

Table 48: Physical asset account for forests (area in km2)

Class	Opening stock in 2004-05	Changes during the period		Closing stock in 2010-11
		Additions to stock	Reductions in stock	
Very dense forest	83,472	984	954	83,502
Moderately dense forest	319,948	11,047	12,250	318,745
Open forest	286,751	24,638	15,737	295,652
Scrub	41,286	2,605	2,508	41,383
Non forest	2,555,806	14,291	22,116	2,547,981
Total	**3,287,263**	**53,565**	**53,565**	**3,287,263**

Class	Opening Stock in 2010-11	Changes during the period		Closing stock in 2015-16
		Additions to stock	Reductions in stock	
Very dense forest	83,502	19,833	5,177	98,158
Moderately dense forest	318,745	26,958	37,385	308,318
Open forest	295,651	51,607	45,461	301,797
Scrub	41,383	18,776	14,180	45,979
Non forest	2,547,982	34,810	49,575	2,533,217
Total	**3,287,263**	**151,984**	**151,778**	**3,287,469**

6.2 Water

Water, the magical substance from which all life springs forth, is essential to the very existence of every life form on earth. The role of water for the living organisms has not changed since life›s first creation billions of years ago. It is, therefore, quite aptly referred to as the «nectar of life». The earth has an abundance of water, but unfortunately, only a small percentage (about 0.3 per cent), is even usable by humans. The other 99.7 per cent is in the oceans, soils, icecaps and floating in the atmosphere. Still, much of the 0.3 per cent that is useable is unattainable. Most of the water used by humans comes from rivers. The visible bodies of water are referred to as surface water. The majority of fresh water is actually found underground as soil moisture and in aquifers. Groundwater can feed the streams, which is why a river can keep flowing even when there has been no precipitation.

6.2.1 Water resources in India

Inland water resources include both fresh and brackish water bodies. While freshwater is naturally occurring water with low concentration of salt, brackish water has a salt concentration varying between that of freshwater and marine water. Inland water resources of the country are categorised as: rivers and canals; reservoirs; tanks, lakes and ponds; lakes and derelict water bodies; and brackish water. In India, rivers and canals run throughout the country with total length amounting to 0.19 million kilometres and the total water bodies other than rivers and canal cover an area of around 7.31 million hectares. The area of water bodies at an all-India level is given in Table 49. State-wise inland water resources are given at Annexure 10.3.7. Uttar Pradesh and Jammu and Kashmir have the longest length of rivers and canals of 28,500 kilometres and 27,781 kilometres respectively. The inland water resources are unevenly distributed across the states, with the expanse ranging from 0.989 million hectares in Odisha and 0.811 million hectares in Andhra Pradesh (including Telangana) to negligible amounts in the smaller States of Mizoram, Sikkim and Puducherry.

Table 49: Inland water resources of India

Rivers & Canals (length in km)		195,095
Other water bodies (area in km²)		
	Reservoirs	29,300
	Tanks & ponds	24,300
	Flood plain lakes & derelict water bodies	8,000
	Brackish water	11,500
	Total	**73,100**

The river basin is the most important unit of analysis for any water-related study. The river basin, also called the catchment area of the river, is the area from which the rain will flow into that particular river. India can be divided into 20 river basins. The Central Water Commission (CWC) has the responsibility of planning, development and management of surface water resources of the country. Table 50 depicts the river-basin wise catchment area, average water resources potential river-basin wise according to the reassessment studies conducted by CWC (CWC, 1999). The total water resource potential, which occurs as a natural runoff in these rivers, is estimated to be about 1869 Billion Cubic Metre (BCM). Water availability is highest in Brahmaputra basin (537.24 BCM) followed by Ganga Basin (525.02 BCM). The data presented in Table 50 has been updated in CWC, 2019.

Table 50: River basin water availability

S. No.	Basin	Catchment area[4] (km²)	Average water resource potential (BCM)	Utilisable surface water resources (BCM)
1	Indus (up to Border)	321,289	73.31	46
2	Ganga- Brahmaputra- Meghna			
	a) Ganga	861,452	525.02	250
	b) Brahmaputra	194,413	537.24	24
	c) Barak & Others	41,723	48.36	
3	Godavari	312,812	110.54	76.3
4	Krishna	258,948	78.12	58
5	Cauvery	81,155	21.36	19
6	Subarnarekha*	29,196	12.37	6.8
7	Brahmani-Baitarani	51,822	28.48	18.3
8	Mahanadi	141,589	66.88	50
9	Pennar	55,213	6.32	6.9
10	Mahi	34,842	11.02	3.1
11	Sabarmati	21,674	3.81	1.9
12	Narmada	98,796	45.64	34.5
13	Tapi	65,145	14.88	14.5
14	West flowing rivers from Tapi to Tadri	55,940	87.41	11.9
15	West flowing rivers from Tadri to Kanyakumari	56,177	113.53	24.3
16	East flowing rivers between Mahanadi and Pennar	86,643	22.52	13.1
17	East flowing rivers between Pennar and Kanyakumari	100,139	16.46	16.5
18	West flowing rivers of Kutch & Saurashtra including Luni	321,851	15.1	15
19	Area of inland drainage in Rajasthan	139,917.04	Negligible	-
20	Minor rivers draining into Myanmar (Burma) and Bangladesh	36,202	31	-
Total			**1,869.37**	**690.1**

Source: CWC (1999)
Note: *: Combining Subarnarekha and other small rivers between Subarnarekha and Baitarani

The Flows and Status: Precipitation and Groundwater Levels

Rainfall in India is dependent on the south-west and north-east monsoons, on shallow cyclonic depressions and disturbances and on violent local storms which forms in regions where cool humid winds from the sea meet hot dry winds from the land and occasionally reach cyclonic dimension. Rainfall is a major source of water in the country with estimated annual precipitation including snowfall of around 4000 BCM.

State-wise annual rainfall for the past five years has been given in table 51. It can be seen that on an average Meghalaya has received the highest rainfall of around 3179.74 mm of annual rainfall over the period of 2012 to 2016 followed by Goa and Andaman & Nicobar Islands.

Table 51: State-wise annual rainfall (all figures in mm)

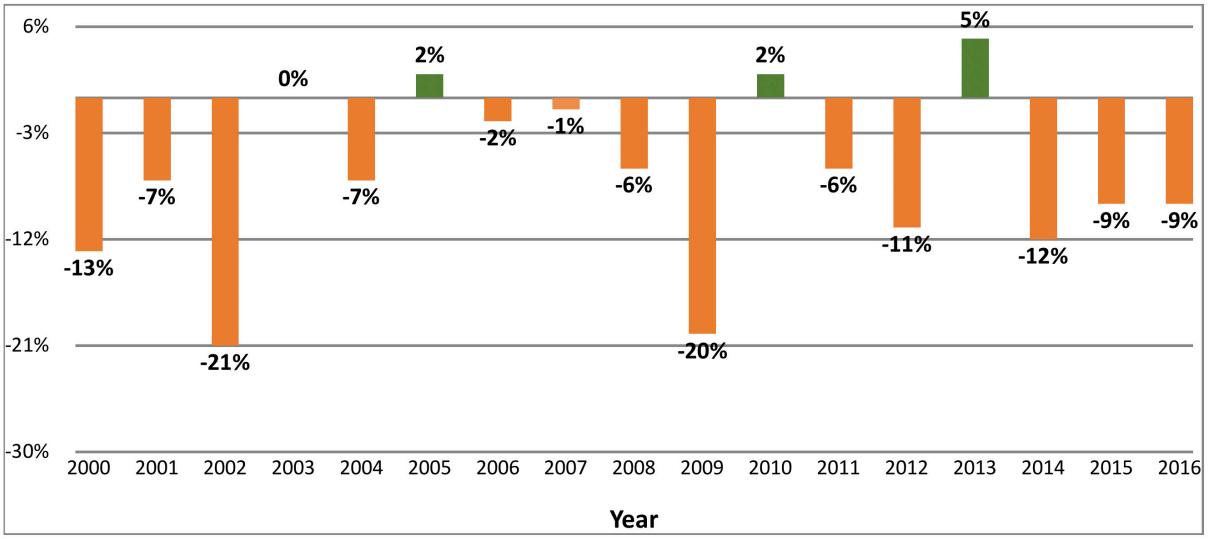
S. No.	States/Union Territories	2012	2013	2014	2015	2016
1	Andhra Pradesh	968.7	1,062.3	687.6	940.7	760.4
2	Arunachal Pradesh	2,760.9	2,042.9	2,403.2	2,593.2	2,706.9
3	Assam	2,193.2	1,797.7	1,899	2,155.3	2,140.5
4	Bihar	924.2	1,069.9	1,061	874	1,158
5	Chhattisgarh	1,366.8	1,418.3	1,274.7	1,136	1,315.8
6	Goa	3,048.9	3,642.6	3,491.2	2,587.1	3,065.1
7	Gujarat	460.6	1,006.5	605.6	584.3	604.9
8	Haryana	307.9	452.2	301.3	426.8	392.9
9	Himachal Pradesh	1,035.1	1,216.9	1,019.9	1,223.2	921.5
10	Jammu & Kashmir	1,116.5	1,193.8	1,278.4	1,572.6	902.8
11	Jharkhand	1,102	1,253.6	1,156.6	1,085.6	1,264
12	Karnataka	956.1	1,235.6	1,238.5	1,024.9	849.9
13	Kerala	2,187.5	3,255.4	3,046.4	2,602.9	1,870.9
14	Madhya Pradesh	1,049.4	1,451.4	891.2	1,000.7	1,203.2
15	Maharashtra	992.4	1,409.8	1,001.6	875.7	1,272.8
16	Manipur	1,647.8	1,428.8	987.5	1,329.1	1,777.4
17	Meghalaya	3,203.6	2,448.4	3,484.4	3,870.8	2,891.5
18	Mizoram	2,142.7	1,848.8	2,029.9	2,310.8	2,233.5
19	Nagaland	1,170	1,350.9	1,333.3	1,308.3	1,364.9
20	Odisha	1,430.2	1,632.4	1,536.9	1,210.1	1,253.5
21	Punjab	338.9	586.6	382.7	512.6	444
22	Rajasthan	485.4	586.6	470.9	543.6	574.4
23	Sikkim	3,006.9	2,567.6	2,627	2,949.1	2,756.6
24	Tamil Nadu	708.3	740.9	911.3	1,201.9	534.6
25	Telangana				747.9	1,043.4
26	Tripura	1,882.2	2,043.5	2,015.7	2,334.4	2,381.9
27	Uttar Pradesh	746.3	995.2	616.4	596.7	801.7
28	Uttarakhand	1,309.7	1,735.4	1,287.4	1,247.6	1,308.6

S. No.	States/Union Territories	2012	2013	2014	2015	2016
28	Uttarakhand	1,309.7	1,735.4	1,287.4	1,247.6	1,308.6
29	West Bengal	1,566	1,939.9	1,483.5	1,717	1,702.6
30	Andaman & Nicobar Islands	3,515.9	3,757.8	2,622.4	2,904.4	2,851.9
31	Chandigarh	879	1,006.1	707	817.1	614.3
32	Dadra & Nagar Haveli	-	-	-	-	-
33	Daman & Diu		911.8	1,821.1	637.1	1,858
34	Delhi	451.9	706.8	416.4	757.7	567.9
35	Lakshadweep	1,433.2	1,426.3	1,395	1,640	1,065.7
36	Puducherry	1,119.6	1,083.2	1,330	1,980.6	655.6

Source: IMD (2016)

Figure 25 shows the departure (%) in annual rainfall from normal rainfall where normal rainfall distribution is based on the rainfall recorded at 2412 locations all over the India during the period from 1951 to 2000. It is observed from Figure 25 that rains have been deficient in most of the years – the only exceptions being 2005, 2010 and 2013.

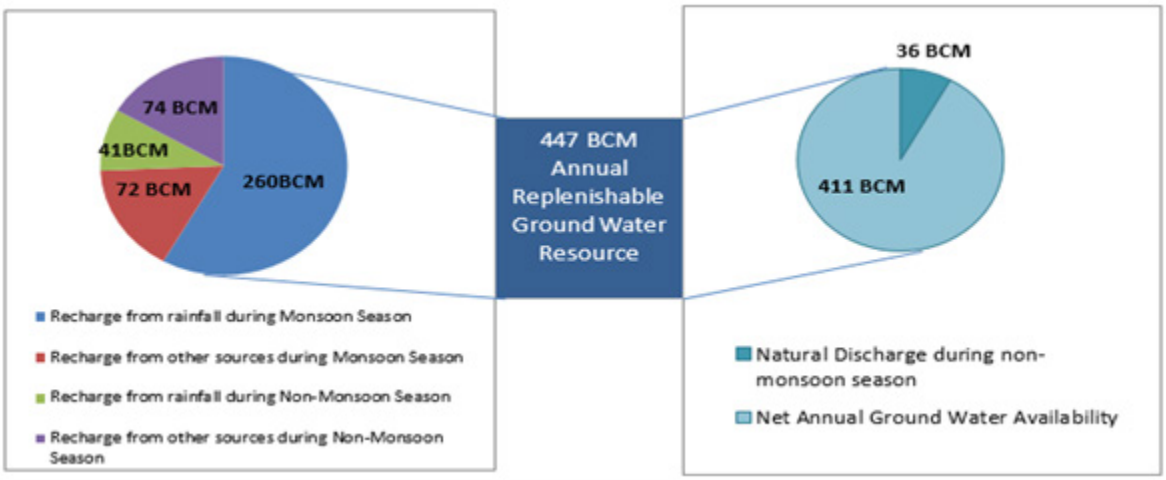
Figure 25: Departures (%) in annual rainfall (2000-2016)



Source: IMD (2016)

This deficiency in rainfall is a cause of concern, since in India, monsoon rain is the major source of ground water recharge, contributing about 67 per cent of the total annual replenishable resource (Figure 26). The Annual Replenishable Ground Water Resources of the area is the sum of recharge during monsoon and non-monsoon seasons and is used majorly for irrigation and domestic uses. Irrigation alone accounts for around 228 BCM usage of ground water whereas industrial and domestic uses in comparison hold a lower usage of around 25 BCM. The amount of usage of ground water highlights its importance as a source of water and indicates the need for proper groundwater management.

Figure 26: Ground water resources availability in India (in BCM)



Source: MoSPI

The assessment of presence of ground water, as well as its potential, is complicated in India based on the occurrence of the diversified geological formations with considerable lithological and chronological variations, complex tectonic framework, climatological dissimilarities and various hydro-chemical conditions.

The Central Ground Water Board (CGWB) has the mandate to make an assessment of groundwater resources. The CGWB undertakes the measurement of groundwater four times a year during January, pre-monsoon, August and post-monsoon through a network of wells drilled throughout the country. The pre-monsoon water level data is collected from all the monitoring stations during the months of March/April/May, depending on the climatological conditions of the region. For north-eastern states, pre-monsoon data is collected during March, since the onset of monsoon is normally observed in April. Similarly, for Odisha, West Bengal and Kerala where monsoon appears early in May the monitoring is carried out during the month of April. For remaining states, pre-monsoon monitoring month is May. Water levels during August are monitored to access the impact of monsoon on the ground water resources. Post monsoon data collected during November reflects the cumulative effect of ground water recharge and withdrawal of ground water for various purposes. January water level data indicates the effect of withdrawal for Rabi crops.[28] It has been estimated by CGWB that as on March 2013, the annual replenishable ground water is around 447 BCM.

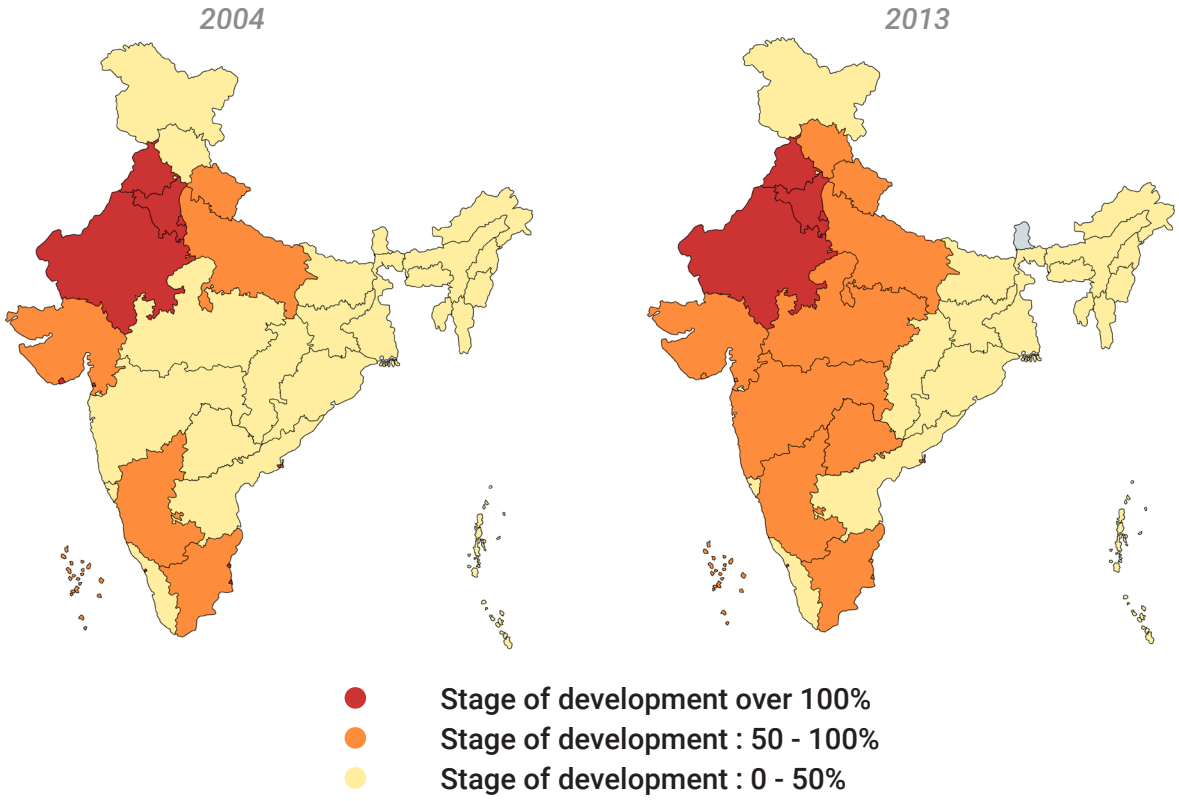
An indicator of the stress on groundwater is the stage of ground water development, which is denoted by the percentage of utilization with respect to recharge and can be computed as:

$$\text{Stage of development} = \frac{Existing\ Gross\ Draft\ For\ All\ Uses}{Net\ Annual\ GroundwaterAvailability} * 100$$

[28] Crops that are grown in the winter season, from November to April are called Rabi Crops. Some of the important rabi crops are wheat, barley, peas, gram and mustard.

The overall stage of ground water development in the country is 62 per cent. The stage of ground water development is very high in the states of Delhi, Haryana, Punjab and Rajasthan, where it is more than 100 per cent, which implies that in these states the annual ground water consumption is more than annual ground water recharge. On comparing the stage of development over the years, it is observed that in some states like Madhya Pradesh, Maharashtra and Himachal Pradesh, the stage of development has improved and shifted to the orange zone depicting the range of 50-100 per cent (Figure 27). The colour code depicts the range of stage of development, yellow is 0-50 per cent, orange is 50-100 per cent and red is over 100 per cent. Uttar Pradesh (17.08 per cent) ranks first among the various states in terms of share of replenishable ground water resources for the year 2013. State-wise ground water availability, utilization and stage of development for 2004, 2009, 2011 and 2013 can be seen in EnviStats India 2018 (MoSPI 2018) (CGWB 2006, 2011, 2014, 2017a).

Figure 27: Changes in the stage of groundwater extraction



Source: MoSPI

In order to allow for focused interventions in areas (referred to as assessment units) where the ground water resources need attention, the CGWB has classified areas into safe, semi-critical, critical and over-exploited ground water resources based on two criteria, namely:

1. Stage of ground water development (percentage of utilization with respect to recharge).
2. Long-term trend of pre and post monsoon water levels.

The long-term ground water trend is computed generally for a period of 10 years and the significant rate of water level decline is taken to be between 10 and 20 cm per year depending upon the local hydrogeological conditions. The criterion for categorisation is given in Table 52.

Table 52: Criteria for categorisation of assessment units

Stage of ground water development	Significant long term water level decline trend		Category
	Pre-monsoon	Post-monsoon	
<=90%	No	No	Safe
>70% and <=100%	No	Yes	Semi-critical
>70% and <=100%	Yes	No	Semi-critical
>90% and <=100%	Yes	Yes	Critical
>100%	No	Yes	Over-exploited
>100%	Yes	No	Over-exploited
>100%	Yes	Yes	Over-exploited

Apart from the above four categories, one more category is used, where the entire assessment area is having poor quality and is demarcated as "saline".

The CGWB has classified the country into these categories; the proportion of safe units in the States are indicated in Table 53 (state-wise details can be seen in EnviStats India 2018 (MoSPI 2018)). It may be noted that the assessment units can be blocks, talukas, watersheds, mandals, island, district or regions and are not uniform across the states.

Table 53: Classification of states by proportion of safe area units

% of units	States
90+	Arunachal Pradesh, Assam, Bihar, Goa, Jammu&Kashmir, Jharkhand, Maharashtra, Manipur, Meghalaya, Mizoram, Nagaland, Odisha, Tripura, Andaman &Nicobar Islands, Chandigarh, Dadra & Nagar Haveli
75-90	Chhattisgarh, Gujarat, Himachal Pradesh, Kerala, Uttarakhand
40-75	Andhra Pradesh, Karnataka, Madhya Pradesh, Telangana, Uttar Pradesh, West Bengal, Daman & Diu, Lakshadweep, Puducherry
20-40	Haryana, Tamil Nadu
5-20	Delhi, Rajasthan, Punjab

Section 7:
Indicators and Analysis - SDG Indicators

7.1 Introduction

Owing to their integrated nature, ecosystem accounts that are formed under the ambit of the SEEA framework, whether they are extent accounts, condition accounts or ecosystem service accounts, provide an underpinning that informs the 2030 Agenda for Sustainable Development. Among them, the ecosystem extent account is an essential determinant for several SDG indicators, as it is comparatively easy to assess and it provides a good indicator for broader sustainable development concerns. For example, the extent of freshwater ecosystems is a good proxy for water provisioning services. Forest extent is a good proxy for conservation of forest biodiversity and the delivery of forest ecosystem services.

There are numerous advantages in using the SEEA for calculating SDG target indicators, as well as other global and national indicators. The framework provides consistent use of definitions and concepts although its flexible and adapts easily to different contexts. Also, it acknowledges harmonisation of environmental data from multiple sources and brings coherence and consistency across disparate statistics. It also establishes a centralised system for organizing information on the environment and the economy, thereby decreasing the likelihood of repetition of data-collecting activities across different government agencies and can help streamline reporting across multiple national reporting commitments. It also ensures that it initiates the discussions across different agencies and sectors and facilitates the trade-offs and synergies related to environmental management decisions to be more readily revealed. In a nutshell, SEEA ensures that indicators are:

- **Consistent –** Internally and with supporting accounts and basic statistics;
- **Coherent –** Allowing integration of environmental data with other statistics;
- **Comprehensive –** Allowing a comprehensive assessment of environmental assets.

The UN Statistical Commission has recognised the SEEA as a useful framework for measuring the SDGs related to environment-economy nexus. As part of the NCAVES work stream[29] the set of global SDG indicators were reviewed and an effort was made to identify those indicators that could in part (e.g. ratio indicators) or completely be generated by the SEEA framework (e.g. SDG Indicator 15.1.1 forest area as a proportion of total land area), or that could provide input data to the SEEA framework (e.g. SDG Indicator 14.3.1 on marine acidity for ecosystem condition accounting). Each indicator was assigned a 'Full', 'Partial', or 'None' possibility for

[29] UN (2019c). See: https://seea.un.org/sites/seea.un.org/files/seea_global_indicator_review_methodological_note_post_workshop_0.pdf

alignment with the selected SEEA accounting modules where:

Full:
Where the SEEA has obvious potential to provide all, or most, of the information that is required to calculate the indicator or when the indicator clearly represents an input data for an accounting item of interest (e.g. an indicator of condition that could be directly integrated into an ecosystem condition account). This represents a conceptual alignment based on the structure of the SEEA framework.

Partial:
Where the SEEA could organise some of the information for calculating the indicator but:

- There were more efficient /accepted means already in place;
- The indicator was derived from a statistical procedure to deal with missing data gaps (e.g. Living Planet Index); or
- The SEEA provides information that is essential or highly suited for calculating the indicator, but substantial additional information from non-SEEA sources is also required.

None:

- Where the identified accounts were not considered relevant to the issue the indicator is designed to inform on.

A similar exercise was also undertaken for mapping the SEEA framework to India's SDG National Indicator Framework that is depicted in Table 54. Out of the 43 SDG Indicators that were found to be aligned with SEEA, 39 indicators are fully aligned with SEEA in comparison to 4 indicators which are partially aligned.

Table 54: Mapping of National Indicator Framework to SEEA

Target	Indicator Id	National indicator	Relevant account	CF/EA	Possibilities of alignment (Full/ Partial)
6.3: By 2030, improve water quality by reducing pollution, eliminating dumping and minimising release of hazardous chemicals and materials, halving the proportion of untreated wastewater and substantially increasing recycling and safe reuse globally.	**6.3.1**	Percentage of sewage treated before discharge into surface water bodies	Physical flow accounts for waste	CF-waste	Full
	6.3.2	Percentage of industries (17 category of highly polluting industries/grossly polluting industry/red category of industries) complying with waste water treatment as per CPCB norms	Residuals	CF-residuals	Full
	6.3.3	Proportion of waste water treatment capacity created vis-à-vis total generation	Residuals	CF-residuals	Full
8.4: Improve progressively, through 2030, global resource efficiency in consumption and production and endeavour to decouple economic growth from environmental degradation, in accordance with the 10year framework of programmes on sustainable consumption and production, with developed countries taking the lead.	**8.4.3**	Proportion of waste recycled vs. waste generated	Physical flow accounts for waste	CF-residuals	Full
9.4: By 2030, upgrade infrastructure and retrofit industries to make them sustainable, with increased resource-use efficiency and greater adoption of clean and environmentally sound technologies and industrial processes, with all countries taking action in accordance with their respective capabilities.	**9.4.1**	CO2 emissions of power sector per unit of GDP	Physical flow accounts for energy	CF-energy	Full
11.6: By 2030, reduce the adverse per capita environmental impact of cities, including by paying special attention to air quality and municipal and other waste management.	**11.6.2**	Annual mean levels of fine particulate matter (e.g. PM2.5 and PM10) in cities (population weighted)	SEEA (air emission/ residual) accounts	CF-residuals	Full
	11.6.3	Number of days the levels of fine particulate matter (PM 2.5 and PM 10) above mean level	SEEA (air emission/ residual) accounts	CF-residuals	Partial
12.2: By 2030, achieve the sustainable management and efficient use of natural resources.	**12.2.1**	Percentage variation in per capita use of natural resources	Material flow accounts	CF-MFA	Full
	13.2.1	Pre 2020 action achievements of pre 2020 Goals as per country priority Percentage reduction in emission intensity of GDP, over 2005 level	Emission accounts	CF-residuals	Partial

Target	Indicator Id	National indicator	Relevant account	CF/EA	Possibilities of alignment (Full/ Partial)
13.2: Integrate climate change measures into national policies, strategies and planning.	**13.2.2**	Achievement of Nationally Determined Contribution(NDC) Goals in post 2020 period • To reduce the emissions intensity of its GDP by 33 to 35% by 2030 from 2005 level- emission accounts • To create an additional carbon sink of 2.5 to 3 billion tonnes of CO2 equivalent through additional forest and tree cover by 2030- forest accounts • To achieve about 40% cumulative electric power installed capacity from non-fossil fuel based energy resources by 2030 with the help of transfer of technology and low cost international finance including from Green Climate Fund (GCF)- energy accounts	Emission accounts/ forest accounts/ energy accounts	CF & EA	Partial
14.2: By 2020, sustainably manage and protect marine and coastal ecosystems to avoid significant adverse impacts, including by strengthening their resilience, and take action for their restoration in order to achieve healthy and productive oceans.	**14.2.1**	Percentage change in area under mangroves	SEEA extent account for forests	EA	Full
	14.2.3	Percentage change in marine protected areas (MPA)	Protected area accounts	EA	Full
14.5: By 2020, conserve at least 10 per cent of coastal and marine areas, consistent with national and international law and based on the best available scientific information.	**14.5.1**	Coverage of protected areas in relation to marine areas	Protected area accounts	EA	Full
	14.5.2	Percentage change in area under mangroves	SEEA extent account for forests	EA	Full
15.1: By 2020, ensure the conservation, restoration and sustainable use of terrestrial and inland freshwater ecosystems and their services, in particular forests, wetlands, mountains and dry lands, in line with obligations under international agreement.	**15.1.1**	Forest cover as a proportion of total geographic area	SEEA-CF land and SEEA-EEA extent accounts	EA	Full
	15.1.2	Protected areas as proportion of total land area	Protected area accounts	EA	Full
15.2: By 2020, promote the implementation of sustainable management of all types of forests, halt deforestation, restore degraded forests and substantially increase afforestation and reforestation globally.	**15.2.1**	Percentage change in forest cover	SEEA-CF land and SEEA-EEA extent accounts	EA	Full
	15.2.3	Tree cover as a percentage of total geographical area	SEEA-CF land and SEEA-EEA condition accounts	EA	Full
15.4: By 2030, ensure the conservation of mountain ecosystems, including their biodiversity, in order to enhance their capacity to provide benefits that are essential for sustainable development.	**15.4.1**	Percentage change in forest cover in hill districts	SEEA-CF land and SEEA-EA extent accounts	EA	Full
			Thematic biodiversity accounts may help in developing new indicators	EA	Partial
15.5: Take urgent and significant action to reduce the degradation of natural habitats, halt the loss of biodiversity and, by 2020, protect and prevent the extinction of threatened species.	**15.5.1**	Red List Index	Biodiversity accounts	EA	Full
15.8: By 2020, introduce measures to prevent the introduction and significantly reduce the impact of invasive alien species on land and water ecosystems and control or eradicate the priority species.	**15.8.1**	Percentage change in prevention and control of invasive alien species	Biodiversity accounts	EA	Full
15.9: By 2020, integrate ecosystem and biodiversity values into national and local planning, development processes, poverty reduction strategies and accounts.	**15.9.1**	15.9.1 (a) Progress towards national targets established in accordance with Aichi Biodiversity Target 2 of the Strategic Plan for Biodiversity 2011-2020. (b) Integration of biodiversity into national accounting and reporting systems, defined as implementation of the System of Environmental-Economic Accounting	SEEA-EA accounts	EA	Full
6.4: By 2030, substantially increase water-use efficiency across all sectors and ensure sustainable withdrawals and supply of freshwater to address water scarcity and substantially reduce the number of people suffering from water scarcity.	**6.4.1**	Percentage ground water withdrawal against availability	SEEA-water accounts	CF-water	Full
	6.4.2	Per capita storage of water (in m3/person)	SEEA-water accounts	CF-water	Full
	6.4.3	Per capita availability of water 2011 (in m3/person)	SEEA-water accounts	CF-water	Full
6.6: By 2020, protect and restore water-related ecosystems, including mountains, forests, wetlands, rivers, aquifers and lakes.	**6.6.2**	Percentage sewage load treated in major rivers	Residuals	CF-waste	Full
	6.6.3	Biological assessment information of surface water bodies	SEEA-water accounts	CF-water	Full
7.2: By 2030, increase substantially the share of renewable energy in the global energy mix.	**7.2.1**	Renewable energy share in the total installed electricity generation	SEEA-energy	CF-energy	Full
7.3 By 2030, double the global rate of improvement in energy efficiency.	**7.3.1**	Energy intensity measured in terms of primary energy and GDP (in mega joules per rupee)	SEEA-energy	CF-energy	Full

Target	Indicator Id	National indicator	Relevant account	CF/EA	Possibilities of alignment (Full/ Partial)
9.4: By 2030, upgrade infrastructure and retrofit industries to make them sustainable, with increased resource-use efficiency and greater adoption of clean and environmentally sound technologies and industrial processes, with all countries taking action in accordance with their respective capabilities.	**9.4.1**	CO2 emissions of power sector per unit of GDP	SEEA-emissions	CF-energy/ emissions	Full
	9.4.2	Energy use intensity of manufacturing value added	SEEA-energy	CF-energy	Full
12.5: By 2030, substantially reduce waste generation through prevention, reduction, recycling and reuse.	**12.5.1**	Number of waste recycling plants installed	SEEA-waste	CF-waste	Full
	12.5.2	Number of municipal corporations using waste segregation techniques	SEEA-waste	CF-waste	Full
	12.5.3	Number of municipal corporations banning single use plastic	SEEA-waste	CF-waste	Full
14.1: By 2025, prevent and significantly reduce marine pollution of all kinds, in particular from land-based activities, including marine debris and nutrient pollution.	**14.1.1**	Coastal Water Quality Index	Marine accounts	CF/EA - marine	Full
14.3: Minimise and address the impacts of ocean acidification, including through enhanced scientific cooperation at all levels.	**14.3.1**	Average marine acidity (pH) measured at agreed site of representative sampling stations	Marine Accounts	CF/EA - marine	Full
15.b: Mobilise significant resources from all sources and at all levels to finance sustainable forest management and provide adequate incentives to developing countries to advance such management, including for conservation and reforestation.	**15.b.1**	Percentage of government spending on environmental protection to total government expenditure	Environment Expenditure Accounts	CF-EPEA	Full
8.4: Improve progressively, through 2030, global resource efficiency in consumption and production and Endeavour to decouple economic growth from environmental degradation, in accordance with the 10-year framework of programmes on sustainable consumption and production, with developed countries taking the lead.	**8.4.2**	Per capita fossil fuel consumption, (in Kg)	SEEA-energy	CF-energy	Full

Assessing SDG global indicators using SEEA

Several SDG indicators are dependent upon the ecosystem account, whether being ecosystem extent or condition or services accounts or thematic accounts. To assess the linkages, some of the SDG global indicators had been identified for testing their calculation using the SEEA. These indicators draw complete (or substantial) information from the SEEA EA ecosystem extent accounts, given their relevance. They comprise of the following indicators:

- **SDG Indicator 15.1.1 -** Forest area as a proportion of total land area.
- **SDG Indicator 6.6.1 -** Change in the extent of water-related ecosystems over time.
- **SDG Indicator 15.3.1 -** Proportion of land that is degraded over total land area.
- **SDG Indicator 11.3.1 -** Ratio of land consumption rate to population growth rate.

The results of each of these indicators are given in the next section.

7.2 Results

7.2.1 SDG Indicator 15.1.1 – Forest area as a proportion of total land area.

SDG indicator 15.1.1 aligns with the SEEA extent account and can be calculated using the SEEA. Here, SDG 15.1.1 has been calculated using data from the India State of Forest Report (ISFR) by the Forest Survey of India (FSI), which is available with a periodicity of two years. The forest area, referred to as forest cover in ISFR, has been used for the calculation of SDG indicator 15.1.1. The indicator is expressed as percentage and is calculated using the following equation using the extent account (given in Table 45 and Table 55):

$$SDG\ 15.1.1 = \frac{\text{Forest area (reference year)}}{\text{Geographical area of the country}} * 100$$

Table 55: Calculating SDG 15.1.1

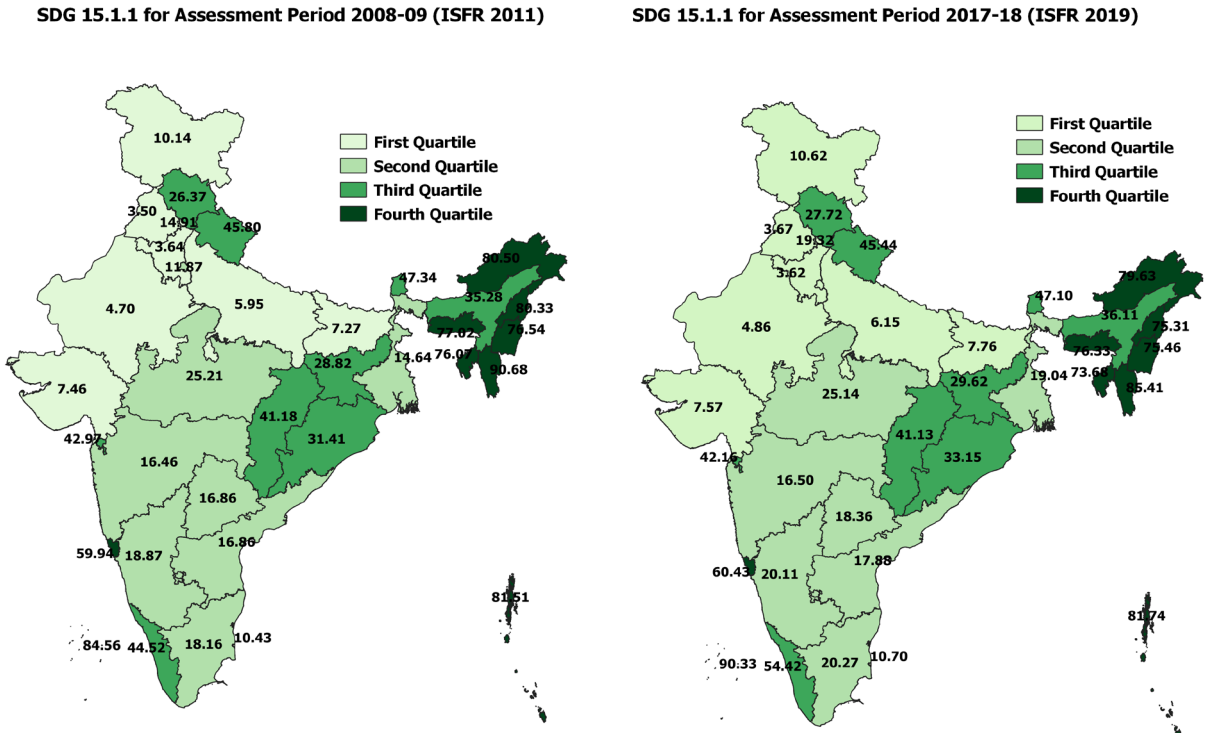
	Very dense forest	Moderately dense forest	Open forest	Total	Scrub	Non-forest	Total geographic area	SDG 15.1.1
Opening stock (2008-09, km²)	83,471	320,736	287,820	692,027	42,176	2,553,060	**3,287,263**	***21.05***
Net change in the stock	15,807	-12,264	16,679	20,222	4,121	-24,137	**206**	
Closing stock (2017-18, km²)	99,278	308,472	304,499	712,249	46,297	2,528,923	**3,287,469**	***21.67***

* White Indicates data relevant to forest area of SDG indicator 15.1.1
^ Light blue indicates the type that do not contribute to SDG 15.1.1

Table 45 provides the SDG indicator for 15.1.1 for 2005-06 and from 2008-09 to 2017-18 biennially as the FSI presents its forest resource assessment at national level biennially by publishing the ISFR. And Table 55 represents the data in the form similar to extent accounts in order to depict the alignment of SEEA extent account with the SDG indicator 15.1.1. The value of indicator has increased from 21.05 per cent in 2008-09 to 21.67 per cent in 2017-18 depicting an overall increase in forest cover in India.

Annexure 10.3.8 show the state-wise SDG indicator 15.1.1 for 2008-09 and 2017-18, maps for the same are presented in below in Figure 28.

Figure 28: State-wise SDG 15.1.1 for assessment period 2008-09 and 2017-18



Source: MoSPI

7.2.2 SDG Indicator 6.6.1 – Change in the extent of water-related ecosystems over time

SDG 6.6.1 is envisaged to cover beyond spatial extent to also include the quality and the quantity of water-related ecosystems. This approach aligns well with the measurement of the 'stocks' of ecosystem assets in the SEEA-EA, in terms of their extent and condition. The indicator is defined in terms of the change in extent over time, within a water-related ecosystem, measured against a point of reference. This is calculated as the sum of changes in the spatial extent of each water-related ecosystem type[30] i (i =1 to n) over a period t_0 to t_1, divided by the total spatial extent of all water -related ecosystem types at the start of that period (i.e., at t_0). This is set out in the equation below, where the result is multiplied by 100 to express the change as a percentage:

$$SDG\ 6.6.1 = \left(\frac{\sum_{i=1}^{n} \left(Spatial\ Extent_{it0} - Spatial\ Extent_{it1} \right)}{\sum_{i=1}^{n} Spatial\ Extent_{it0}} \right) * 100$$

As described in Chapter 2, land-use and land-cover (LULC) statistics are maintained by the NRSC. As per the classification adopted by the NRSC, the LULC class, "Wetland/Water Bodies", consists of "All submerged or water-saturated lands, natural or man-made, inland or coastal, permanent or temporary, static or dynamic, vegetated or non-vegetated, which necessarily have a land-water interface". This class can be further classified as:

1. **Inland wetland:** Includes ox-bow lakes, cut-off meanders, playas, marsh, etc. which are seasonal as well as permanent in nature, and manmade wetlands like waterlogged areas (seasonal and perennial).
2. **Coastal wetland:** Includes estuaries, lagoons, creek, backwater, bay, tidal flat/mud flat, sand/beach, rocky coast, mangrove, salt marsh/marsh vegetation and other hydrophytic vegetation and saltpans.
3. **River /stream/canals:** Rivers/streams refer to the natural course of water flowing on the land surface along a definite channel/ slope regularly or intermittently towards a sea in most cases or in to a lake or an inland basin in desert areas or a marsh or another river. Canals are artificial watercourse constructed for irrigation, navigation or to drain out excess water from agricultural lands.
4. **Water bodies:** Comprises areas with surface water in the form of ponds, lakes, tanks and reservoirs.

Based on the change matrices by the NRSC, the account for water related ecosystems has been provided in Table 56. State-wise details are given in Annexure 10.3.9 and Figure 29.

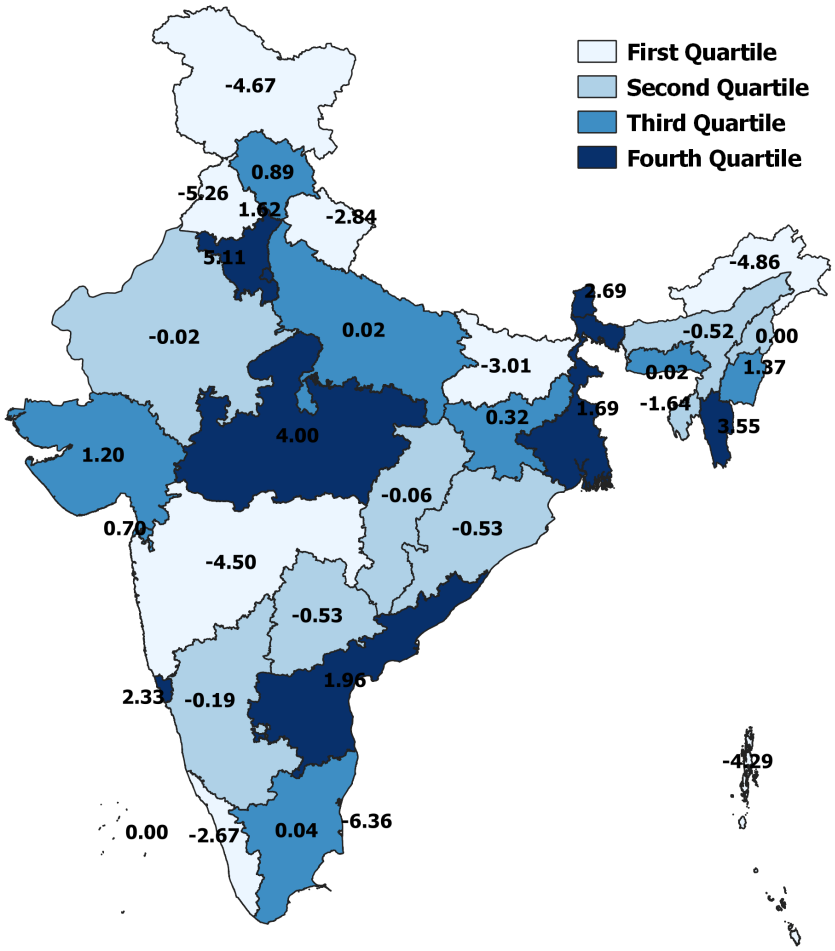
[30] According to its meta-data, the indicator includes five categories: 1) vegetated wetlands, 2) rivers and estuaries, 3) lakes, 4) aquifers, and 5) artificial waterbodies, see: https://unstats.un.org/sdgs/metadata/?Text=&Goal=6&Target=6.6

Table 56: Extent Account for Wetlands and Water bodies in India (km2)

L1	L2	Opening Stock (2011-12)	Addition to Stock	Reduction in Stock	Closing Stock (2015-16)
Wetlands/water bodies	Inland wetland	8,175	458	1,027	7,606
	Coastal wetland	10,719	189	121	10,787
	River/stream/ Canals	61,032	2,130	2,333	60,829
	Water bodies	58,367	1,478	1,293	58,552
	Total	**138,294**	**4,254**	**4,775**	**137,774**

The SDG indicator can be calculated as follows:
SDG 6.6.1= ((137774-138294)/138294) *100 = -0.38% (*for* 2011-12 *to* 2015-16)

Figure 29: State-wise SDG indicator 6.6.1 (for 2011-12 to 2015-16)



Source: MoSPI

7.2.3 SDG Indicator 15.3.1 - Proportion of land that is degraded over total land area

The assessment of areas of degraded land is made for each land cover class or ecosystem type and then aggregated for the entire area of the analysis (or ecosystem accounting area). The total degraded area across all classes or types within a monitoring period t_n ($A(Degraded)t_n$), comprises the sum of land that has degraded within that monitoring period (t_n) and the land already assessed as degraded at the beginning of that monitoring period and also remains degraded at the end of the monitoring period. SDG 15.3.1 can be calculated by dividing this by the total area within the ecosystem accounting area ($A(Total)$). This is shown in equation 3 below (which would represent the closing extent of degraded area for an accounting period):

$$\text{SDG } 15.3.1 = \left(\frac{A(Degraded)_{t_n}}{A(Total)} \right) * 100$$

To date, this indicator has been calculated and reported in India using data from NRSC at the national level, with a periodicity of five years as per India's Progress Report on SDG (MoSPI, 2020b) and as described in Section 2.4 – Table 8 on land degradation. For instance, in 2015-16, the value of the indicator for India is 27.77 as reported in the SDG Progress Report (by NRSC). This value denotes the absolute value of degraded land (which can be broken down into various classes) as described in table 7 and 8 in Section 2.4.

As an alternative estimate, the indicator has also been compiled using mapping techniques and 3 sub-indicators which can be aligned with and derived from the SEEA EA extent and condition accounts.

Calculating SDG Indicator 15.3.1 requires estimating three sub-indicators: land cover and land cover change, land productivity and carbon stocks above and below ground. To estimate these, the QGIS plugin, Trends.Earth was used. Trends.Earth (formerly the Land Degradation Monitoring Toolbox) is a platform for monitoring the changes in land using Google Earth Engine. It allows the user to compute each of these sub-indicators in a spatially explicit way generating raster maps which are then integrated into a final SDG 15.3.1 indicator map and produces a table result reporting areas potentially improved and degraded for the area of analysis by using Google Earth Engine by using land cover maps from ESA CCI. The integration of the three SDG 15.3.1 sub-indicators is done following the one-out all-out rule, this means that if an area was identified as potentially degraded by any of the sub-indicators, then that area will be considered potentially degraded for reporting purposes. Though the tool provides the option to use the custom data for each of the sub-indicators but for this analysis, the default dataset i.e. the UNCCD default data has been used. The time period under consideration is 2001 and 2015. Table 57 presents the results of the estimation. No data is an indication that no data existed in at least one of input datasets used in the analysis. Further details are given in Annexure 10.3.10.

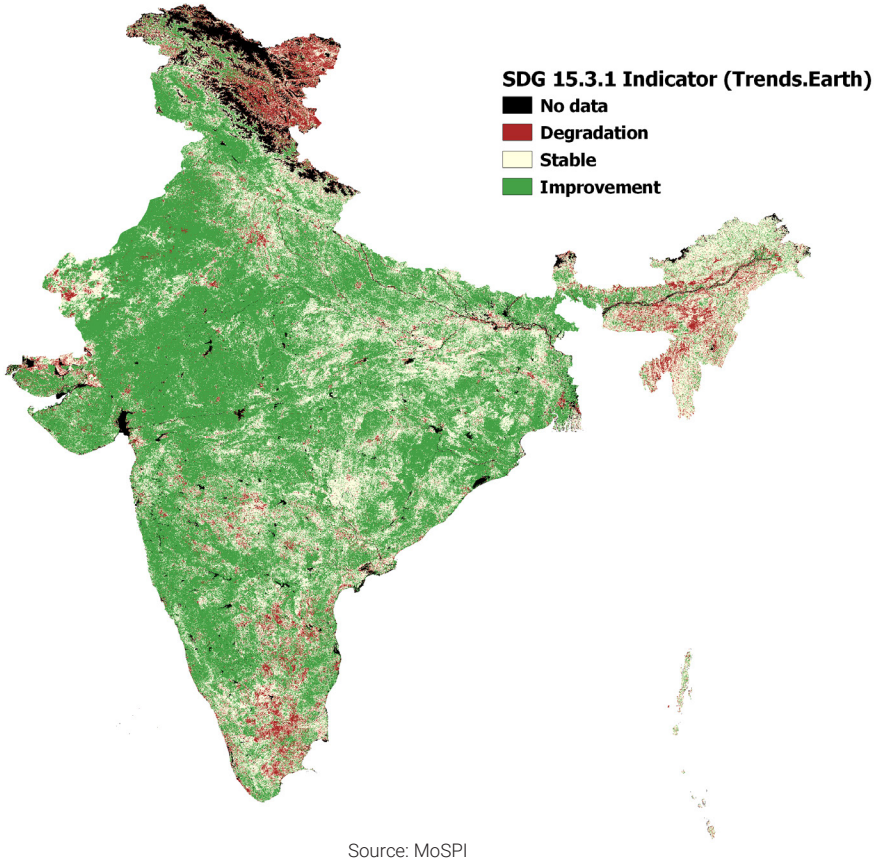
It is important to stress that the estimate obtained using the Trends.Earth tool represents the change in degraded land of the assessed year compared to the reference period, unlike the estimate given by the NRSC which measures the absolute degraded land area and not the change.

Table 57: Summary of SDG 15.3.1 indicator

	Area (km^2)	Percentage of total land area
Total land area:	3,215,129.6	100.00%
Land area improved:	1,789,096.3	55.65%
Land area stable:	1,077,146.2	33.50%
Land area degraded:	261,197.6	8.12%
Land area with no data:	87,689.5	2.73%

The Table 57 and Figure 30 show that 8.12 per cent area has degraded over the span of 15 years from 2001 to 2015. These are the estimates using the global datasets and can be refined further using the national and local level datasets for calculating each of the sub-indicators and indicator itself.

Figure 30: Map showing SDG indicator 15.3.1 for 2001-2015



Source: MoSPI

7.2.4 SDG Indicator 11.3.1 - Ratio of land consumption rate to population growth rate.

Indicator 11.3.1 is computed as follows:

Population growth rate (PGR):

$$PGR = \frac{\ln(\frac{Pop_{t+n}}{Pop_t})}{n}$$

Where:

Pop_t: Total population within the city in the past/initial year

Pop_{t+y}: Total population within the city in the current/final year

n: The number of years between the two measurement periods

Land consumption rate (LCR): This rate gives a measure of compactness which indicates a progressive spatial expansion of a city.

$$LCR = \frac{\ln(\frac{Urb_{t+n}}{Urb_t})}{n}$$

Where:

Urb_t: Total areal extent of the urban agglomeration in km2 for past/initial year

Urb_{t+n}: Total areal extent of the urban agglomeration in km2 for current/final year

n: The number of years between the two measurement periods

SDG 11.3.1 is defined as the ratio of land consumption rate to population growth rate (LCRPGR)

$$\text{SDG 11.3.1} = = \frac{LCR}{PGR}$$

The Global Human Settlement Layer (GHSL) of the EU Joint Research Centre (JRC) is a freely available global dataset showing the spatial extent of urban/built-up areas and of population. These gridded raster datasets are available at four epochs: 1975, 1990, 2000 and 2014. Besides these datasets, the GHSL project has a suite of tools available to assist with research. The tool that was used in this analysis to estimate SDG indicator 11.3.1 is the Land Use Efficiency (LUE) tool which is available as a QGIS plugin.

The LUE tool allows the calculation of the LUE indicator as defined below in Equation 5 and the SDG indicator 11.3.1. Applying this tool on the global urban and population datasets using GHSL, the estimates of 11.3.1 compiled for the years 2000 and 2015 along with the foundational data as per the GHSL are given in Table 58. This tool calculates the urban area for the area or city in question along with the corresponding population of the city and thus calculates indicator 11.3.1 using the former parameters. The analysis has been done for 52 cities in India for the years 2000 and 2015, each of which had more than 1 million inhabitants as per Population Census of 2011.

Ideally, the LCR should be synchronized with the PGR, indicating that the development of the two is coordinated. The indicator as per UN-Habitat can be interpreted as follows:

City urban extent density	Indicator value: LCRPGR Value	
	<1	>1
10-150 persons/hectare	Efficient land use	Inefficient land use
151 -250 persons/hectare	Moving toward efficiency	Moving away from efficiency
Greater than 250 persons/ hectare	Insufficient land per person	Moving toward sufficient land per person

Table 58: Summary of SDG 11.3.1 indicator

S.No.	Million plus cities	Built-up area (km²)		Population		Population growth rate (PGR)*	Land consumption rate (LCR)*	SDG-11.3
		2000	2015	2000	2015			
1	Delhi	535.95	574.37	11,935,312	15,531,798	0.02	0.00	**0.26**
2	Greater Mumbai	317.59	327.95	16,999,844	20,470,412	0.01	0.00	**0.17**
3	Kolkata	1,669.63	1,801.05	27,834,202	31,778,530	0.01	0.01	**0.57**
4	Chennai	376.26	450.97	10,417,138	13,996,528	0.02	0.01	**0.61**
5	Bangalore	281.08	398.79	6,705,881	11,644,489	0.04	0.02	**0.63**
6	Hyderabad	383.65	477.89	9,990,576	13,099,904	0.02	0.01	**0.81**
7	Ahmedabad	195.71	260.95	6,481,823	8,370,143	0.02	0.02	**1.13**
8	Pune	191.33	300.29	6,927,953	10,029,066	0.02	0.03	**1.22**
9	Surat	72.39	94.11	3,981,396	6,599,944	0.03	0.02	**0.52**
10	Jaipur	165.19	215.58	4,643,163	6,437,605	0.02	0.02	**0.81**
11	Kanpur	81.13	98.40	3,546,565	4,028,626	0.01	0.01	**1.51**
12	Lucknow	75.49	98.98	3,300,038	4,576,152	0.02	0.02	**0.83**
13	Nagpur	125.54	148.07	3,792,530	4,536,954	0.01	0.01	**0.92**
14	Ghaziabad (NCR)	122.90	140.91	2,106,180	3,391,502	0.03	0.01	**0.29**
15	Indore	94.40	138.72	2,236,351	3,325,779	0.03	0.03	**0.97**
16	Coimbatore	114.35	142.58	2,835,523	3,559,949	0.02	0.01	**0.97**
17	Kochi	211.78	269.15	3,451,226	3,692,139	0.00	0.02	**3.55**
18	Patna	61.50	66.54	4,307,235	5,748,874	0.02	0.01	**0.27**
19	Kozhikode	88.98	103.53	3,062,793	3,348,708	0.01	0.01	**1.70**
20	Bhopal	65.56	85.28	1,670,302	2,380,512	0.02	0.02	**0.74**
21	Thrissur	125.32	165.91	3,319,210	3,479,151	0.00	0.02	**5.96**
22	Vadodara	88.35	103.72	2,483,906	2,963,535	0.01	0.01	**0.91**
23	Agra	65.19	90.96	3,220,018	4,212,359	0.02	0.02	**1.24**
24	Vishakhapatnam	85.32	102.44	3,759,262	4,436,787	0.01	0.01	**1.10**
25	Malappuram	107.99	127.86	3,844,444	4,503,356	0.01	0.01	**1.07**
26	Thiruvananthapuram	131.96	144.06	3,571,934	3,596,108	0.00	0.01	**13.01**
27	Ludhiana	201.75	233.30	2,630,305	3,166,283	0.01	0.01	**0.78**
28	Kannur	100.81	122.66	2,564,482	2,695,536	0.00	0.01	**3.93**
29	Nashik	72.92	107.59	4,688,253	6,173,266	0.02	0.03	**1.41**
30	Vijayawada	216.59	251.74	8,683,135	9,596,213	0.01	0.01	**1.50**
31	Madurai	33.06	41.91	2,824,343	3,543,186	0.02	0.02	**1.05**
32	Varanasi	70.84	85.52	2,987,367	3,697,858	0.01	0.01	**0.88**
33	Meerut	58.37	90.06	2,605,820	3,155,884	0.01	0.03	**2.27**
34	Faridabad (NCR)	95.04	108.24	1,198,953	1,777,085	0.03	0.01	**0.33**
35	Rajkot	89.95	114.90	2,315,919	2,968,480	0.02	0.02	**0.99**
36	Jamshedpur	44.86	46.41	2,005,747	2,474,249	0.01	0.00	**0.16**
37	Jabalpur	25.43	30.75	1,974,701	2,370,078	0.01	0.01	**1.04**
38	Asansol	336.76	401.19	6,527,659	7,524,842	0.01	0.01	**1.23**
39	Vasai - Virar (MMR)	129.80	139.47	5,282,612	8,152,592	0.03	0.00	**0.17**
40	Allahabad	31.96	39.66	4,379,362	5,700,824	0.02	0.01	**0.82**
41	Dhanbad	92.86	96.51	2,262,857	2,605,968	0.01	0.00	**0.27**
42	Aurangabad	60.37	79.58	2,714,577	3,779,537	0.02	0.02	**0.83**
43	Amritsar	78.79	103.76	1,842,904	2,222,663	0.01	0.02	**1.47**

S.No.	Million plus cities	Built-up area (km²)		Population		Population growth rate (PGR)*	Land consumption rate (LCR)*	SDG-11.3
		2000	2015	2000	2015			
44	Jodhpur	74.40	93.57	2,548,764	3,601,689	0.02	0.02	**0.66**
45	Ranchi	39.02	45.49	2,167,559	2,907,543	0.02	0.01	**0.52**
46	Raipur	59.00	73.60	1,505,410	2,278,593	0.03	0.01	**0.53**
47	Kollam	102.94	110.47	2,716,713	2,708,840	0.00	0.00	**-24.35**
48	Gwalior	34.67	44.28	1,467,464	1,995,485	0.02	0.02	**0.80**
49	Durg-Bhilainagar	67.22	82.10	1,334,223	1,691,684	0.02	0.01	**0.84**
50	Chandigarh	13.39	16.47	443,392	540,450	0.01	0.01	**1.05**
51	Tiruchirapalli	29.67	59.24	2,567,477	3,010,417	0.01	0.05	**4.34**
52	Kota	66.50	80.99	1,377,661	1,856,173	0.02	0.01	**0.66**

With the proposed global indicator computation, it may be difficult to capture the dynamics of cities with negative or zero population growth; or cities that, due to severe disaster, have lost part of their territories. To address this challenge, JRC has developed a tool to calculate the indicator 11.3.1 based on a proxy of LUE. JRC tool proposes to adapt the formulation of the Land Use Efficiency indicator in order to measure the change rate of the built-up area per capita (Idxt) (Corbane et al. 2016):

$$Id\,x_t = \frac{Y_t - Y_{t+n}}{Y_t}$$

Where:

$\mathbf{Y_t}$ = BU_t / POP_t;

$\mathbf{BU_t}$ = built-up surface at t and

$\mathbf{POP_t}$ = population at t.

The indicator can be estimated at different time intervals upon the availability of observations. In order to ensure the comparability of the results at different times, it is recommended to normalise the values to obtain the variation a 10-year average change which divides the indicator by n (the number of years that separate the observations) and then multiply by 10.

The formula of the normalised indicator is:

$$Id\,x_t = \frac{Y_t - Y_{t+n}}{Y_t} * \frac{10}{n}$$

The map for LUE for each of the cities, as prepared using the tool, is shown in Annexure 10.3.11. The map shows the negative, zero and positive values of LUE. According to Melchiorri et al., 2019, the LUE can be interpreted as follows:

LUE class	Information about the urban centre (Melchiorri et al., 2019)
LUE < 0	Demographic growth is less than the spatial expansion
LUE = 0	Demographic growth is in line with the spatial expansion
LUE > 0	Spatial expansion takes place at a place that is at least double the one of demographic growth

This tool has a limitation which is its inability to capture the vertical development of constructions, which is primarily since the available input data represents 2D information of built surface and population.

Section 8:
Discussion and Conclusions

8.1 Mainstreaming

In this report, ecosystem extent accounts covering land, land degradation, wetlands, have been discussed which show how human activities have influenced land use and land cover across both positive and negative directions and would help in planning the policies according to the concerned area.

Ecosystem condition accounts have also been discussed, where water quality accounts for surface and ground water, coastal water quality index, condition accounts for forests and croplands were covered. The application of these accounts helps to focus the resources on the hotspots that are majorly affected and in better allocation of resources. For instance, water quality accounts can help in identifying areas that require resources for artificial ground water recharging in the immediate future. The report includes ecosystem services accounts that help in valuation of services provided by the ecosystems like crop provisioning, timber and NTFP provisioning and carbon retention services. Next, the focus was on the thematic accounts on biodiversity in India. Here, India's biodiversity is illustrated through a set of statistics on biodiversity hotspots and flora and fauna species accounts, including a map of species richness, an overview of biodiversity related expenditures and a discussion of the role of SEEA in the Post-2020 monitoring framework.

In the following sections of the report, the alignment of the SEEA with SDG indicators has been discussed in view of the fact that the SEEA framework helps harmonise environmental data from multiple sources and brings coherence and consistency across disparate statistics. With a specific reference to the Indian context, mapping of SEEA with India's SDG National Indicator Framework has been presented which would help in measuring and monitoring the progress made by the country towards achieving SDGs.

Ecosystem accounts, as discussed throughout the report, address multiple policy objectives by establishing a sound method for natural capital accounting with a strong focus on ecosystems and the services they deliver. These accounts show the wide range of services provided by different ecosystem types and provide information on the capacity of a certain ecosystem to provide services. All this information is useful for policies that have an impact on natural capital, such as agriculture and transport. Ecosystem accounts also allow for monitoring the status of ecosystem assets over time (both their extent and condition) and thus give an indication of the change in their status. This intends to support policy-makers to discern the ecosystem assets and services showing the most significant changes and to also help to identify policy priorities. Also, ecosystem accounts, through a panoramic view of the complex interactions involving the ecosystems of the country, provide relevant information for integrated multi-faceted policy areas such as the SDGs.

Policy inputs provided by these accounts differ in nature with the respective accounts but all are interconnected, like land accounts, giving an approach to sustainable land management practices/decisions which also is a main element in spatial planning, albeit for regulating the built-up area or infrastructure development or managing eco-sensitive areas like river basins, watershed areas, wetlands, flood-prone areas, wildlife areas, mining areas, coastal areas, peri-urban areas and areas having tourism potential.

Especially in the face of climate change and variability, the various indicators of the human footprint on land, such as the use of land need to be assessed on a regular basis for scientific and effective land use planning, management and ecological restoration. Similarly, accounting for ecosystem services such as the valuation of nature-based tourism helps to create awareness of environmental values. Since the preservation of the environment is one of the main drivers of nature based tourism, sustainable tourism development takes into account current and future economic, social and environmental impacts, while addressing the needs of visitors, the industry, the host communities and most importantly, the environment. It can serve as a tool to finance protection of natural areas and increase their economic importance. These accounts also help in estimation of SDG and help in achievement of goals towards Agenda 2030.

8.2 Future Outlook

India is a diverse country with an abundance of natural resources with different ecosystem prevailing within them. In this report, a summary is presented of the results achieved on Natural Capital Accounting supported by the EU-funded NCAVES project (for further details refer to EnviStats India-Volume II 2018, 2019 and 2020, MoSPI). It is important to explore all the different ecosystems that exist in the country in order to help in decision-making for ensuring sustainability of these resources for the future since natural capital depletion both in terms of quality and quantity is hard to regain. Thus, accounting for environment should be an ongoing process and should be refined with time. As seen in the report, some of the work can be improved further by using the national datasets. There is a need for improvement and expansion of the accounts developed until now. For this, there needs to be a continued and an ongoing process for stakeholder consultation in order to better know their needs and concerns regarding the environment accounts.

The objective of these efforts is also to demonstrate the relevance of these accounts so that the key policy or decision-makers give due consideration to the value of nature and the ecosystem services it provides. MoSPI will continue to strive for expanding the coverage of the information, so as to guide the country and the decision-makers towards a “better environment, better tomorrow”.

Section 9:
References

Aguilar, J., Gramig, G. G., Hendrickson, J. R., Archer, D. W., Forcella, F., Liebig, M. A. (2015). Crop species diversity changes in the United States: 1978–2012. PLoS ONE 10(8): e0136580. doi:10.1371/journal.pone.0136580

Amara, D. M. K., Patil, P. L., Kamara, A. M., Saidu, D. H. (2017). Assessment of soil fertility status using nutrient index approach. Academia Journal of Agricultural Research, 5(2), pp.28-38. Available at: https://www.academiapublishing.org/journals/ajar/pdf/2017/Feb/Denis%20et%20al.pdf

Ansari, N.A., Hembrom N.,Barthwal D., Mathur V.B. (2018). Biodiversity Expenditure Review (BER) at Central Government Level, India. Final Report, WII-UNDP Biodiversity Finance Initiative (BIOFIN) Project, Wildlife Institute of India, Dehradun. Available at https://www.biodiversityfinance.net/sites/default/files/content/knowledge_products/Final%20BER%20Report%20India_Oct%202018.pdf

Benavidez, R., Jackson, B., Maxwell, D., Norton, K. (2018). A review of the (Revised) Universal Soil Loss Equation ((R) USLE): with a view to increasing its global applicability and improving soil loss estimates. Hydrology and Earth System Sciences, 22(11), pp. 6059-6086.

Central Ground Water Board (CGWB), Ministry of Jal Shakti, Government of India (2006). Dynamic Ground Water Resources of India (as on 31st March, 2004). Available at: http://cgwb.gov.in/Documents/Dynamic-GW-Resources-2004.pdf

Central Ground Water Board (CGWB), Ministry of Jal Shakti, Government of India (2010). Ground Water Scenario of India 2009-2010. Available at: http://cgwb.gov.in/Documents/Ground%20Water%20Year%20Book%202009-10.pdf

Central Ground Water Board (CGWB), Ministry of Jal Shakti, Government of India (2011). Dynamic Ground Water Resources of India (as on 31st March, 2009). Available at:http://cgwb.gov.in/Documents/Dynamic-GW-Resources-2009.pdf

Central Ground Water Board (CGWB), Ministry of Jal Shakti, Government of India (2014). Dynamic Ground Water Resources of India (as on 31st March, 2011). Available at: http://cgwb.gov.in/documents/National%20Dynamic-GW-Resources-2011.pdf

Central Ground Water Board (CGWB), Ministry of Jal Shakti, Government of India (2017a). Dynamic Ground Water Resources of India (as on 31st March, 2013). Available at: http://cgwb.gov.in/Documents/Dynamic%20GWRE-2013.pdf

Central Ground Water Board (CGWB), Ministry of Jal Shakti, Government of India (2017b). Ground Water Year Book-India 2016-2017. Available at: http://cgwb.gov.in/Ground-Water/Groundwater%20Year%20Book%202016-17.pdf

Central Water Commission (CWC), Ministry of Jal Shakti, Government of India (1999). Reassessment of water resources potential of India. Available at: http://cwc.gov.in/sites/default/files/1993-reassessment-waterresourcespotential.pdf

Central Water Commission (CWC), Ministry of Jal Shakti, Government of India (2019). Reassessment of water availability in India using space inputs. Available at: http://cwc.gov.in/sites/default/files/main-report.pdf

Champion, H. G., Seth, S. K. (1968). A Revised Survey of Forest Types of India, Government of India Press, New Delhi, p. 404.

Chase, P., Singh, O. P. (2014). Soil nutrients and fertility in three traditional land use systems of Khonoma, Nagaland, India. Resources and Environment, 4(4), pp. 181-189.

Eco Health Report Cards. Available at: https://ecoreportcard.org/

Food and Agriculture Organization (FAO) (1980). Soil and Plant Testing and Analysis, FAO Soils Bulletin 38/1. Available at: http://www.fao.org/3/ar117e/ar117e.pdf

Food and Agriculture Organization (FAO) (2001). Global Forest Resources Assessment 2000 Main Report, FAO Forestry Paper 140. Available at: http://www.fao.org/3/y1997e/y1997e00.htm

Forest Survey of India (FSI), Ministry of Environment, Forest & Climate Change, Government of India. India State of Forest Report (various years). Available at: https://fsi.nic.in/index.php

Intergovernmental Panel on Climate Change (2003), Good Practice Guidance for Land Use,

Land-Use Change and Forestry Intergovernmental Panel on Climate Change, National Greenhouse Gas Inventories Programme (IPCC-NGGIP). Available at https://www.ipcc.ch/site/assets/uploads/2018/03/GPG_LULUCF_FULLEN.pdf

Jhala, Y.V., Qureshi, Q. and Nayak, A.K. (eds) (2020). Status of tigers, co-predators and prey in India, 2018. National Tiger Conservation Authority, Government of India, New Delhi, and Wildlife Institute of India, Dehradun. Available at http://moef.gov.in/wp-content/uploads/2020/07/Tiger-Status-Report-2018_For-Web_compressed_compressed.pdf

Keith, D. A., Ferrer, J. R., Nicholson, E., Bishop, M.J., Polidoro, B. A., Ramirez-Llodra, E., Tozer, M. G., Nel, J. L., Mac Nally, R., Gregr, E. J., Watermeyer, K. E., Essl, F., Faber-Langendoen, D.,Franklin, J., Lehmann, C. E., Etter, A., Roux, D. J., Stark, J. S., Rowland, J. A., Brummitt, N. A.,Fernandez-Arcaya, U. C., Suthers, I. M., Wiser, S. K., Donohue, I., Jackson, L. J., Pennington, R. T.,Pettorelli, N., Andrade, A., Kontula, T., Lindgaard, A., Tahvanainan, T., Terauds, A., Venter, O.,Watson, J. E., Chadwick, M. A., Murray, N. J., Moat, J., Pliscoff, P., Zager, I., Kingsford, R. T. (2020). The IUCN global ecosystem typology v1. 01: Descriptive profiles for biomes and Ecosystem Functional Groups. IUCN CEM. Available at: https://iucnrle.org/static/media/uploads/references/research-development/keith_etal_iucnglobalecosystemtypology_v1.01.pdf

Mahapatra, S. K., Reddy, G. O., Nagdev, R., Yadav, R. P., Singh, S. K., Sharda, V. N. (2018). Assessment of soil erosion in the fragile Himalayan ecosystem of Uttarakhand, India using USLE and GIS for sustainable productivity. Current Science, 115(1),p.108.

Mandal, D. K., Mandal, C., Singh, S.K. (2016). Agro-Ecological Regions of India (Revised), NBSS&LUP Publ. No 170, ICAR-NBSS&LUP, Nagpur, India, pp.89.

Melchiorri, M., Pesaresi, M., Florczyk, A. J., Corbane, C., Kemper, T. (2019). Principles and applications of the global human settlement layer as baseline for the land use efficiency indicator—SDG 11.3.1. ISPRS International Journal of Geo-Information, 8(2). https://doi.org/10.3390/ijgi8020096

Ministry of Agriculture & Farmers Welfare (MOAFW), Department of Agriculture, Cooperation & Farmers Welfare, Government of India (2012). Agriculture Census 2005-06. Available at: http://agcensus.nic.in/document/ac0506/ac0506rep.html

Ministry of Agriculture & Farmers Welfare (MOAFW), Department of Agriculture, Cooperation & Farmers Welfare, Government of India (2015). Agriculture Census 2010-2011. Available at: http://agricoop.nic.in/sites/default/files/air2010-11complete.pdf

Ministry of Agriculture & Farmers Welfare (MOAFW), Department of Agriculture, Cooperation & Farmers Welfare, Government of India (2016). State of Indian Agriculture 2015-16.Available at: https://eands.dacnet.nic.in/PDF/State_of_Indian_Agriculture,2015-16.pdf

Ministry of Agriculture & Farmers Welfare (MOAFW), Department of Agriculture, Cooperation & Farmers Welfare, Government of India (2017a). Land Use Statistics (2005-06 to 2014-15).

Ministry of Agriculture & Farmers Welfare (MOAFW), Department of Animal Husbandry, Dairying & Fisheries, Government of India (2017b). Annual Report 2016-2017. Available at: https://dahd.nic.in/sites/default/filess/Annual%20Report%202016-17.pdf

Ministry of Agriculture & Farmers Welfare (MOAFW), Department of Agriculture, Cooperation & Farmers Welfare, Government of India (2019). Agriculture Census 2015-2016: All India Report on Number and Area of Operational Holdings. Available at: http://agcensus.nic.in/document/agcen1516/T1_ac_2015_16.pdf

Ministry of Earth Sciences, Indian Meteorological Department (IMD), Government of India (2016). Rainfall Statistics of India (accessed for the years 2012 to 2016. Available at: http://hydro.imd.gov.in/hydrometweb/(S(trjz0ify0zqdh55510015uf2))/landing.aspx

Ministry of Earth Sciences (MOES), Government of India (2018). Seawater Quality at Selected Locations along Indian Coast – Status Report (1990-2015).

Ministry of Environment, Forest & Climate Change (MoEF&CC), Government of India (2019). Implementation of India's National Biodiversity Action Plan – An Overview 2019. Available at: https://www.cbd.int/doc/world/in/in-nbsap-other-en.pdf.

Ministry of Statistics and Programme Implementation Government of India (2010). Domestic Tourism in India, NSS 65th round (July 2008 – June 2009) Report No. 536. Available at: https://mospi.gov.in/web/mospi/reports-publications

Ministry of Statistics and Programme Implementation Government of India (2017). Domestic Tourism in India, NSS 72nd round (July 2014 – June 2015) Report No. 580. Available at: https://mospi.gov.in/web/mospi/reports-publications

Ministry of Statistics and Programme Implementation (MoSPI), Government of India (2018). EnviStats India 2018 (Supplement on Environmental Accounts). Available at: https://mospi.gov.in/web/mospi/reports-publications

Ministry of Statistics and Programme Implementation (MoSPI), Government of India (2019). EnviStats India 2019 (Vol.II- Environment Accounts). Available at: https://mospi.gov.in/web/mospi/reports-publications

Ministry of Statistics and Programme Implementation (MoSPI), Government of India (2020a). EnviStats India 2020 (Vol.II- Environment Accounts). Available at: https://mospi.gov.in/web/mospi/reports-publications

Ministry of Statistics and Programme Implementation (MoSPI), Government of India (2020b). Sustainable Development Goals, National Indicator Framework, Progress Report 2020 (Version 2.0). Available at: https://mospi.gov.in/web/mospi/reports-publications

Ministry of Statistics and Programme Implementation (MoSPI), Government of India (2020c). National Accounts Statistics 2020. Available at: https://mospi.gov.in/web/mospi/reports-publications

Morgan, R. (2005). Soil erosion and conservation. National Soil Resources Institute. Cranfield University,125.

National Bureau of Soil Survey & Land Use Planning (NBSS&LUP) (1999). Agro-ecological Subregions of India for Planning and Development. NBSS Publ., 35, NBSS & LUP, Nagpur, India

National Remote Sensing Centre (NRSC), Government of India (2019). Status of Land Degradation in India-2015-16.

National Remote Sensing Centre (NRSC), Government of India (2019). Land Use / Land Cover Analysis - Third Cycle, Technical Document on – Land Use / Land Cover Database for Dissemination through Bhuvan, Natural Resource Census 2019.

National Remote Sensing Centre (NRSC), Government of India (2020). Digitally classified LULC map generated under NR Census project Land Use Land Cover Mapping for 2017-18 using Multi-temporal AWiFS Data.

Obst, C., Hein, L., Edens, B. (2016). National Accounting and the Valuation of Ecosystem Assets and Their Services. Environmental and Resource Economics, 64(1), pp.1–23.

OSPAR Commission (2005). Synergies between the OSPAR Comprehensive Procedure, the integrated set of OSPAR Ecological Quality Objectives (EcoQOs) for eutrophication and the EC Water Framework Directive.

Panagos, P., Borrelli, P., Meusburger, K. et al. Global rainfall erosivity assessment based on high-temporal resolution rainfall records. Sci Rep 7, 4175 (2017). https://doi.org/10.1038/s41598-017-04282-8

Parker, F. W., Nelson, W. L., Winters, E., Miles, I. E. (1951). The broad interpretation and application of soil test information. Agronomy Journal, 43(3), pp.105-112.

Pathak, H. (2010). Trend of fertility status of Indian soils. Current Advances in Agricultural Sciences, 2(1), pp.10-12.

Patil, R. J., Sharma, S. K., Tignath, S., Sharma, A. P. M. (2017). Use of remote sensing, GIS and C++ for soil erosion assessment in the Shakkar River basin, India. Hydrological sciences journal, 62(2), pp. 217-231.

Portela, R., Wendland, K. J., Pennypacker, L. L. (2008). The Idea of Market-Based Mechanisms for Forest Conservation and Climate Change. In: Streck, C., O'Sullivan, R., JansonSmith, T., Tarasofsky, R. (eds.). Climate Change and Forests. Emerging Policy and Market Opportunities. Chatham House London and Brookings Institution Press Washington, DC. p. 11–29.

Rawat, G.S., Adhikari, B.S. (Eds.) (2015). Ecology and Management of Grassland Habitats in India, ENVIS Bulletin: Wildlife and Protected Areas.Vol. 17. Avaliable at:http://wiienvis.nic.in/WriteReadData/Publication/19_Grassland%20Habitat_2016.pdf

Renard, K. G. (1997). Predicting soil erosion by water: A guide to conservation planning with the Revised Universal Soil Loss Equation (RUSLE). United States Government Printing.

Ricke, K., Drouet, L., Caldeira, K., Tavoni, M. (2018). Country-level social cost of carbon. Nature Climate Change, 8(10), pp. 895-900.

Rodgers, W. A., Panwar, S. H. (1988). Biogeographical classification of India. New Forest, Dehra Dun, India.

Rodgers, W. A., Panwar, H. S., Mathur, V. B. (2000). Wildlife Protected Area Network in India: a review. Executive Summary, Wildlife Institute of India, Dehradun, p. 44.

Shetty, Y. V., Nagamma, M. S., Kumar, M. D., Jayaprakash, S. M. (2008). Fertility status in arecanut garden soils of Karnataka. Karnataka J. Agric. Sci, 21(4), pp.503-506.

Sidharam, P., Kumar, K. S. A., Srinivasamurthy, C. A. (2017). Soil fertility status and nutrient index for primary nutrients in Western Ghats and Coastal Karnataka under different agro-ecological systems. Asian Journal of Soil Science, 12(2), pp. 314-319.

Singh, G., Sharma, M., Manan, J., Singh, G. (2016). Assessment of soil fertility status under different cropping sequences in District Kapurthala. J Krishi vigyan, 5(1), pp. 1-9.

Singh, G., Panda, R. K. (2017). Grid-cell based assessment of soil erosion potential for identification of critical erosion prone areas using USLE, GIS and remote sensing: A case study in the Kapgari watershed, India. International Soil and Water Conservation Research, 5(3), pp. 202-211.

Sivakumar K. (2013) Coastal and Marine Biodiversity Protected Areas in India: Challenges and Way Forward. In: Venkataraman K., Sivaperuman C., Raghunathan C. (eds) Ecology and Conservation of Tropical Marine Faunal Communities. Springer, Berlin, Heidelberg. http://doi-org-443.webvpn.fjmu.edu.cn/10.1007/978-3-642-38200-0_30

Soil and Land Use Survey of India (SLUSI), Ministry of Agriculture & Farmers Welfare, Government of India. Detailed Soil Survey (DSS). Available at: https://slusi.dacnet.nic.in/dss/aboutdss.html

Space Applications Centre (SAC), Indian Space Research Organisation, Government of India (2011). National Wetland Atlas. Available at: http://saconenvis.nic.in/publication%5CNWIA_National_atlas.pdf

Stewart, B., Woolhiser, D., Wischmeier, W., Caro, J., Frere M. H. (1975). Control of water pollution from cropland.

United Nations (2012). System of Environmental-Economic Accounting for Water. UN. Series F No. 100 (ST/ESA/SER.F/100).

United Nations, European Commission, Food and Agricultural Organization of the United Nations, International Monetary Fund, Organisation for Economic Co-operation and Development, The World Bank (2014a). System of Environmental-Economic Accounting 2012 – Central Framework. United Nations, New York.

United Nations, European Commission, Food and Agricultural Organization of the United Nations, Organisation for Economic Co-operation and Development, The World Bank (2014b). System of Environmental-Economic Accounting 2012 – Experimental Ecosystem Accounting. United Nations, New York.

Venkataraman, K., Rajan, R., Satyanarayana, C. H., Raghunathan, C., Venkatraman, C. (2012). Marine Ecosystems and Marine Protected Areas of India. Zoological Survey of India, Kolkata, India.

Villa, F., Bagstad, K. J., Voigt, B., Johnson, G. W., Portela, R., Honzák, M., Batker, D. (2014). A methodology for adaptable and robust ecosystem services assessment. PloS one, 9(3), e91001.

Wischmeier, W. H., Smith, D. D. (1978). Predicting rainfall erosion losses: a guide to conservation planning (No. 537). Department of Agriculture, Science and Education Administration.

A list of web links used in the report:

http://14.139.123.73/bhoomigeoportal/publication_pdf/annual_report_publication/15_16.pdf

http://agcensus.nic.in/

http://trends.earth/docs/en/training/tutorial_compute_sdg_indicator.html

http://www.agriculture.uk.gov.in/files/Soil_Testing_Method_by_Govt_of_India.pdf

http://www.fao.org/3/a-am352e.pdf%20

https://bhuvan-app1.nrsc.gov.in/thematic/thematic/index.php

https://bhuvan-app3.nrsc.gov.in/data/download/tools/document/soil_nices.pdf

https://farmingfirst.org/sdg-toolkit#section_2

https://ghsl.jrc.ec.europa.eu/

https://iucnrle.org/about-rle/ongoing-initiatives/global-ecosystem-typology/

https://iucnrle.org/static/media/uploads/references/research-development/keith_etal_iucnglobalecosystemtypology_v1.01.pdf

https://seea.un.org/home/Natural-Capital-Accounting-Project

https://shodhganga.inflibnet.ac.in/bitstream/10603/7519/11/11_chapter%202.pdf

https://unstats.un.org/sdgs/iaeg-sdgs/tier-classification/

https://unstats.un.org/sdgs/metadata/files/Metadata-06-06-01a.pdf

https://unstats.un.org/sdgs/metadata/files/Metadata-06-06-01b.pdf

https://unstats.un.org/sdgs/metadata/files/Metadata-11-03-01.pdf

https://unstats.un.org/sdgs/metadata/files/Metadata-15-01-01.pdf

https://vedas.sac.gov.in/vedas/downloads/atlas/Wetlands/National%20Wetland%20Atlas_High%20Altitude%20Lakes%20of%20India.pdf

https://vikaspedia.in/agriculture/crop-production/weather-information/agroclimatic-zones-in-india

https://www.millenniumassessment.org/en/index.html

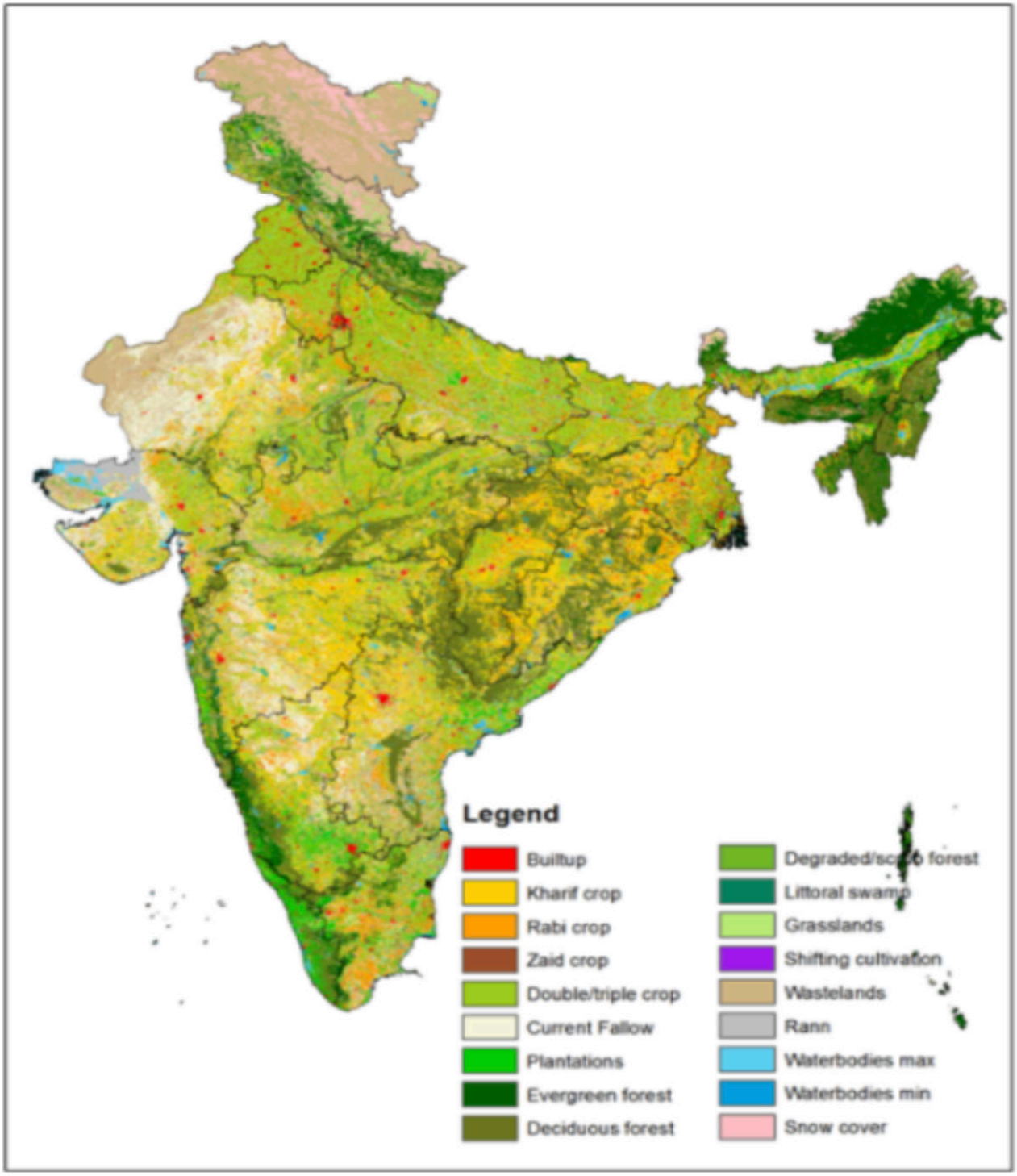
Section 10:
Annexures

10.1 Classifications

Annexure 10.1.1: Political map of India

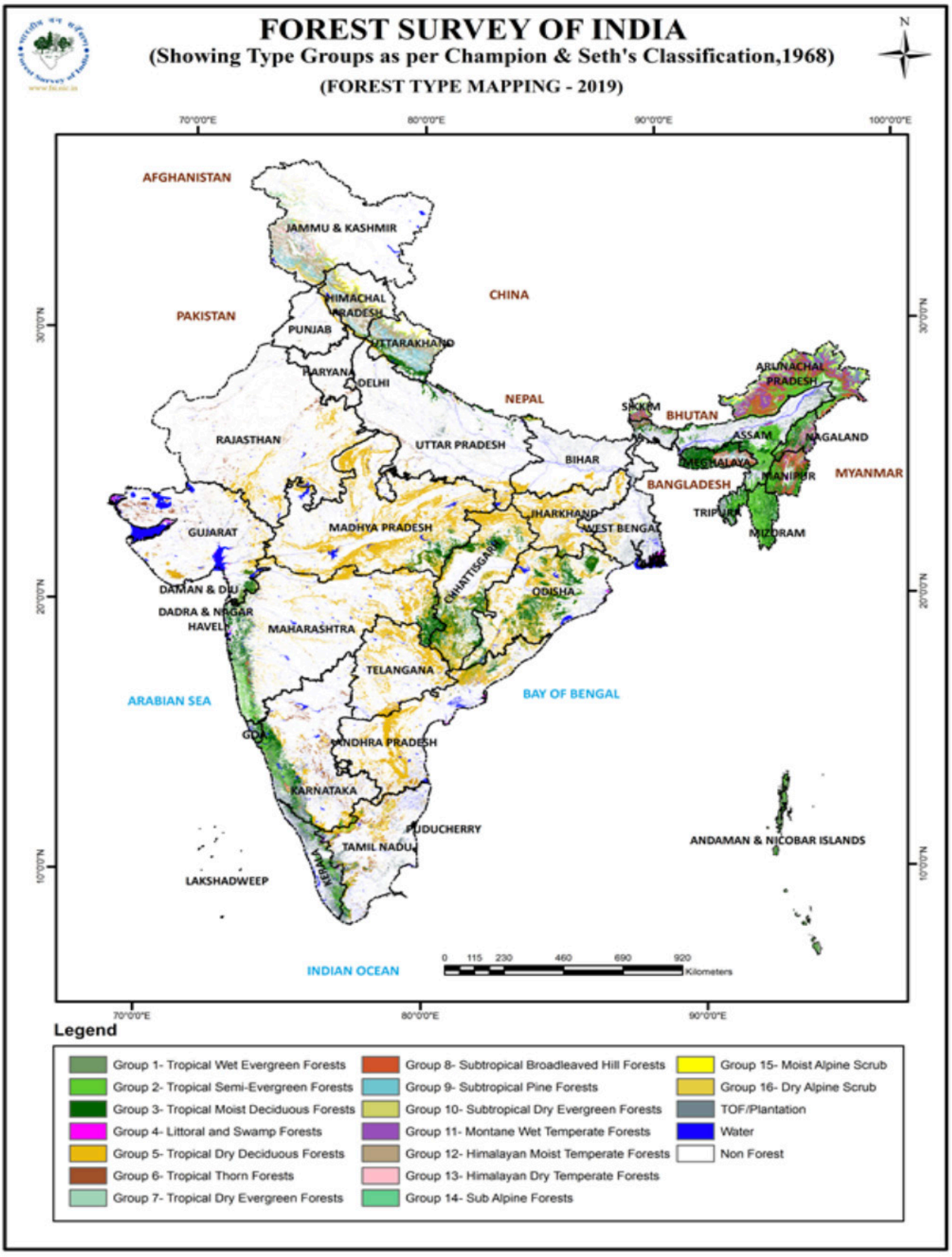
Source: Survey of India (2019) Political Map of India-Eighth Edition.

Annexure 10.1.2: Land use/land cover map of India (2015-16)



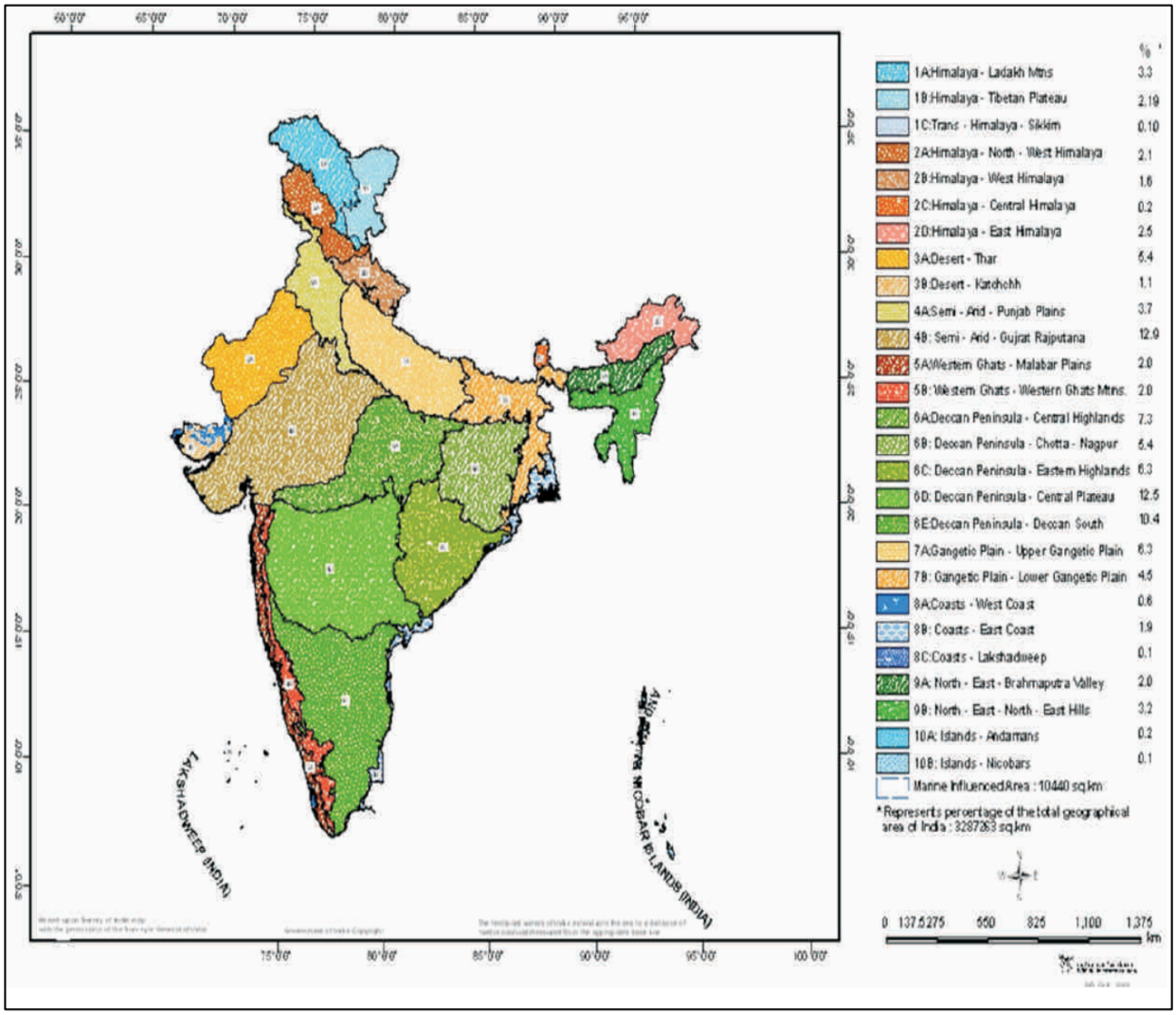
Source: NRSC (2020)

Annexure 10.1.3: Forest type mapping-2019



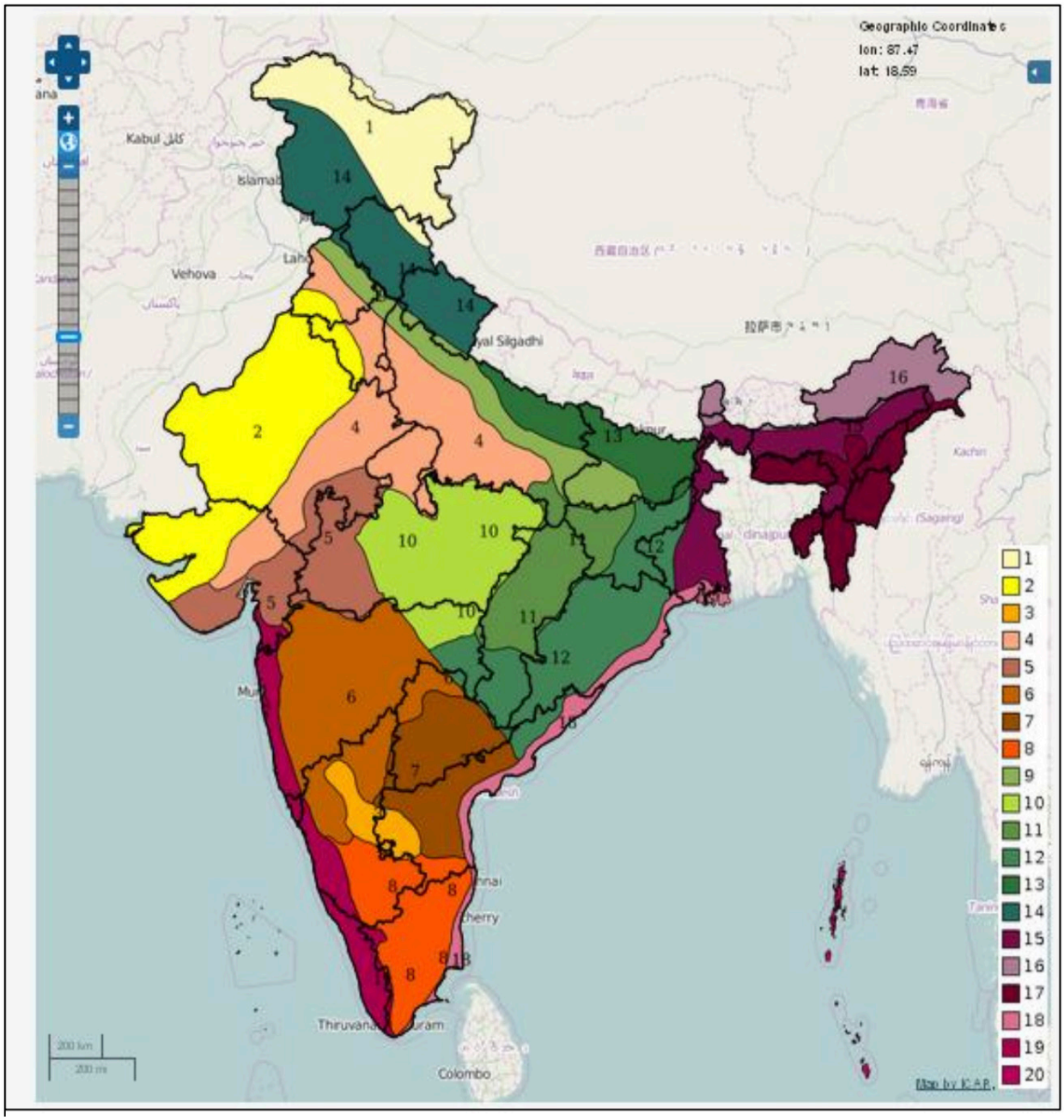
Source: FSI (2019)

Annexure 10.1.4: Biogeographic classification of India



Source: Rodgers, W. A., Panwar, H. S., Mathur, V. B. (2000)

Annexure 10.1.5: Agro-ecological regions



Source: NBSS&LUP (1999)

10.2 Bridge tables

Annexure 10.2.1: Concordance of IUCN EFGs with national ecosystem classification

(a) Built-up

National classification			IUCN EFGs		
Level I	**Level II**	**Level III**	**T7.4 Urban and infrastructure lands**	**S2.1 Anthropogenic subterranean voids**	**F3.2 Constructed lacustrine wetlands**
Built-up	Urban	Built-up – compact (continuous)	1		
Built-up	Urban	Built up – sparse (discontinuous)	1		
Built-up	Urban	Built-up – vegetated/open area	1		
Built-up	Urban	Industrial area	1		
Built-up	Urban	Ash/cooling pond / effluent and other waste			1
Built-up	Rural	Rural	COULD NOT BE MAPPED		
Built-up	Mining	Mining – active		1	
Built-up	Mining	Mining – abandoned		1	
Built-up	Mining	Quarry	COULD NOT BE MAPPED		

(b) Agriculture

National classification			IUCN EFGs			
Level I	**Level II**	**Level III**	**T7.1 Croplands**	**T7.2 Sown pastures and old fields**	**T7.3 Plantations**	**F3.3 Rice paddies**
Agriculture	Crop land	Kharif	0.78			0.22
Agriculture	Crop land	Rabi	1			
Agriculture	Crop land	Zaid	1			
Agriculture	Crop land	Cropped in two seasons	1			
Agriculture	Crop land	Cropped in more than two seasons	1			
Agriculture	Plantation	Agriculture plantation			1	
Agriculture	Fallow	Fallow land		1		
Agriculture	Current shifting cultivation	Shifting cultivation – current	1			

(c) Grass / Grazing

National Classification			IUCN EFGs			
Level I	**Level II**	**Level III**	**T4.1 Trophic savannas**	**T4.2 Pyric tussock savannas**	**T5.1 Semi-desert steppes**	**T6.4 Temperate alpine meadows and shrublands**
Grass/ grazing	Grass/ grazing	Grassland: Alpine/sub-alpine				1
Grass/ grazing	Grass/ grazing	Grassland: Temperate				1
Grass/ grazing	Grass/ grazing	Grassland: Subtropical/ tropical	0.50	0.50		
Grass/ Grazing	Grass/ Grazing	Grassland: Desertic			1	

(d) Forest

National Classification		IUCN EFGs							
Level I	**Level II**	**T1.1Tropical/ subtropical lowland rainforests**	**T1.2 Tropical/ subtropical dry forests and scrubs**	**T1.3 Tropical/ subtropical montane rainforests**	**T2.1 Boreal and montane needle-leaved forest and woodland**	**T2.2 Temperate deciduous forests and shrublands**	**T5.2 Thorny deserts and semi-deserts**	**TF1.1 Tropical flooded forests and peat forests**	**TM2.1 Coastal shrublands and grasslands**
Forest	Tropical wet evergreen forests	1							
Forest	Tropical semi evergreen forests	1							
Forest	Tropical moist deciduous forests			1					
Forest	Littoral & swamp forests							0.25	0.75
Forest	Tropical dry deciduous forests				1				
Forest	Tropical thorn forests						1		
Forest	Tropical dry evergreen Forests		1						
Forest	Subtropical broad leaved hill forests					1			
Forest	Subtropical pine forests				1				
Forest	Subtropical dry evergreen forests		1						
Forest	Montane wet temperate forests			1					
Forest	Himalayan moist temperate forests			1					
Forest	Himalayan dry temperate Forests					1			
Forest	Sub alpine forests					1			
Forest	Moist alpine scrub					1			
Forest	Dry alpine scrub					1			

(e) *Barren/unculturable/wasteland*

National classification			IUCN EFGs						
Level I	**Level II**	**Level III**	**T5.1 Semi-desert steppes**	**T5.2 Thorny deserts and semi-deserts**	**TF1.5 Episodic arid floodplains**	**MT1.2 Muddy shores**	**MT1.3 Sandy shores**	**MT1.4 Boulder/ cobble shores**	**MFT 1.3 Coastal saltmarshes**
Barren/ unculturable/ Wasteland	Salt affected land	Salt affected land	COULD NOT BE MAPPED						
Barren/ unculturable/ Wasteland	Gullied/ravine landscape	Gullied/ravine landscape	COULD NOT BE MAPPED						
Barren/ unculturable/ wasteland	Scrub land	Dense/closed and Open category of scrub land	COULD NOT BE MAPPED						
Barren/ unculturable/ wasteland	Sandy area	Desertic	0.50	0.50					
Barren/ unculturable/ wasteland	Sandy area	Coastal				0.33	0.33	0.33	
Barren/ unculturable/ wasteland	Sandy area	Riverine sandy area			1				
Barren/ unculturable/ wasteland	Barren rocky	Barren rocky	COULD NOT BE MAPPED						
Barren/ unculturable/ wasteland	Rann	Rann							1

(f) *Wetlands: River/streams/canals*

National Classification			IUCN EFGs														
Level I	**Level II**	**Level III**	**F 1.1 Permanent upland streams**	**F 1.2 Permanent lowland rivers**	**F 1.4 Seasonal upland stream**	**F 1.5 Seasonal lowland rivers**	**F 1.6 Episodic arid rivers**	**F1.7 Large lowland rivers**	**F2.1 Large permanent freshwater lakes**	**F2.2 Small permanent freshwater lakes**	**F2.3 Seasonal freshwater lakes**	**F2.7 Ephemeral salt lakes**	**F3.1 Large reservoirs**	**F3.2 Constructed lacustrine wetlands**	**F3.4 Freshwater aquafarms**	**F3.5 Canals and storm water drains**	**M4.2 Marine aquafarms**
Wetlands/ water bodies	River/ stream/ canals	Perennial river	0.30	0.35				0.35									
Wetlands/ water bodies	River/ stream/ canals	Non-perennial River			0.33	0.33	0.33										
Wetlands/ water bodies	River/ stream/ canals	Canal/drain														1	
Wetlands/ water bodies	Water bodies	Aquaculture													0.60		0.40
Wetlands/ water bodies	Water bodies	Permanent lake/ ponds							0.33	0.33					0.33		
Wetlands/ water bodies	Water bodies	Seasonal lake/ ponds									0.90	0.10					
Wetlands/ water bodies	Water bodies	Reservoir/ tanks											0.50	0.50			

(g) *Wetlands: River/streams/canals and snow*

National Classification			IUCN EFGs									
Level I	**Level II**	**Level III**	**T6.1 Ice sheets, glaciers and perennial snowfields**	**TF1.3 Permanent marshes**	**TF1.4 Seasonal floodplain marshes**	**F2.4 Freeze-thaw freshwater lakes**	**F3.2 Constructed lacustrine wetlands**	**FM 1.2 Permanently open riverine estuaries and bays**	**FM 1.3 Intermittently closed coastal lagoons**	**M1.3 Photic coral reefs**	**M1.4 Shellfish beds and reefs**	**MFT 1.3 Coastal saltmarshes**
Wetlands/ water bodies	**Inland wetland**	Wetland - inland Natural (ox-bow lake, cut off meander, waterlogged etc.)		0.49	0.49	0.02						
Wetlands/ water bodies	**Inland wetland**	Inland Manmade (water logged, saltpans etc.)					1					
Wetlands/ water bodies	**Coastal wetland**	Wetland – lagoon							1			
Wetlands/ water bodies	**Coastal wetland**	Wetland – creeks						1				
Wetlands/ water bodies	**Coastal wetland**	Wetland – mudflats						1				
Wetlands/ water bodies	**Coastal wetland**	Wetland – saltpan etc.										1
Wetlands/ water bodies	**Coastal wetland**	Coral reefs								0.50	0.50	
Snow	**Snow**	Snow	1									

Annexure 10.2.2: Comparison of land cover classes under SEEA- CF vs. Classes in India

LULC classes in India	LULC under SEEA-CF
Urban **Rural** **Mining**	Artificial surface (including urban and associated areas)
Crop land **Fallow** **Current shifting cultivation**	Herbaceous crops multiple or layered crops
Plantation	Woody crops
Evergreen/semi-evergreen **Deciduous** **Forest plantation**	Tree-covered areas
Scrub forest	Shrub-covered areas
Swamp/mangroves	Mangroves
Grass/grazing	Grass land
Salt affected Land **Gullied/ravine landscape** **Scrub land** **Sandy area** **Barren rocky** **Rann**	Sparsely natural vegetated areas (partially) Terrestrial barren land
Inland Wetlands **River/stream/canals** **Water bodies**	Inland water bodies
Coastal wetlands	Coastal water bodies and intertidal areas
Snow	Permanent snow and glacier

10.3 Detailed tables

Annexure 10.3.1: Soil Nutrient Indices

State-wise Soil Nutrient Indices, by macro and micro nutrients, Cycle I (2015-2017) (As on 5.9.2019)

S.No.	States / UT's	Macro Nutrients			
		Nitrogen (N)	Phosphorus (P)	Potassium (K)	Organic Carbon (OC)
1	Andaman and Nicobar Islands	1.01	1.08	1.16	1.32
2	Andhra Pradesh	1.07	2.47	1.96	2.00
3	Arunachal Pradesh	2.72	1.15	2.02	2.74
4	Assam	1.91	1.36	1.29	2.32
5	Bihar	1.29	1.79	1.75	1.87
6	Chhattisgarh	1.31	1.87	2.06	1.75
7	Dadra and Nagar Haveli	0.00	1.36	2.86	1.82
8	Delhi	1.22	1.50	2.07	1.40
9	Goa	1.91	1.31	2.06	2.72
10	Gujarat	1.00	2.01	2.31	1.83
11	Haryana	1.00	1.22	1.89	1.04
12	Himachal Pradesh	1.59	2.10	2.20	2.67
13	Jammu and Kashmir	1.94	1.59	1.73	2.31
14	Jharkhand	1.50	1.45	1.76	1.94
15	Karnataka	1.62	1.97	2.16	1.76
16	Kerala	1.02	1.84	1.87	2.41
17	Madhya Pradesh	1.25	1.43	2.28	1.91
18	Maharashtra	1.63	1.92	2.56	1.66
19	Manipur	1.02	1.45	1.18	2.26
20	Meghalaya	1.25	1.23	1.38	2.72
21	Mizoram	1.88	1.05	1.86	1.56
22	Nagaland	2.48	1.19	1.93	2.87
23	Odisha	1.24	1.38	1.76	1.56
24	Puducherry	1.01	1.12	1.89	0.00
25	Punjab	1.27	1.39	1.95	1.10
26	Rajasthan	1.00	1.86	2.18	1.23
27	Sikkim	1.77	1.67	2.29	2.98
28	Tamil Nadu	1.02	1.79	1.91	1.26
29	Telangana	1.31	1.54	1.98	1.22
30	Tripura	1.93	1.66	1.25	2.18
31	Uttar Pradesh	1.02	1.10	1.82	1.15
32	Uttarakhand	1.02	1.95	1.81	1.79
33	West Bengal	1.54	2.63	2.07	1.77

S.No.	States / UT's	Micro Nutrients					
		Boron (B)	Copper (Cu)	Iron (Fe)	Manganese (Mn)	Sulphur (S)	Zinc (Zn)
1	Andaman and Nicobar Islands	1.97	1.96	1.98	1.99	1.01	1.76
2	Andhra Pradesh	1.52	1.93	1.67	1.88	1.84	1.59
3	Arunachal Pradesh	1.24	1.77	1.93	1.76	1.81	1.57
4	Assam	1.20	1.94	1.96	1.96	1.90	1.93
5	Bihar	1.00	1.25	1.23	1.23	1.00	1.15
6	Chhattisgarh	1.59	1.95	1.86	1.92	1.74	1.62
7	Dadra and Nagar Haveli	2.00	2.00	1.92	2.00	2.00	1.89
8	Delhi	1.75	1.88	1.60	1.67	2.00	1.86
9	Goa	1.52	1.98	1.99	1.99	1.69	1.80
10	Gujarat	1.33	1.85	1.51	1.84	1.42	1.41
11	Haryana	1.85	1.91	1.69	1.75	1.92	1.78
12	Himachal Pradesh	1.90	1.94	1.89	1.71	1.97	1.89
13	Jammu and Kashmir	1.41	1.76	1.65	1.51	1.66	1.56
14	Jharkhand	1.67	1.94	1.91	1.92	1.60	1.66
15	Karnataka	1.54	1.92	1.49	1.82	1.65	1.46
16	Kerala	1.46	1.95	1.96	1.90	1.52	1.89
17	Madhya Pradesh	1.68	1.93	1.74	1.89	1.69	1.57
18	Maharashtra	1.24	1.97	1.38	1.89	1.24	1.50
19	Manipur	1.97	1.83	1.33	1.42	1.80	1.71
20	Meghalaya	1.12	1.90	1.66	1.70	1.38	1.76
21	Mizoram	1.67	2.00	1.94	1.99	1.68	1.93
22	Nagaland	1.77	1.57	1.86	1.73	1.94	1.61
23	Odisha	1.34	1.55	1.62	1.51	1.45	1.53
24	Puducherry	1.00	1.97	1.82	1.91	2.00	1.90
25	Punjab	1.22	1.99	1.89	1.58	1.92	1.91
26	Rajasthan	1.00	1.94	1.49	1.89	1.52	1.56
27	Sikkim	1.64	1.72	1.95	1.67	1.79	1.75
28	Tamil Nadu	1.38	1.96	1.67	1.80	1.63	1.72
29	Telangana	1.09	1.11	1.06	1.09	1.10	1.08
30	Tripura	1.89	1.97	1.93	1.97	1.62	1.89
31	Uttar Pradesh	1.64	1.95	1.76	1.88	1.63	1.71
32	Uttarakhand	1.07	1.90	1.86	1.87	1.71	1.77
33	West Bengal	1.28	1.97	1.94	1.77	1.38	1.52

State-wise Soil Nutrient Indices, by macro and micro nutrients, Cycle II (2017-2019) (As on 5.9.2019)

S.No.	States / UT's	Macro Nutrients			
		Nitrogen (N)	Phosphorus (P)	Potassium (K)	Organic Carbon (OC)
1	Andaman and Nicobar Islands	1.01	1.02	1.03	1.15
2	Andhra Pradesh	1.25	2.49	2.40	1.70
3	Arunachal Pradesh	2.96	1.02	1.17	2.97
4	Assam	1.86	1.15	1.24	1.96
5	Bihar	1.03	1.88	1.88	2.00
6	Chhattisgarh	1.25	1.82	2.21	1.70
7	Dadra and Nagar Haveli	1.27	1.44	2.79	1.88
8	Daman and Diu	1.01	1.23	1.93	1.96
9	Delhi	1.72	1.11	2.34	2.10
10	Goa	1.85	1.48	1.99	2.59
11	Gujarat	1.35	2.12	2.38	1.92
12	Haryana	1.00	1.24	2.00	1.09
13	Himachal Pradesh	1.64	2.12	2.22	2.57
14	Jammu and Kashmir	2.00	1.54	1.79	2.41
15	Jharkhand	1.46	1.45	1.75	2.02
16	Karnataka	1.57	1.89	2.16	1.77
17	Kerala	1.02	1.81	1.93	2.43
18	Madhya Pradesh	1.25	1.44	2.19	1.95
19	Maharashtra	1.39	2.04	2.57	1.68
20	Manipur	1.33	1.55	1.78	2.88
21	Meghalaya	1.31	1.21	1.45	2.73
22	Mizoram	1.89	1.03	1.93	1.59
23	Nagaland	2.72	1.14	1.91	2.78
24	Odisha	1.22	1.35	1.83	1.54
25	Puducherry	1.01	1.28	2.20	2.50
26	Punjab	1.13	1.55	2.02	1.32
27	Rajasthan	1.00	1.80	2.10	1.19
28	Sikkim	1.27	2.24	2.17	2.93
29	Tamil Nadu	1.03	1.90	2.23	1.22
30	Telangana	1.21	2.20	2.17	1.66
31	Tripura	1.46	1.71	1.37	1.74
32	Uttar Pradesh	1.02	1.16	1.79	1.13
33	Uttarakhand	1.13	2.02	1.94	1.89
34	West Bengal	1.70	2.69	1.69	2.39

S.No.	States / UT's	Micro Nutrients					
		Boron (B)	Copper (Cu)	Iron (Fe)	Manganese (Mn)	Sulphur (S)	Zinc (Zn)
1	Andaman and Nicobar Islands	1.96	1.84	2.00	1.99	1.00	1.85
2	Andhra Pradesh	1.83	1.95	1.72	1.90	1.89	1.64
3	Arunachal Pradesh	1.06	1.81	1.98	1.74	1.11	1.59
4	Assam	1.04	2.00	2.00	1.94	1.97	1.92
5	Bihar	1.57	1.94	1.56	1.83	1.71	1.94
6	Chhattisgarh	1.70	1.96	1.90	1.97	1.64	1.56
7	Dadra and Nagar Haveli	2.00	2.00	1.99	2.00	2.00	1.93
8	Daman and Diu	1.37	1.92	1.75	1.89	1.95	1.84
9	Delhi	1.85	1.99	1.93	1.88	1.77	1.99
10	Goa	1.45	1.98	2.00	1.99	1.26	1.84
11	Gujarat	1.50	1.94	1.75	1.95	1.78	1.69
12	Haryana	1.57	1.96	1.64	1.61	1.92	1.71
13	Himachal Pradesh	1.95	1.97	1.90	1.80	1.85	1.90
14	Jammu and Kashmir	1.74	1.79	1.68	1.56	1.63	1.66
15	Jharkhand	1.76	1.93	1.91	1.87	1.70	1.71
16	Karnataka	1.45	1.92	1.46	1.83	1.63	1.38
17	Kerala	1.53	1.97	1.98	1.95	1.65	1.93
18	Madhya Pradesh	1.72	1.94	1.79	1.91	1.76	1.59
19	Maharashtra	1.54	1.97	1.34	1.86	1.46	1.47
20	Manipur	1.47	1.80	1.96	1.97	1.43	1.49
21	Meghalaya	1.79	1.87	1.92	1.64	1.54	1.63
22	Mizoram	2.00	0.00	2.00	0.00	2.00	2.00
23	Nagaland	1.98	1.95	2.00	1.94	1.98	1.66
24	Odisha	1.32	1.44	1.48	1.34	1.43	1.51
25	Puducherry	1.01	1.99	1.89	1.98	2.00	1.91
26	Punjab	1.35	1.99	1.89	1.54	1.85	1.86
27	Rajasthan	1.00	1.95	1.48	1.92	1.84	1.49
28	Sikkim	1.56	1.91	1.94	1.95	1.93	1.72
29	Tamil Nadu	1.45	1.96	1.66	1.76	1.63	1.70
30	Telangana	1.76	1.90	1.56	1.78	1.80	1.60
31	Tripura	1.82	1.99	1.99	1.98	1.95	1.80
32	Uttar Pradesh	1.64	1.96	1.74	1.84	1.63	1.70
33	Uttarakhand	1.49	1.89	1.84	1.82	1.75	1.81
34	West Bengal	1.83	1.99	2.00	1.96	1.24	1.95

Annexure 10.3.2: Threshold limits for quality parameters for surface water

Designated best use	Class of water	Criteria
Drinking water source without conventional treatment but after disinfection	**A**	Total coliforms organism MPN/100ml - 50 or less pH between 6.5 and 8.5 Dissolved Oxygen 6mg/l or more Biochemical oxygen demand 5 days 20^{0}C 2mg/l or less Arsenic (mg/L) – max 0.01 Fluoride (mg/L)- max 1.0[4] Nitrate, nitrogen (mgN/L)- Max 45 (limit taken that for nitrate) [4]
Outdoor bathing (organised)	**B**	Total coliforms organism MPN/100ml - 500 or less pH between 6.5 and 8.5 Dissolved oxygen 5mg/l or more Biochemical oxygen demand 5 days 20^{0}C 3mg/l or less
Drinking water source after conventional treatment and disinfection	**C**	Total coliforms organism MPN/100ml - 5000 or less pH between 6 to 9 Dissolved Oxygen 4mg/l or more Biochemical oxygen demand 5 days 20^{0}C 3mg/l or less Arsenic (mg/L) - max 0.01[4] Fluoride (mg/L)- max 1.5[4] Nitrate, Nitrogen (mgN/L) - Max 45 (limit taken that for nitrate) [4]
Propagation of wildlife and fisheries	**D**	pH between 6.5 to 8.5 Dissolved oxygen 4mg/l or more Free ammonia (as N) 1.2 mg/l or less
Irrigation, industrial cooling, controlled waste disposal	**E**	pH between 6.0 to 8.5 Electrical conductivity at 25^{0}C micro mhos/cm Max.2250 Sodium adsorption ratio max. 26 Boron max. 2mg/l
Unclassified	**U**	

Annexure 10.3.3: Threshold limits for quality parameters for ground water

Designated Best Use	Class of Water	Criteria
Drinking water source – class I, as defined by the acceptable limits of IS 10500:2012[4]	**A**	pH between 6.5 to 8.5 Total dissolved solids, mg/l, Max- 500 Total hardness (as $CaCO_3$), mg/l, Max- 200 Iron (as Fe), mg/l, Max- 1.0 Chlorides (as Cl), mg/l, Max- 250 Sulphate (as SO_4), mg/l, Max - 200 Fluorides (as F), mg/l, Max- 1.0 Arsenic (as As), mg/l, Max- 0.01 Nitrates (as NO_3), mg/l, Max- 45 Calcium (as Ca), mg/l, Max- 75 Magnesium (as Mg), mg/l, Max- 30 Bicarbonate- 244
Drinking water source – class II, as defined by the permissible limits of IS 10500:2012[4]	**C**	pH between 6.5 to 8.5 Total dissolved solids, mg/l, Max- 2000 Total hardness (as $CaCO_3$), mg/l, Max- 600 Iron (as Fe), mg/l, Max- 1.0 Chlorides (as Cl), mg/l, Max- 1000 Sulphate (as SO_4), mg/l, Max- 400 Fluorides (as F), mg/l, Max- 1.5 Arsenic (as), mg/l, Max- 0.01 Nitrates (as NO_3), mg/l, Max- 45 Calcium (as Ca), mg/l, Max- 200 Magnesium (as Mg), mg/l, Max- 100 Bicarbonate- 732[5]
Irrigation water, as defined by the IS 11624 (1986, reaffirmed 2009)	**E**	Electrical conductance at 25° C, µS Max- 3000 Sodium adsorption Ratio, Max- 18 Sodium percentage, Max- 60 RSC, meq/l, Max- 3.0
Unclassified	**U**	

Annexure 10.3.4 Forest Condition Account

Note:
* signifies that adequate number of sample plots are not available
** Data from ISFR 2017

Country	**India**
State	**Puducherry**
Ecosystem type	Forests, by type of forests

Indicator	*Unit*	*Value*	
Extent			
Geographical Area(GA)	sq km	490	
	% of Total GA	0.01	
Type of Protection			
Recorded Forest Area (RFA)	sq km	13	
% of GA		*2.65*	
Reserved Forests (RF)	sq km	0	
Protected Forest (PF)	sq km	2	
Unclassed Forests	sq km	11	
Growing Stock			
Volume of Growing Stock	million cum	0.05	
% of country's Growing Stock		0.00	
Growing Stock in Forest	cum/ha	38.46	
Carbon Stock			
Total	'000 tonnes	403	
AGB	'000 tonnes	97	
BGB	'000 tonnes	22	
Dead Wood	'000 tonnes	0.63	
Litter	'000 tonnes	7	
SOC	'000 tonnes	276	
Carbon Stock per hectare			
Total	per hectare stock in tonnes	76.87	
AGB	per hectare stock in tonnes	18.54	
BGB	per hectare stock in tonnes	4.22	
Dead Wood	per hectare stock in tonnes	0.12	
Litter	per hectare stock in tonnes	1.42	
SOC	per hectare stock in tonnes	52.57	
Wetlands Within RFA	Number	8	
	Area (in ha)	127	
	% of RFA	41.64	
Biodiversity Assessment			
	Herbs	***Shrubs***	***Trees***
Total Number of species			
Shannon Weiner Index	***Herbs***	***Shrubs***	***Trees***
Effective number of species (ENC)	***Herbs***	***Shrubs***	***Trees***
Forest Fragmentation**			
Average Patch Size	Sq km	0.06	
Proportion of small patches (≥0.01sq km to≤1 sq km)	%	99.65	
Patch Size Range (in sq. km)	**No. of Patches**	**Area (Sq km)**	**Percentage**
>=0.01 <=1.0	853	49	90.42
>1.0 <=10	3	5	9.58
>10 <=100			
>100 <=500			
>500 <=1000			
>1000 <=5000			
>5000 <=10000			
>10000			
Total	856	54	100

Country	**India**
State	**Lakshadweep**
Ecosystem type	Forests, by type of forests

Note:
* signifies that adequate number of sample plots are not available
** Data from ISFR 2017

Indicator	*Unit*	*Value*	
Extent			
Geographical Area(GA)	sq km	30	
	% of Total GA	0.00	
Type of Protection			
Recorded Forest Area (RFA)	sq km	0	
% of GA		*0.00*	
Reserved Forests (RF)	sq km	0	
Protected Forest (PF)	sq km	0	
Unclassed Forests	sq km	0	
Growing Stock			
Volume of Growing Stock	million cum	0.00	
% of country's Growing Stock		0.00	
Growing Stock in Forest	cum/ha	0.00	
Carbon Stock			
Total	'000 tonnes	86.98	
AGB	'000 tonnes	24.73	
BGB	'000 tonnes	5.42	
Dead Wood	'000 tonnes	0.17	
Litter	'000 tonnes	1.77	
SOC	'000 tonnes	54.89	
Carbon Stock per hectare			
Total	per hectare stock in tonnes		
AGB	per hectare stock in tonnes		
BGB	per hectare stock in tonnes		
Dead Wood	per hectare stock in tonnes		
Litter	per hectare stock in tonnes		
SOC	per hectare stock in tonnes		
Wetlands Within RFA	Number		
	Area (in ha)		
	% of RFA		

Biodiversity Assessment			
	Herbs	***Shrubs***	***Trees***
Total Number of species			
Shannon Weiner Index	***Herbs***	***Shrubs***	***Trees***
Effective number of species (ENC)	***Herbs***	***Shrubs***	***Trees***

Forest Fragmentation**			
Average Patch Size	Sq km	1.29	
Proportion of small patches (≥0.01sq km to≤1 sq km)	%	61.90	
Patch Size Range (in sq. km)	**No. of Patches**	**Area (Sq km)**	**Percentage**
>=0.01 <=1.0	13	4	13.14
>1.0 <=10	8	24	86.86
>10 <=100			
>100 <=500			
>500 <=1000			
>1000 <=5000			
>5000 <=10000			
>10000			
Total	**21**	**27**	**100**

Country	**India**
State	**Daman & Diu**
Ecosystem type	Forests, by type of forests

Note:
* signifies that adequate number of sample plots are not available
** Data from ISFR 2017

Indicator	*Unit*	*Value*	
Extent			
Geographical Area(GA)	sq km	111	
	% of Total GA	0.00	
Type of Protection			
Recorded Forest Area (RFA)	sq km	8	
% of GA		*7.21*	
Reserved Forests (RF)	sq km	0	
Protected Forest (PF)	sq km	0	
Unclassed Forests	sq km	8	
Growing Stock			
Volume of Growing Stock	million cum	0.09	
% of country's Growing Stock		0.00	
Growing Stock in Forest	cum/ha	112.50	
Carbon Stock			
Total	'000 tonnes	152	
AGB	'000 tonnes	35	
BGB	'000 tonnes	10	
Dead Wood	'000 tonnes	0.27	
Litter	'000 tonnes	2	
SOC	'000 tonnes	105	
Carbon Stock per hectare			
Total	per hectare stock in tonnes	74.65	
AGB	per hectare stock in tonnes	17.23	
BGB	per hectare stock in tonnes	4.91	
Dead Wood	per hectare stock in tonnes	0.13	
Litter	per hectare stock in tonnes	1.21	
SOC	per hectare stock in tonnes	51.15	
Wetlands Within RFA	Number		
	Area (in ha)		
	% of RFA		
Biodiversity Assessment			
	Herbs	***Shrubs***	***Trees***
Total Number of species			
Shannon Weiner Index	***Herbs***	***Shrubs***	***Trees***
Effective number of species (ENC)	***Herbs***	***Shrubs***	***Trees***
Forest Fragmentation**			
Average Patch Size	Sq km	0.13	
Proportion of small patches (≥0.01sq km to≤1 sq km)	%	98.05	
Patch Size Range (in sq. km)	**No. of Patches**	**Area (Sq km)**	**Percentage**
>=0.01 <=1.0	151	12	58.71
>1.0 <=10	3	8	41.29
>10 <=100			
>100 <=500			
>500 <=1000			
>1000 <=5000			
>5000 <=10000			
>10000			
Total	**154**	**20**	**100**

Country	**India**
State	**Dadra & Nagar Haveli**
Ecosystem type	Forests, by type of forests

Note:
* signifies that adequate number of sample plots are not available
** Data from ISFR 2017

Indicator	*Unit*	*Value*	
Extent			
Geographical Area(GA)	sq km	491	
	% of Total GA	0.01	
Type of Protection			
Recorded Forest Area (RFA)	sq km	204	
% of GA		*41.55*	
Reserved Forests (RF)	sq km	199	
Protected Forest (PF)	sq km	5	
Unclassed Forests	sq km	0	
Growing Stock			
Volume of Growing Stock	million cum	0.74	
% of country's Growing Stock		0.02	
Growing Stock in Forest	cum/ha	36.27	
Carbon Stock			
Total	'000 tonnes	1,800	
AGB	'000 tonnes	500	
BGB	'000 tonnes	113	
Dead Wood	'000 tonnes	7	
Litter	'000 tonnes	47	
SOC	'000 tonnes	1,133	
Carbon Stock per hectare			
Total	per hectare stock in tonnes	86.91	
AGB	per hectare stock in tonnes	24.14	
BGB	per hectare stock in tonnes	5.47	
Dead Wood	per hectare stock in tonnes	0.35	
Litter	per hectare stock in tonnes	2.25	
SOC	per hectare stock in tonnes	54.70	
Wetlands Within RFA	Number	5	
	Area (in ha)	322	
	% of RFA	1.53	
Biodiversity Assessment			
	Herbs	***Shrubs***	***Trees***
Total Number of species	11	8	25
Shannon Weiner Index	***Herbs***	***Shrubs***	***Trees***
Tropical Moist Deciduous Forests	1.33	0.97	2.48
Tropical Dry Deciduous Forests	0.69	*	*
Effective number of species (ENC)	***Herbs***	***Shrubs***	***Trees***
Tropical Moist Deciduous Forests	3.78	2.64	11.94
Tropical Dry Deciduous Forests	1.99		
Forest Fragmentation**			
Average Patch Size	Sq km	0.13	
Proportion of small patches (≥0.01sq km to≤1 sq km)	%	98.05	
Patch Size Range (in sq. km)	**No. of Patches**	**Area (Sq km)**	**Percentage**
>=0.01 <=1.0	168	20	9.67
>1.0 <=10	10	21	10.14
>10 <=100	5	166	80.19
>100 <=500			
>500 <=1000			
>1000 <=5000			
>5000 <=10000			
>10000			
Total	**183**	**207**	**100**

Country	**India**
State	**Chandigarh**
Ecosystem type	Forests, by type of forests

Note:
* signifies that adequate number of sample plots are not available
** Data from ISFR 2017

Indicator	*Unit*	*Value*	
Extent			
Geographical Area(GA)	sq km	114	
	% of Total GA	0.00	
Type of Protection			
Recorded Forest Area (RFA)	sq km	35	
% of GA		*30.70*	
Reserved Forests (RF)	sq km	32	
Protected Forest (PF)	sq km	0	
Unclassed Forests	sq km	3	
Growing Stock			
Volume of Growing Stock	million cum	0.29	
% of country's Growing Stock		0.01	
Growing Stock in Forest	cum/ha	82.86	
Carbon Stock			
Total	'000 tonnes	189	
AGB	'000 tonnes	57	
BGB	'000 tonnes	18	
Dead Wood	'000 tonnes	0.46	
Litter	'000 tonnes	3	
SOC	'000 tonnes	111	
Carbon Stock per hectare			
Total	per hectare stock in tonnes	86.08	
AGB	per hectare stock in tonnes	25.91	
BGB	per hectare stock in tonnes	8.1	
Dead Wood	per hectare stock in tonnes	0.21	
Litter	per hectare stock in tonnes	1.58	
SOC	per hectare stock in tonnes	50.28	
Wetlands Within RFA	Number	4	
	Area (in ha)	60	
	% of RFA	6.09	
Biodiversity Assessment			
	Herbs	***Shrubs***	***Trees***
Total Number of species	7	4	21
Shannon Weiner Index	***Herbs***	***Shrubs***	***Trees***
Tropical Dry Deciduous Forests	1.56	1.23	1.6
Effective number of species (ENC)	***Herbs***	***Shrubs***	***Trees***
Tropical Dry Deciduous Forests	4.76	3.42	4.95
Forest Fragmentation**			
Average Patch Size	Sq km	0.13	
Proportion of small patches (≥0.01sq km to≤1 sq km)	%	97.58	
Patch Size Range (in sq. km)	**No. of Patches**	**Area (Sq km)**	**Percentage**
>=0.01 <=1.0	161	12	54.87
>1.0 <=10	4	10	45.13
>10 <=100			
>100 <=500			
>500 <=1000			
>1000 <=5000			
>5000 <=10000			
>10000			
Total	**165**	**22**	**100**

Country	**India**
State	**Andaman & Nicobar Islands**
Ecosystem type	Forests, by type of forests

Note:
* signifies that adequate number of sample plots are not available
** Data from ISFR 2017

Indicator	*Unit*	*Value*	
Extent			
Geographical Area(GA)	sq km	8,249	
	% of Total GA	0.25	
Type of Protection			
Recorded Forest Area (RFA)	sq km	7,171	
% of GA		*86.93*	
Reserved Forests (RF)	sq km	5,613	
Protected Forest (PF)	sq km	1,558	
Unclassed Forests	sq km	0	
Growing Stock			
Volume of Growing Stock	million cum	90.82	
% of country's Growing Stock		2.13	
Growing Stock in Forest	cum/ha	126.65	
Carbon Stock			
Total	'000 tonnes	112,666	
AGB	'000 tonnes	49,468	
BGB	'000 tonnes	15,823	
Dead Wood	'000 tonnes	1,116	
Litter	'000 tonnes	2,912	
SOC	'000 tonnes	43,347	
Carbon Stock per hectare			
Total	per hectare stock in tonnes	167.09	
AGB	per hectare stock in tonnes	73.36	
BGB	per hectare stock in tonnes	23.47	
Dead Wood	per hectare stock in tonnes	1.66	
Litter	per hectare stock in tonnes	4.32	
SOC	per hectare stock in tonnes	64.29	
Wetlands Within RFA	Number	2,267	
	Area (in ha)	89,022	
	% of RFA	13.19	

Biodiversity Assessment			
	Herbs	***Shrubs***	***Trees***
Total Number of species	79	102	89
Shannon Weiner Index	***Herbs***	***Shrubs***	***Trees***
Tropical Wet Evergreen Forests	3.28	3.34	3.01
Tropical Semi- Evergreen Forests	3.21	3.31	3.19
Tropical Moist Deciduous Forests	2.85	3.10	2.67
Littoral and Swamp Forests	2.11	2.29	*
Effective number of species (ENC)	***Herbs***	***Shrubs***	***Trees***
Tropical Wet Evergreen Forests	26.58	28.22	20.29
Tropical Semi- Evergreen Forests	24.78	27.39	24.29
Tropical Moist Deciduous Forests	17.29	22.20	14.44
Littoral and Swamp Forests	8.25	9.87	

Forest Fragmentation**			
Average Patch Size	Sq km	7.68	
Proportion of small patches (≥0.01sq km to≤1 sq km)	%	90.89	
Patch Size Range (in sq. km)	**No. of Patches**	**Area (Sq km)**	**Percentage**
>=0.01 <=1.0	798	70	1.04
>1.0 <=10	49	155	2.30
>10 <=100	21	628	9.31
>100 <=500	5	709	10.52
>500 <=1000	2	1,493	22.14
>1000 <=5000	3	3,687	54.69
>5000 <=10000			
>10000			
Total	**878**	**6,742**	**100**

Country	**India**
State	**West Bengal**
Ecosystem type	Forests, by type of forests

Note:
* signifies that adequate number of sample plots are not available
** Data from ISFR 2017

Indicator	*Unit*	*Value*	
Extent			
Geographical Area(GA)	sq km	88,752	
	% of Total GA	2.70	
Type of Protection			
Recorded Forest Area (RFA)	sq km	11,879	
% of GA		*13.38*	
Reserved Forests (RF)	sq km	7,054	
Protected Forest (PF)	sq km	3,772	
Unclassed Forests	sq km	1,053	
Growing Stock			
Volume of Growing Stock	million cum	54.87	
% of country's Growing Stock		1.28	
Growing Stock in Forest	cum/ha	46.19	
Carbon Stock			
Total	'000 tonnes	147,705	
AGB	'000 tonnes	40,388	
BGB	'000 tonnes	12,193	
Dead Wood	'000 tonnes	447	
Litter	'000 tonnes	2,533	
SOC	'000 tonnes	92,144	
Carbon Stock per hectare			
Total	per hectare stock in tonnes	87.39	
AGB	per hectare stock in tonnes	23.9	
BGB	per hectare stock in tonnes	7.21	
Dead Wood	per hectare stock in tonnes	0.26	
Litter	per hectare stock in tonnes	1.5	
SOC	per hectare stock in tonnes	54.52	
Wetlands Within RFA	Number	11,515	
	Area (in ha)	438,476	
	% of RFA	32.68	
Biodiversity Assessment			
	Herbs	***Shrubs***	***Trees***
Total Number of species	79	102	89
Shannon Weiner Index	***Herbs***	***Shrubs***	***Trees***
Tropical Semi- Evergreen Forests	2.40	2.51	2.33
Tropical Moist Deciduous Forests	1.59	1.21	2.76
Littoral and Swamp Forests	1.10	1.28	*
Tropical Dry Deciduous Forests	19.5	2.49	2.32
Subtropical Broadleaved Hill Forests	2.33	2.36	1.76
Montane Wet Temperate Forests	1.76	2.66	1.51
Himalayan Moist Temperate Forests	2.32	2.72	1.96
Sub-Alpine Forests	1.24	2.03	1.19
Effective number of species (ENC)	***Herbs***	***Shrubs***	***Trees***
Tropical Semi- Evergreen Forests	11.02	12.30	10.28
Tropical Moist Deciduous Forests	4.90	3.35	15.80
Littoral and Swamp Forests	3.00	3.60	
Tropical Dry Deciduous Forests	7.03	12.06	10.18
Subtropical Broadleaved Hill Forests	10.28	10.59	5.81
Montane Wet Temperate Forests	5.81	14.30	4.53
Himalayan Moist Temperate Forests	10.18	15.18	7.10
Sub-Alpine Forests	3.46	7.61	3.29
Forest Fragmentation**			
Average Patch Size	Sq km	0.25	
Proportion of small patches (≥0.01sq km to≤1 sq km)	%	98.01	
Patch Size Range (in sq. km)	**No. of Patches**	**Area (Sq km)**	**Percentage**
>=0.01 <=1.0	66,713	4,583	27.20
>1.0 <=10	1,151	3,089	18.33
>10 <=100	194	5,025	29.83
>100 <=500	7	1,155	6.86
>500 <=1000	1	517	3.07
>1000 <=5000	2	2,478	14.71
>5000 <=10000			
>10000			
Total	**68,068**	**16,847**	**100**

Country	**India**
State	**Uttarakhand**
Ecosystem type	Forests, by type of forests

Note:
* signifies that adequate number of sample plots are not available
** Data from ISFR 2017

Indicator	*Unit*	*Value*	
Extent			
Geographical Area(GA)	sq km	53,483	
	% of Total GA	1.63	
Type of Protection			
Recorded Forest Area (RFA)	sq km	38,000	
% of GA		*71.05*	
Reserved Forests (RF)	sq km	26,547	
Protected Forest (PF)	sq km	9,885	
Unclassed Forests	sq km	1,568	
Growing Stock			
Volume of Growing Stock	million cum	406.08	
% of country's Growing Stock		9.50	
Growing Stock in Forest	cum/ha	106.86	
Carbon Stock			
Total	'000 tonnes	370,912	
AGB	'000 tonnes	152,540	
BGB	'000 tonnes	40,975	
Dead Wood	'000 tonnes	2,948	
Litter	'000 tonnes	4,904	
SOC	'000 tonnes	169,545	
Carbon Stock per hectare			
Total	per hectare stock in tonnes	152.62	
AGB	per hectare stock in tonnes	62.77	
BGB	per hectare stock in tonnes	16.86	
Dead Wood	per hectare stock in tonnes	1.21	
Litter	per hectare stock in tonnes	2.02	
SOC	per hectare stock in tonnes	69.76	
Wetlands Within RFA	Number	221	
	Area (in ha)	54,129	
	% of RFA	2.12	

Biodiversity Assessment			
	Herbs	***Shrubs***	***Trees***
Total Number of species	94	73	112
Shannon Weiner Index	***Herbs***	***Shrubs***	***Trees***
Tropical Dry Deciduous Forests	2.18	2.19	2.53
Subtropical Pine Forests	2.41	1.90	1.84
Himalayan Moist Temperate Forests	3.70	2.58	2.41
Himalayan Dry Temperate Forests	1.85	1.76	0.65
Sub-Alpine Forests	2.82	2.49	*
Dry Alpine Scrub	1.10	1.36	*
Tropical Moist Deciduous Forests	*	2.08	2.51
Moist Alpine Scrub	*	*	1.35
Effective number of species (ENC)	***Herbs***	***Shrubs***	***Trees***
Tropical Dry Deciduous Forests	8.85	8.94	12.55
Subtropical Pine Forests	11.13	6.69	6.30
Himalayan Moist Temperate Forests	40.45	13.20	11.13
Himalayan Dry Temperate Forests	6.36	5.81	1.92
Sub-Alpine Forests	16.78	12.06	
Dry Alpine Scrub	3.00	3.90	
Tropical Moist Deciduous Forests		8.00	12.30
Moist Alpine Scrub			3.86

Forest Fragmentation**			
Average Patch Size	Sq km	1.96	
Proportion of small patches (≥0.01sq km to≤1 sq km)	%	96.93	
Patch Size Range (in sq. km)	**No. of Patches**	**Area (Sq km)**	**Percentage**
>=0.01 <=1.0	12,017	972	4.00
>1.0 <=10	322	862	3.55
>10 <=100	47	1,372	5.65
>100 <=500	6	1,040	4.28
>500 <=1000	3	2,017	8.3
>1000 <=5000	1	1,166	4.80
>5000 <=10000	1	5,153	21.21
>10000	1	11,713	48.21
Total	**12,398**	**24,295**	**100**

Country	**India**
State	**Uttar Pradesh**
Ecosystem type	Forests, by type of forests

Note:
* signifies that adequate number of sample plots are not available
** Data from ISFR 2017

Indicator	*Unit*	*Value*	
Extent			
Geographical Area(GA)	sq km	240,928	
	% of Total GA	7.33	
Type of Protection			
Recorded Forest Area (RFA)	sq km	16,582	
% of GA		*6.88*	
Reserved Forests (RF)	sq km	12,017	
Protected Forest (PF)	sq km	1,157	
Unclassed Forests	sq km	3,354	
Growing Stock			
Volume of Growing Stock	million cum	96.04	
% of country's Growing Stock		2.25	
Growing Stock in Forest	cum/ha	57.92	
Carbon Stock			
Total	'000 tonnes	115,690	
AGB	'000 tonnes	32,498	
BGB	'000 tonnes	10,374	
Dead Wood	'000 tonnes	372	
Litter	'000 tonnes	1,893	
SOC	'000 tonnes	70,553	
Carbon Stock per hectare			
Total	per hectare stock in tonnes	78.14	
AGB	per hectare stock in tonnes	21.95	
BGB	per hectare stock in tonnes	7.01	
Dead Wood	per hectare stock in tonnes	0.25	
Litter	per hectare stock in tonnes	1.28	
SOC	per hectare stock in tonnes	47.65	
Wetlands Within RFA	Number	2,351	
	Area (in ha)	42,244	
	% of RFA	3.14	
Biodiversity Assessment			
	Herbs	***Shrubs***	***Trees***
Total Number of species	86	71	84
Shannon Weiner Index	***Herbs***	***Shrubs***	***Trees***
Tropical Semi- Evergreen Forests	2.49		
Tropical Moist Deciduous Forests	2.26		
Littoral and Swamp Forests	2.63		
Tropical Dry Deciduous Forests	2.97		
Tropical Thorn Forests	*		
Effective number of species (ENC)	***Herbs***	***Shrubs***	***Trees***
Tropical Semi- Evergreen Forests	12.06	11.94	
Tropical Moist Deciduous Forests	9.58	11.13	10.07
Littoral and Swamp Forests	13.87	9.87	7.24
Tropical Dry Deciduous Forests	19.49	8.58	31.19
Tropical Thorn Forests		7.92	4.14
Forest Fragmentation**			
Average Patch Size	Sq km	0.22	
Proportion of small patches (≥0.01sq km to≤1 sq km)	%	98.70	
Patch Size Range (in sq. km)	**No. of Patches**	**Area (Sq km)**	**Percentage**
>=0.01 <=1.0	64,469	3,627	24.71
>1.0 <=10	728	1,934	13.17
>10 <=100	97	2,508	17.09
>100 <=500	20	4,086	27.84
>500 <=1000	4	2,524	17.19
>1000 <=5000			
>5000 <=10000			
>10000			
Total	**65,318**	**14,679**	**100**

Country	**India**
State	**Tripura**
Ecosystem type	Forests, by type of forests

Note:
* signifies that adequate number of sample plots are not available
** Data from ISFR 2017

Indicator	*Unit*	*Value*	
Extent			
Geographical Area(GA)	sq km	10,486	
	% of Total GA	0.32	
Type of Protection			
Recorded Forest Area (RFA)	sq km	6,294	
% of GA		*60.02*	
Reserved Forests (RF)	sq km	4,175	
Protected Forest (PF)	sq km	2	
Unclassed Forests	sq km	2,117	
Growing Stock			
Volume of Growing Stock	million cum	19.74	
% of country's Growing Stock		0.46	
Growing Stock in Forest	cum/ha	31.36	
Carbon Stock			
Total	'000 tonnes	76,057	
AGB	'000 tonnes	25,061	
BGB	'000 tonnes	5,513	
Dead Wood	'000 tonnes	297	
Litter	'000 tonnes	2,169	
SOC	'000 tonnes	43,017	
Carbon Stock per hectare			
Total	per hectare stock in tonnes	98.44	
AGB	per hectare stock in tonnes	32.44	
BGB	per hectare stock in tonnes	7.14	
Dead Wood	per hectare stock in tonnes	0.38	
Litter	per hectare stock in tonnes	2.81	
SOC	per hectare stock in tonnes	55.68	
Wetlands Within RFA	Number	710	
	Area (in ha)	3,879	
	% of RFA	0.66	
Biodiversity Assessment			
	Herbs	***Shrubs***	***Trees***
Total Number of species	22	37	89
Shannon Weiner Index	***Herbs***	***Shrubs***	***Trees***
Tropical Semi- Evergreen Forests	3.47	1.69	2.77
Tropical Moist Deciduous Forests	2.97	2.95	3.14
Effective number of species (ENC)	***Herbs***	***Shrubs***	***Trees***
Tropical Semi- Evergreen Forests	32.14	5.42	15.96
Tropical Moist Deciduous Forests	19.49	19.11	23.10
Forest Fragmentation**			
Average Patch Size	Sq km	2.27	
Proportion of small patches (≥0.01sq km to≤1 sq km)	%	97.39	
Patch Size Range (in sq. km)	**No. of Patches**	**Area (Sq km)**	**Percentage**
>=0.01 <=1.0	3,316	253	3.27
>1.0 <=10	81	211	2.73
>10 <=100	5	140	1.81
>100 <=500	2	363	4.70
>500 <=1000	0	0	0.00
>1000 <=5000	0	0	0.00
>5000 <=10000	1	6,759	87.49
>10000			
Total	**3,405**	**7,726**	**100**

Country	**India**
State	**Telangana**
Ecosystem type	Forests, by type of forests

Note:
* signifies that adequate number of sample plots are not available
** Data from ISFR 2017

Indicator	*Unit*	*Value*	
Extent			
Geographical Area(GA)	sq km	112,077	
	% of Total GA	3.41	
Type of Protection			
Recorded Forest Area (RFA)	sq km	26,904	
% of GA		*24.00*	
Reserved Forests (RF)	sq km	20,353	
Protected Forest (PF)	sq km	5,939	
Unclassed Forests	sq km	612	
Growing Stock			
Volume of Growing Stock	million cum	80.96	
% of country's Growing Stock		1.89	
Growing Stock in Forest	cum/ha	30.09	
Carbon Stock			
Total	'000 tonnes	151,842	
AGB	'000 tonnes	41,389	
BGB	'000 tonnes	17,227	
Dead Wood	'000 tonnes	333	
Litter	'000 tonnes	2,031	
SOC	'000 tonnes	90,862	
Carbon Stock per hectare			
Total	per hectare stock in tonnes	73.77	
AGB	per hectare stock in tonnes	20.11	
BGB	per hectare stock in tonnes	8.37	
Dead Wood	per hectare stock in tonnes	0.16	
Litter	per hectare stock in tonnes	0.99	
SOC	per hectare stock in tonnes	44.15	
Wetlands Within RFA	Number	1,070	
	Area (in ha)	28,239	
	% of RFA	1.05	
Biodiversity Assessment			
	Herbs	***Shrubs***	***Trees***
Total Number of species	33	67	167
Shannon Weiner Index	***Herbs***	***Shrubs***	***Trees***
Tropical Moist Deciduous Forests	1.95	3.03	2.65
Tropical Dry Deciduous Forests	2.34	2.68	3.63
Tropical Thorn Forests	1.80	2.33	2.42
Effective number of species (ENC)	***Herbs***	***Shrubs***	***Trees***
Tropical Semi- Evergreen Forests	7.03	20.70	14.15
Tropical Dry Deciduous Forests	10.38	14.59	37.71
Tropical Thorn Forests	6.05	10.28	11.25
Forest Fragmentation**			
Average Patch Size	Sq km	1.47	
Proportion of small patches (≥0.01sq km to≤1 sq km)	%	94.86	
Patch Size Range (in sq. km)	**No. of Patches**	**Area (Sq km)**	**Percentage**
>=0.01 <=1.0	13,150	1,258	6.16
>1.0 <=10	583	1,699	8.32
>10 <=100	106	2,544	12.46
>100 <=500	16	3,155	15.45
>500 <=1000	4	2,792	13.68
>1000 <=5000	4	8,971	43.93
>5000 <=10000			
>10000			
Total	**13,863**	**20,419**	**100**

Country	**India**
State	**Tamil Nadu**
Ecosystem type	Forests, by type of forests

Note:
* signifies that adequate number of sample plots are not available
** Data from ISFR 2017

Indicator	*Unit*	*Value*	
Extent			
Geographical Area(GA)	sq km	130,060	
	% of Total GA	3.96	
Type of Protection			
Recorded Forest Area (RFA)	sq km	22,877	
% of GA		*17.59*	
Reserved Forests (RF)	sq km	20,293	
Protected Forest (PF)	sq km	1,782	
Unclassed Forests	sq km	802	
Growing Stock			
Volume of Growing Stock	million cum	96.97	
% of country's Growing Stock		2.27	
Growing Stock in Forest	cum/ha	42.39	
Carbon Stock			
Total	'000 tonnes	216,782	
AGB	'000 tonnes	62,092	
BGB	'000 tonnes	21,433	
Dead Wood	'000 tonnes	776	
Litter	'000 tonnes	4,107	
SOC	'000 tonnes	128,374	
Carbon Stock per hectare			
Total	per hectare stock in tonnes	82.23	
AGB	per hectare stock in tonnes	23.55	
BGB	per hectare stock in tonnes	8.13	
Dead Wood	per hectare stock in tonnes	0.29	
Litter	per hectare stock in tonnes	1.56	
SOC	per hectare stock in tonnes	48.69	
Wetlands Within RFA	Number	1,523	
	Area (in ha)	45,219	
	% of RFA	2.09	

Biodiversity Assessment			
	Herbs	***Shrubs***	***Trees***
Total Number of species	87	313	252
Shannon Weiner Index	***Herbs***	***Shrubs***	***Trees***
Tropical Wet Evergreen Forests	2.03	3.23	3.25
Tropical Semi- Evergreen Forests	2.30	2.82	2.77
Tropical Moist Deciduous Forests	2.31	3.27	3.39
Littoral and Swamp Forests	1.43	1.04	*
Tropical Dry Deciduous Forests	2.26	3.91	3.92
Tropical Thorn Forests	1.85	3.10	3.09
Tropical Dry Evergreen Forests	1.77	2.82	2.81
Subtropical Broadleaved Hill Forests	0.62	3.20	2.94
Montane Wet Temperate Forests	2.36	2.68	2.18
Effective number of species (ENC)	***Herbs***	***Shrubs***	***Trees***
Tropical Wet Evergreen Forests	7.61	25.28	25.79
Tropical Semi- Evergreen Forests	9.97	16.78	15.96
Tropical Moist Deciduous Forests	10.07	26.31	29.67
Littoral and Swamp Forests	4.18	2.83	
Tropical Dry Deciduous Forests	9.58	49.90	50.40
Tropical Thorn Forests	6.36	22.20	21.98
Tropical Dry Evergreen Forests	5.87	16.78	16.61
Subtropical Broadleaved Hill Forests	1.86	24.53	18.92
Montane Wet Temperate Forests	10.59	14.59	8.85

Forest Fragmentation**			
Average Patch Size	Sq km	0.62	
Proportion of small patches (≥0.01sq km to≤1 sq km)	%	97.55	
Patch Size Range (in sq. km)	**No. of Patches**	**Area (Sq km)**	**Percentage**
>=0.01 <=1.0	41,335	3,288	12.51
>1.0 <=10	907	2,461	9.36
>10 <=100	112	2,871	10.92
>100 <=500	12	3,019	11.49
>500 <=1000	0	0	0.00
>1000 <=5000	6	14,642	55.72
>5000 <=10000			
>10000			
Total	**42,372**	**26,281**	**100**

Country	**India**
State	**Sikkim**
Ecosystem type	Forests, by type of forests

Note:
* signifies that adequate number of sample plots are not available
** Data from ISFR 2017

Indicator	*Unit*	*Value*	
Extent			
Geographical Area(GA)	sq km	7,096	
	% of Total GA	0.22	
Type of Protection			
Recorded Forest Area (RFA)	sq km	5,841	
% of GA		*82.31*	
Reserved Forests (RF)	sq km	5,452	
Protected Forest (PF)	sq km	389	
Unclassed Forests	sq km	0	
Growing Stock			
Volume of Growing Stock	million cum	35.32	
% of country's Growing Stock		0.83	
Growing Stock in Forest	cum/ha	60.47	
Carbon Stock			
Total	'000 tonnes	57,180	
AGB	'000 tonnes	17,645	
BGB	'000 tonnes	5,372	
Dead Wood	'000 tonnes	505	
Litter	'000 tonnes	664	
SOC	'000 tonnes	32,994	
Carbon Stock per hectare			
Total	per hectare stock in tonnes	171.04	
AGB	per hectare stock in tonnes	52.78	
BGB	per hectare stock in tonnes	16.07	
Dead Wood	per hectare stock in tonnes	1.51	
Litter	per hectare stock in tonnes	1.99	
SOC	per hectare stock in tonnes	98.69	
Wetlands Within RFA	Number	74	
	Area (in ha)	2,609	
	% of RFA	0.95	
Biodiversity Assessment			
	Herbs	***Shrubs***	***Trees***
Total Number of species	29	35	59
Shannon Weiner Index	***Herbs***	***Shrubs***	***Trees***
Tropical Moist Deciduous Forests	2.35	1.95	1.08
Subtropical Broadleaved Hill Forests	2.199	2.62	2.75
Montane Wet Temperate Forests	1.90	2.41	2.53
Himalaya Moist Temperate Forests	1.66	2.57	*
Sub-Alpine Forests	0.83	1.87	2.09
Moist Alpine Forests	0.69	0.64	*
Effective number of species (ENC)	***Herbs***	***Shrubs***	***Trees***
Tropical Moist Deciduous Forests	10.49	7.03	2.94
Subtropical Broadleaved Hill Forests	8.94	13.74	15.64
Montane Wet Temperate Forests	6.69	11.13	12.55
Himalaya Moist Temperate Forests	5.26	13.07	
Sub-Alpine Forests	2.29	6.49	8.08
Moist Alpine Forests	1.99	1.90	
Forest Fragmentation**			
Average Patch Size	Sq km	4.83	
Proportion of small patches (≥0.01sq km to≤1 sq km)	%	97.40	
Patch Size Range (in sq. km)	**No. of Patches**	**Area (Sq km)**	**Percentage**
>=0.01 <=1.0	675	48	1.43
>1.0 <=10	13	37	1.11
>10 <=100	4	119	3.56
>100 <=500	0	0	0.00
>500 <=1000	0	0	0.00
>1000 <=5000	1	3,140	93.90
>5000 <=10000			
>10000			
Total	**693**	**3,344**	**100**

Country	**India**
State	**Rajasthan**
Ecosystem type	Forests, by type of forests

Note:
* signifies that adequate number of sample plots are not available
** Data from ISFR 2017

Indicator	*Unit*	*Value*	
Extent			
Geographical Area(GA)	sq km	342	
	% of Total GA	10.41	
Type of Protection			
Recorded Forest Area (RFA)	sq km	33	
% of GA		*9.57*	
Reserved Forests (RF)	sq km	12,475	
Protected Forest (PF)	sq km	18,217	
Unclassed Forests	sq km	2,045	
Growing Stock			
Volume of Growing Stock	million cum	24.39	
% of country's Growing Stock		0.57	
Growing Stock in Forest	cum/ha	7.45	
Carbon Stock			
Total	'000 tonnes	108,363	
AGB	'000 tonnes	26,155	
BGB	'000 tonnes	10,865	
Dead Wood	'000 tonnes	191	
Litter	'000 tonnes	928	
SOC	'000 tonnes	70,224	
Carbon Stock per hectare			
Total	per hectare stock in tonnes	65.17	
AGB	per hectare stock in tonnes	15.73	
BGB	per hectare stock in tonnes	6.53	
Dead Wood	per hectare stock in tonnes	0.12	
Litter	per hectare stock in tonnes	0.56	
SOC	per hectare stock in tonnes	42.23	
Wetlands Within RFA	Number	3,826	
	Area (in ha)	56,341	
	% of RFA	1.7	
Biodiversity Assessment			
	Herbs	***Shrubs***	***Trees***
Total Number of species	8	30	65
Shannon Weiner Index	***Herbs***	***Shrubs***	***Trees***
Tropical Dry Deciduous Forests	2.01	2.63	2.59
Tropical Thorn Forests	*	1.69	1.86
Effective number of species (ENC)	***Herbs***	***Shrubs***	***Trees***
Tropical Dry Deciduous Forests	7.46	13.87	13.33
Tropical Thorn Forests		5.42	6.42
Forest Fragmentation**			
Average Patch Size	Sq km	0.47	
Proportion of small patches (≥0.01sq km to≤1 sq km)	%	96.44	
Patch Size Range (in sq. km)	**No. of Patches**	**Area (Sq km)**	**Percentage**
>=0.01 <=1.0	33,955	3,308	19.96
>1.0 <=10	1,094	2,819	17.02
>10 <=100	145	3,805	22.96
>100 <=500	10	2,367	14.28
>500 <=1000	6	4,273	25.78
>1000 <=5000			
>5000 <=10000			
>10000			
Total	**35,210**	**16,572**	**100**

Country	**India**
State	**Punjab**
Ecosystem type	Forests, by type of forests

Note:
* signifies that adequate number of sample plots are not available
** Data from ISFR 2017

Indicator	*Unit*	*Value*	
Extent			
Geographical Area(GA)	sq km	50,362	
	% of Total GA	1.53	
Type of Protection			
Recorded Forest Area (RFA)	sq km	3,084	
% of GA		*6.12*	
Reserved Forests (RF)	sq km	44	
Protected Forest (PF)	sq km	1,137	
Unclassed Forests	sq km	1,903	
Growing Stock			
Volume of Growing Stock	million cum	11.12	
% of country's Growing Stock		0.26	
Growing Stock in Forest	cum/ha	36.06	
Carbon Stock			
Total	'000 tonnes	13,344	
AGB	'000 tonnes	3,529	
BGB	'000 tonnes	1,367	
Dead Wood	'000 tonnes	25	
Litter	'000 tonnes	125	
SOC	'000 tonnes	8,298	
Carbon Stock per hectare			
Total	per hectare stock in tonnes	7,218	
AGB	per hectare stock in tonnes	19.09	
BGB	per hectare stock in tonnes	7.4	
Dead Wood	per hectare stock in tonnes	0.14	
Litter	per hectare stock in tonnes	0.67	
SOC	per hectare stock in tonnes	44.89	
Wetlands Within RFA	Number	119	
	Area (in ha)	3,068	
	% of RFA	3.32	
Biodiversity Assessment			
	Herbs	***Shrubs***	***Trees***
Total Number of species	37	31	50
Shannon Weiner Index	***Herbs***	***Shrubs***	***Trees***
Tropical Dry Deciduous Forests	1.65	2.07	3.06
Tropical Thorn Forests	2.28	2.38	1.78
Subtropical Pine Forests	2.36	1.94	*
Effective number of species (ENC)	***Herbs***	***Shrubs***	***Trees***
Tropical Dry Deciduous Forests	5.21	7.92	21.33
Tropical Thorn Forests	9.78	10.80	5.93
Subtropical Pine Forests	10.59	6.96	
Forest Fragmentation**			
Average Patch Size	Sq km	0.30	
Proportion of small patches (≥0.01sq km to≤1 sq km)	%	98.40	
Patch Size Range (in sq. km)	**No. of Patches**	**Area (Sq km)**	**Percentage**
>=0.01 <=1.0	6,086	451	24.55
>1.0 <=10	92	222	12.08
>10 <=100	3	65	3.54
>100 <=500	3	548	29.83
>500 <=1000	1	551	30.00
>1000 <=5000			
>5000 <=10000			
>10000			
Total	**6,185**	**1,837**	**100**

Country	**India**
State	**Odisha**
Ecosystem type	Forests, by type of forests

Note:
* signifies that adequate number of sample plots are not available
** Data from ISFR 2017

Indicator	*Unit*	*Value*	
Extent			
Geographical Area(GA)	sq km	155,707	
	% of Total GA	4.74	
Type of Protection			
Recorded Forest Area (RFA)	sq km	61,204	
% of GA		*39.31*	
Reserved Forests (RF)	sq km	36,049	
Protected Forest (PF)	sq km	25,133	
Unclassed Forests	sq km	22	
Growing Stock			
Volume of Growing Stock	million cum	299.04	
% of country's Growing Stock		7.00	
Growing Stock in Forest	cum/ha	48.86	
Carbon Stock			
Total	'000 tonnes	432,288	
AGB	'000 tonnes	126,656	
BGB	'000 tonnes	39,066	
Dead Wood	'000 tonnes	1,647	
Litter	'000 tonnes	9,062	
SOC	'000 tonnes	255,857	
Carbon Stock per hectare			
Total	per hectare stock in tonnes	83.75	
AGB	per hectare stock in tonnes	24.54	
BGB	per hectare stock in tonnes	7.57	
Dead Wood	per hectare stock in tonnes	0.32	
Litter	per hectare stock in tonnes	1.76	
SOC	per hectare stock in tonnes	49.57	
Wetlands Within RFA	Number	4,127	
	Area (in ha)	64,627	
	% of RFA	1.52	
Biodiversity Assessment			
	Herbs	***Shrubs***	***Trees***
Total Number of species	105	90	192
Shannon Weiner Index	***Herbs***	***Shrubs***	***Trees***
Tropical Semi-Evergreen Forests	2.78	2.51	2.05
Tropical Moist Deciduous Forests	3.48	2.91	3.10
Littoral and Swamp Forests	2.36	2.74	*
Tropical Dry Deciduous Forests	3.61	3.26	3.33
Effective number of species (ENC)	***Herbs***	***Shrubs***	***Trees***
Tropical Semi-Evergreen Forests	16.12	12.30	7.77
Tropical Moist Deciduous Forests	32.46	18.36	22.20
Littoral and Swamp Forests	10.59	15.49	
Tropical Dry Deciduous Forests	36.97	26.05	27.94
Forest Fragmentation**			
Average Patch Size	Sq km	1.33	
Proportion of small patches (≥0.01sq km to≤1 sq km)	%	95.99	
Patch Size Range (in sq. km)	**No. of Patches**	**Area (Sq km)**	**Percentage**
>=0.01 <=1.0	37,175	1,338	2.61
>1.0 <=10	1,344	3,690	7.19
>10 <=100	174	5,158	10.05
>100 <=500	22	4,511	8.79
>500 <=1000	6	4,461	8.69
>1000 <=5000	5	14,580	28.40
>5000 <=10000	1	5,480	10.67
>10000	1	12,127	23.60
Total	**38,728**	**51,345**	**100**

Country	**India**
State	**Nagaland**
Ecosystem type	Forests, by type of forests

Note:
* signifies that adequate number of sample plots are not available
** Data from ISFR 2017

Indicator	*Unit*	*Value*	
Extent			
Geographical Area(GA)	sq km	16,579	
	% of Total GA	0.50	
Type of Protection			
Recorded Forest Area (RFA)	sq km	8,623	
% of GA		*52.01*	
Reserved Forests (RF)	sq km	234	
Protected Forest (PF)	sq km	0	
Unclassed Forests	sq km	8,389	
Growing Stock			
Volume of Growing Stock	million cum	29.52	
% of country's Growing Stock		0.69	
Growing Stock in Forest	cum/ha	34.23	
Carbon Stock			
Total	'000 tonnes	135,527	
AGB	'000 tonnes	35,850	
BGB	'000 tonnes	9,612	
Dead Wood	'000 tonnes	522	
Litter	'000 tonnes	2,897	
SOC	'000 tonnes	86,646	
Carbon Stock per hectare			
Total	per hectare stock in tonnes	108.54	
AGB	per hectare stock in tonnes	28.71	
BGB	per hectare stock in tonnes	7.7	
Dead Wood	per hectare stock in tonnes	0.42	
Litter	per hectare stock in tonnes	2.32	
SOC	per hectare stock in tonnes	69.39	
Wetlands Within RFA	Number	197	
	Area (in ha)	11,522	
	% of RFA	1.08	

Biodiversity Assessment			
	Herbs	***Shrubs***	***Trees***
Total Number of species	113	137	56
Shannon Weiner Index	***Herbs***	***Shrubs***	***Trees***
Tropical Wet Evergreen Forests	2.81	3.09	*
Tropical Semi- Evergreen Forests	2.35	2.97	2.15
Tropical Moist Deciduous Forests	3.61	3.48	2.94
Subtropical Broadleaved Hill Forests	2.92	3.40	2.62
Subtropical Pine Forests	2.19	1.55	1.31
	1.90	1.17	1.04
Himalaya Moist Temperate Forests	*	1.16	*
Effective number of species (ENC)	***Herbs***	***Shrubs***	***Trees***
Tropical Wet Evergreen Forests	16.61	21.98	
Tropical Semi- Evergreen Forests	10.49	19.49	8.58
Tropical Moist Deciduous Forests	36.97	32.46	18.92
Subtropical Broadleaved Hill Forests	18.54	29.96	13.74
Subtropical Pine Forests	8.94	4.71	3.71
Montane Wet Temperate Forests	6.69	3.22	2.83
Himalaya Moist Temperate Forests		3.19	

Forest Fragmentation**			
Average Patch Size	Sq km	2.81	
Proportion of small patches (≥0.01sq km to≤1 sq km)	%	99.15	
Patch Size Range (in sq. km)	**No. of Patches**	**Area (Sq km)**	**Percentage**
>=0.01 <=1.0	4,413	212	1.70
>1.0 <=10	36	93	0.74
>10 <=100	1	12	0.10
>100 <=500	0	0	0.00
>500 <=1000	0	0	0.00
>1000 <=5000	0	0	0.00
>5000 <=10000	0	0	0.00
>10000	1	12,172	97.46
Total	**4,451**	**12,489**	**100**

Country	**India**
State	**Mizoram**
Ecosystem type	Forests, by type of forests

Note:
* signifies that adequate number of sample plots are not available
** Data from ISFR 2017

Indicator	*Unit*	*Value*	
Extent			
Geographical Area(GA)	sq km	21,081	
	% of Total GA	0.64	
Type of Protection			
Recorded Forest Area (RFA)	sq km	5,641	
% of GA		*26.76*	
Reserved Forests (RF)	sq km	4,483	
Protected Forest (PF)	sq km	0	
Unclassed Forests	sq km	1,158	
Growing Stock			
Volume of Growing Stock	million cum	21.30	
% of country's Growing Stock		0.50	
Growing Stock in Forest	cum/ha	37.76	
Carbon Stock			
Total	'000 tonnes	156,554	
AGB	'000 tonnes	44,973	
BGB	'000 tonnes	9,925	
Dead Wood	'000 tonnes	451	
Litter	'000 tonnes	4,516	
SOC	'000 tonnes	96,689	
Carbon Stock per hectare			
Total	per hectare stock in tonnes	86.95	
AGB	per hectare stock in tonnes	24.98	
BGB	per hectare stock in tonnes	5.51	
Dead Wood	per hectare stock in tonnes	0.25	
Litter	per hectare stock in tonnes	2.51	
SOC	per hectare stock in tonnes	53.70	
Wetlands Within RFA	Number	206	
	Area (in ha)	12,456	
	% of RFA	0.6	
Biodiversity Assessment			
	Herbs	***Shrubs***	***Trees***
Total Number of species	56	96	87
Shannon Weiner Index	***Herbs***	***Shrubs***	***Trees***
Tropical Semi- Evergreen Forests	3.15	3.37	3.08
Tropical Moist Deciduous Forests	3.26	3.38	2.78
Subtropical Pine Forests	2.19	2.45	
Effective number of species (ENC)	***Herbs***	***Shrubs***	***Trees***
Tropical Semi- Evergreen Forests	23.34	29.08	21.76
Tropical Moist Deciduous Forests	26.05	29.37	16.12
Subtropical Pine Forests	8.94	11.59	
Forest Fragmentation**			
Average Patch Size	Sq km	14.64	
Proportion of small patches (≥0.01sq km to≤1 sq km)	%	98.63	
Patch Size Range (in sq. km)	**No. of Patches**	**Area (Sq km)**	**Percentage**
>=0.01 <=1.0	1,225	79	0.44
>1.0 <=10	16	28	0.15
>10 <=100	0	0	0.00
>100 <=500	0	0	0.00
>500 <=1000	0	0	0.00
>1000 <=5000	0	0	0.00
>5000 <=10000	0	0	0.00
>10000	1	18,079	99.41
Total	**1,242**	**18,186**	**100**

Country	**India**
State	**Meghalaya**
Ecosystem type	Forests, by type of forests

Note:
* signifies that adequate number of sample plots are not available
** Data from ISFR 2017

Indicator	*Unit*	*Value*	
Extent			
Geographical Area(GA)	sq km	22,429	
	% of Total GA	0.68	
Type of Protection			
Recorded Forest Area (RFA)	sq km	9,496	
% of GA		*42.34*	
Reserved Forests (RF)	sq km	1,113	
Protected Forest (PF)	sq km	12	
Unclassed Forests	sq km	8,371	
Growing Stock			
Volume of Growing Stock	million cum	31.28	
% of country's Growing Stock		0.73	
Growing Stock in Forest	cum/ha	32.94	
Carbon Stock			
Total	'000 tonnes	180,966	
AGB	'000 tonnes	52,302	
BGB	'000 tonnes	14,963	
Dead Wood	'000 tonnes	731	
Litter	'000 tonnes	4,328	
SOC	'000 tonnes	108,642	
Carbon Stock per hectare			
Total	per hectare stock in tonnes	105.71	
AGB	per hectare stock in tonnes	30.55	
BGB	per hectare stock in tonnes	8.74	
Dead Wood	per hectare stock in tonnes	0.43	
Litter	per hectare stock in tonnes	2.53	
SOC	per hectare stock in tonnes	63.46	
Wetlands Within RFA	Number	244	
	Area (in ha)	21,470	
	% of RFA	1.22	
Biodiversity Assessment			
	Herbs	***Shrubs***	***Trees***
Total Number of species	42	176	93
Shannon Weiner Index	***Herbs***	***Shrubs***	***Trees***
Tropical Wet Evergreen Forests	2.17	3.54	2.79
Tropical Semi- Evergreen Forests	0.59	3.10	1.95
Tropical Moist Deciduous Forests	1.19	3.94	3.06
Subtropical Broadleaved Hill Forests	1.86	3.66	1.76
Subtropical Pine Forests	2.59	2.36	2.01
Effective number of species (ENC)	***Herbs***	***Shrubs***	***Trees***
Tropical Wet Evergreen Forests	8.76	34.47	16.28
Tropical Semi- Evergreen Forests	1.80	22.20	7.03
Tropical Moist Deciduous Forests	3.29	51.42	21.33
Subtropical Broadleaved Hill Forests	6.42	38.86	5.81
Subtropical Pine Forests	13.33	10.59	7.46
Forest Fragmentation**			
Average Patch Size	Sq km	2.46	
Proportion of small patches (≥0.01sq km to≤1 sq km)	%	98.62	
Patch Size Range (in sq. km)	**No. of Patches**	**Area (Sq km)**	**Percentage**
>=0.01 <=1.0	6,871	398	2.32
>1.0 <=10	88	224	1.30
>10 <=100	6	135	0.79
>100 <=500	0	0	0.00
>500 <=1000	0	0	0.00
>1000 <=5000	1	1,215	7.09
>5000 <=10000	0	0	0.00
>10000	1	15,174	88.50
Total	**6,967**	**17,146**	**100**

Country	**India**
State	**Manipur**
Ecosystem type	Forests, by type of forests

Note:
* signifies that adequate number of sample plots are not available
** Data from ISFR 2017

Indicator	*Unit*	*Value*	
Extent			
Geographical Area(GA)	sq km	22,327	
	% of Total GA	0.68	
Type of Protection			
Recorded Forest Area (RFA)	sq km	17,418	
% of GA		*78.01*	
Reserved Forests (RF)	sq km	1,467	
Protected Forest (PF)	sq km	4,171	
Unclassed Forests	sq km	11,780	
Growing Stock			
Volume of Growing Stock	million cum	42.03	
% of country's Growing Stock		0.98	
Growing Stock in Forest	cum/ha	24.13	
Carbon Stock			
Total	'000 tonnes	178,723	
AGB	'000 tonnes	44,723	
BGB	'000 tonnes	13,317	
Dead Wood	'000 tonnes	508	
Litter	'000 tonnes	3,924	
SOC	'000 tonnes	116,251	
Carbon Stock per hectare			
Total	per hectare stock in tonnes	106.08	
AGB	per hectare stock in tonnes	26.55	
BGB	per hectare stock in tonnes	7.9	
Dead Wood	per hectare stock in tonnes	0.3	
Litter	per hectare stock in tonnes	2.33	
SOC	per hectare stock in tonnes	69.00	
Wetlands Within RFA	Number	206	
	Area (in ha)	12,424	
	% of RFA	0.71	
Biodiversity Assessment			
	Herbs	***Shrubs***	***Trees***
Total Number of species	56	89	43
Shannon Weiner Index	***Herbs***	***Shrubs***	***Trees***
Tropical Semi- Evergreen Forests	2.02	1.56	2.49
Tropical Moist Deciduous Forests	1.15	2.47	2.25
Subtropical Broadleaved Hill Forests	2.88	3.71	2.26
Subtropical Pine Forests	1.58	2.45	1.12
Montane Wet Temperate Forests	1.75	2.67	1.48
Effective number of species (ENC)	***Herbs***	***Shrubs***	***Trees***
Tropical Semi- Evergreen Forests	7.54	4.76	12.06
Tropical Moist Deciduous Forests	3.16	11.82	9.49
Subtropical Broadleaved Hill Forests	17.81	40.85	9.58
Subtropical Pine Forests	4.85	11.59	3.06
Montane Wet Temperate Forests	5.75	14.44	4.39
Forest Fragmentation**			
Average Patch Size	Sq km	5.00	
Proportion of small patches (≥0.01sq km to≤1 sq km)	%	96.97	
Patch Size Range (in sq. km)	**No. of Patches**	**Area (Sq km)**	**Percentage**
>=0.01 <=1.0	3,364	265	1.53
>1.0 <=10	100	255	1.47
>10 <=100	4	165	0.95
>100 <=500	0	0	0.00
>500 <=1000	0	0	0.00
>1000 <=5000	0	0	0.00
>5000 <=10000	0	0	0.00
>10000	1	16,661	96.05
Total	**3,469**	**17,346**	**100**

Country	**India**
State	**Maharashtra**
Ecosystem type	Forests, by type of forests

Note:
* signifies that adequate number of sample plots are not available
** Data from ISFR 2017

Indicator	*Unit*	*Value*	
Extent			
Geographical Area(GA)	sq km	307,713	
	% of Total GA	9.36	
Type of Protection			
Recorded Forest Area (RFA)	sq km	62	
% of GA		*20.01*	
Reserved Forests (RF)	sq km	49,546	
Protected Forest (PF)	sq km	6,733	
Unclassed Forests	sq km	5,300	
Growing Stock			
Volume of Growing Stock	million cum	231.76	
% of country's Growing Stock		5.42	
Growing Stock in Forest	cum/ha	37.64	
Carbon Stock			
Total	'000 tonnes	440,508	
AGB	'000 tonnes	131,249	
BGB	'000 tonnes	40,380	
Dead Wood	'000 tonnes	1,586	
Litter	'000 tonnes	10,687	
SOC	'000 tonnes	256,606	
Carbon Stock per hectare			
Total	per hectare stock in tonnes	86.75	
AGB	per hectare stock in tonnes	25.85	
BGB	per hectare stock in tonnes	7.95	
Dead Wood	per hectare stock in tonnes	0.31	
Litter	per hectare stock in tonnes	2.10	
SOC	per hectare stock in tonnes	50.53	
Wetlands Within RFA	Number	8,821	
	Area (in ha)	116,837	
	% of RFA	2.07	
Biodiversity Assessment			
	Herbs	***Shrubs***	***Trees***
Total Number of species	54	135	170
Shannon Weiner Index	***Herbs***	***Shrubs***	***Trees***
Tropical Semi- Evergreen Forests	2.44	2.65	3.38
Tropical Moist Deciduous Forests	2.09	2.60	3.57
Tropical Dry Deciduous Forests	2.76	2.83	3.03
Tropical Thorn Forests	1.96	2.51	1.51
Subtropical Broadleaved Hill Forests	1.07	2.40	0.78
Littoral and Swamp Forests	*	0.77	0.56
Effective number of species (ENC)	***Herbs***	***Shrubs***	***Trees***
Tropical Semi- Evergreen Forests	11.47	14.15	29.37
Tropical Moist Deciduous Forests	8.08	13.46	35.52
Tropical Dry Deciduous Forests	15.80	16.95	20.70
Tropical Thorn Forests	7.10	12.30	4.53
Subtropical Broadleaved Hill Forests	2.92	11.20	2.18
Littoral and Swamp Forests		2.16	1.75
Forest Fragmentation**			
Average Patch Size	Sq km	0.21	
Proportion of small patches (≥0.01sq km to≤1 sq km)	%	97.48	
Patch Size Range (in sq. km)	**No. of Patches**	**Area (Sq km)**	**Percentage**
>=0.01 <=1.0	235,087	18,506	36.51
>1.0 <=10	5,666	14,148	27.92
>10 <=100	380	9,478	18.70
>100 <=500	22	4,212	8.31
>500 <=1000	4	2,626	5.18
>1000 <=5000	1	1,712	3.38
>5000 <=10000			
>10000			
Total	**241,160**	**50,682**	**100**

Country	**India**
State	**Madhya Pradesh**
Ecosystem type	Forests, by type of forests

Note:
* signifies that adequate number of sample plots are not available
** Data from ISFR 2017

Indicator	*Unit*	*Value*	
Extent			
Geographical Area(GA)	sq km	308,252	
	% of Total GA	9.38	
Type of Protection			
Recorded Forest Area (RFA)	sq km	94,689	
% of GA		*30.72*	
Reserved Forests (RF)	sq km	61,886	
Protected Forest (PF)	sq km	31,098	
Unclassed Forests	sq km	1,705	
Growing Stock			
Volume of Growing Stock	million cum	342.62	
% of country's Growing Stock		8.02	
Growing Stock in Forest	cum/ha	36.18	
Carbon Stock			
Total	'000 tonnes	588,727	
AGB	'000 tonnes	165,067	
BGB	'000 tonnes	64,630	
Dead Wood	'000 tonnes	1,535	
Litter	'000 tonnes	8,156	
SOC	'000 tonnes	349,339	
Carbon Stock per hectare			
Total	per hectare stock in tonnes	75.98	
AGB	per hectare stock in tonnes	21.3	
BGB	per hectare stock in tonnes	8.34	
Dead Wood	per hectare stock in tonnes	0.2	
Litter	per hectare stock in tonnes	1.05	
SOC	per hectare stock in tonnes	45.09	
Wetlands Within RFA	Number	8,540	
	Area (in ha)	162,573	
	% of RFA	1.83	
Biodiversity Assessment			
	Herbs	***Shrubs***	***Trees***
Total Number of species	72	79	146
Shannon Weiner Index	***Herbs***	***Shrubs***	***Trees***
Tropical Moist Deciduous Forests	2.77	2.55	2.91
Tropical Dry Deciduous Forests	2.60	1.21	3.16
Tropical Thorn Forests	2.35	2.11	*
Subtropical Broadleaved Hill Forests	2.09	2.49	*
Littoral and Swamp Forests	*	*	0.94
Effective number of species (ENC)	***Herbs***	***Shrubs***	***Trees***
Tropical Moist Deciduous Forests	15.96	12.81	18.36
Tropical Dry Deciduous Forests	13.46	3.35	23.57
Tropical Thorn Forests	10.49	8.25	
Subtropical Broadleaved Hill Forests	8.08	12.06	
Littoral and Swamp Forests			2.56
Forest Fragmentation**			
Average Patch Size	Sq km	1.53	
Proportion of small patches (≥0.01sq km to≤1 sq km)	%	96.53	
Patch Size Range (in sq. km)	**No. of Patches**	**Area (Sq km)**	**Percentage**
>=0.01 <=1.0	48,950	3,143	4.06
>1.0 <=10	1,387	3,260	4.21
>10 <=100	260	5,895	7.62
>100 <=500	42	7,497	9.68
>500 <=1000	10	5,528	7.14
>1000 <=5000	58	24,935	32.21
>5000 <=10000	5	27,156	35.08
>10000			
Total	**50,712**	**77,414**	**100**

Country	**India**
State	**Kerala**
Ecosystem type	Forests, by type of forests

Note:
* signifies that adequate number of sample plots are not available
** Data from ISFR 2017

Indicator	*Unit*	*Value*	
Extent			
Geographical Area(GA)	sq km	38,852	
	% of Total GA	1.18	
Type of Protection			
Recorded Forest Area (RFA)	sq km	11,309	
% of GA		*29.11*	
Reserved Forests (RF)	sq km	11,309	
Protected Forest (PF)	sq km	0	
Unclassed Forests	sq km	0	
Growing Stock			
Volume of Growing Stock	million cum	147.10	
% of country's Growing Stock		3.44	
Growing Stock in Forest	cum/ha	130.07	
Carbon Stock			
Total	'000 tonnes	212,956	
AGB	'000 tonnes	67,979	
BGB	'000 tonnes	19,070	
Dead Wood	'000 tonnes	1,017	
Litter	'000 tonnes	5,001	
SOC	'000 tonnes	119,889	
Carbon Stock per hectare			
Total	per hectare stock in tonnes	100.72	
AGB	per hectare stock in tonnes	32.15	
BGB	per hectare stock in tonnes	9.02	
Dead Wood	per hectare stock in tonnes	0.48	
Litter	per hectare stock in tonnes	2.36	
SOC	per hectare stock in tonnes	56.70	
Wetlands Within RFA	Number	359	
	Area (in ha)	23,157	
	% of RFA	2.03	
Biodiversity Assessment			
	Herbs	***Shrubs***	***Trees***
Total Number of species	81	158	238
Shannon Weiner Index	***Herbs***	***Shrubs***	***Trees***
Tropical Wet Evergreen Forests	2.94	3.26	3.78
Tropical Semi-Evergreen Forests	2.15	2.87	3.80
Tropical Moist Deciduous Forests	2.62	2.97	3.48
Littoral and Swamp Forests	0.95	1.42	*
Tropical Dry Deciduous Forests	2.45	2.63	3.10
Tropical Thorn Forests	1.43	2.46	*
Montane Wet Temperate Forests	2.14	2.20	1.84
Effective number of species (ENC)	***Herbs***	***Shrubs***	***Trees***
Tropical Wet Evergreen Forests	18.92	26.05	43.82
Tropical Semi-Evergreen Forests	8.58	17.64	44.70
Tropical Moist Deciduous Forests	13.74	19.49	32.46
Littoral and Swamp Forests	2.59	4.14	
Tropical Dry Deciduous Forests	11.59	13.87	22.20
Tropical Thorn Forests	4.18	11.70	
Montane Wet Temperate Forests	8.50	9.03	6.30
Forest Fragmentation**			
Average Patch Size	Sq km	0.62	
Proportion of small patches (≥0.01sq km to≤1 sq km)	%	98.25	
Patch Size Range (in sq. km)	**No. of Patches**	**Area (Sq km)**	**Percentage**
>=0.01 <=1.0	32,038	2,083	10.25
>1.0 <=10	523	1,309	6.44
>10 <=100	42	1,006	4.95
>100 <=500	3	687	3.38
>500 <=1000	2	1,180	5.81
>1000 <=5000	2	14,056	69.17
>5000 <=10000			
>10000			
Total	**32,610**	**20,321**	**100**

Country	**India**
State	**Karnataka**
Ecosystem type	Forests, by type of forests

Note:
* signifies that adequate number of sample plots are not available
** Data from ISFR 2017

Indicator	*Unit*	*Value*	
Extent			
Geographical Area(GA)	sq km	191,791	
	% of Total GA	5.83	
Type of Protection			
Recorded Forest Area (RFA)	sq km	38,284	
% of GA		*19.96*	
Reserved Forests (RF)	sq km	28,690	
Protected Forest (PF)	sq km	3,931	
Unclassed Forests	sq km	5,663	
Growing Stock			
Volume of Growing Stock	million cum	334.08	
% of country's Growing Stock		7.82	
Growing Stock in Forest	cum/ha	87.26	
Carbon Stock			
Total	'000 tonnes	383,763	
AGB	'000 tonnes	128,882	
BGB	'000 tonnes	38,742	
Dead Wood	'000 tonnes	1,993	
Litter	'000 tonnes	8,931	
SOC	'000 tonnes	205,215	
Carbon Stock per hectare			
Total	per hectare stock in tonnes	99.49	
AGB	per hectare stock in tonnes	33.41	
BGB	per hectare stock in tonnes	10.04	
Dead Wood	per hectare stock in tonnes	0.52	
Litter	per hectare stock in tonnes	2.32	
SOC	per hectare stock in tonnes	53.20	
Wetlands Within RFA	Number	2,038	
	Area (in ha)	53,119	
	% of RFA	1.71	

Biodiversity Assessment			
	Herbs	***Shrubs***	***Trees***
Total Number of species	40	140	325
Shannon Weiner Index	***Herbs***	***Shrubs***	***Trees***
Tropical Wet Evergreen Forests	2.22	3.09	4.19
Tropical Semi-Evergreen Forests	1.85	2.58	4.00
Tropical Moist Deciduous Forests	2.24	2.66	3.56
Tropical Dry Deciduous Forests	1.04	2.68	3.66
Tropical Thorn Forests	1.01	2.32	3.09
Subtropical Broadleaved Hill Forests	1.29	2.55	2.53
Montane Wet Temperate Forests	*	*	1.88
Effective number of species (ENC)	***Herbs***	***Shrubs***	***Trees***
Tropical Wet Evergreen Forests	9.21	21.98	66.02
Tropical Semi-Evergreen Forests	6.36	13.20	54.60
Tropical Moist Deciduous Forests	9.39	14.30	35.16
Littoral and Swamp Forests	2.83	14.59	38.86
Tropical Dry Deciduous Forests	2.75	10.18	21.98
Subtropical Broadleaved Hill Forests	3.63	12.81	12.55
Montane Wet Temperate Forests			6.55

Forest Fragmentation**			
Average Patch Size	Sq km	0.95	
Proportion of small patches (≥0.01sq km to≤1 sq km)	%	97.05	
Patch Size Range (in sq. km)	**No. of Patches**	**Area (Sq km)**	**Percentage**
>=0.01 <=1.0	38,215	3,137	8.35
>1.0 <=10	1,011	2,819	7.51
>10 <=100	136	3,712	9.89
>100 <=500	10	1,770	4.71
>500 <=1000	1	947	2.52
>1000 <=5000	3	5,529	14.72
>5000 <=10000	1	8,389	22.34
>10000	1	11,246	29.95
Total	**39,378**	**37,549**	**100**

Country	**India**
State	**Jharkhand**
Ecosystem type	Forests, by type of forests

Note:
* signifies that adequate number of sample plots are not available
** Data from ISFR 2017

Indicator	*Unit*	*Value*	
Extent			
Geographical Area(GA)	sq km	79,716	
	% of Total GA	2.42	
Type of Protection			
Recorded Forest Area (RFA)	sq km	23,605	
% of GA		*29.61*	
Reserved Forests (RF)	sq km	4,387	
Protected Forest (PF)	sq km	19,185	
Unclassed Forests	sq km	33	
Growing Stock			
Volume of Growing Stock	million cum	96.22	
% of country's Growing Stock		2.25	
Growing Stock in Forest	cum/ha	40.76	
Carbon Stock			
Total	'000 tonnes	178,012	
AGB	'000 tonnes	48,994	
BGB	'000 tonnes	19,899	
Dead Wood	'000 tonnes	423	
Litter	'000 tonnes	2,826	
SOC	'000 tonnes	105,870	
Carbon Stock per hectare			
Total	per hectare stock in tonnes	75.39	
AGB	per hectare stock in tonnes	20.75	
BGB	per hectare stock in tonnes	8.43	
Dead Wood	per hectare stock in tonnes	0.18	
Litter	per hectare stock in tonnes	1.20	
SOC	per hectare stock in tonnes	44.84	
Wetlands Within RFA	Number	1,162	
	Area (in ha)	16,528	
	% of RFA	0.87	
Biodiversity Assessment			
	Herbs	***Shrubs***	***Trees***
Total Number of species	40	26	111
Shannon Weiner Index	***Herbs***	***Shrubs***	***Trees***
Tropical Moist Deciduous Forests	2.43	1.77	2.18
Tropical Dry Deciduous Forests	3.04	2.04	2.70
Effective number of species (ENC)	***Herbs***	***Shrubs***	***Trees***
Tropical Moist Deciduous Forests	11.36	5.87	8.85
Tropical Dry Deciduous Forests	20.91	7.69	14.88
Forest Fragmentation**			
Average Patch Size	Sq km	0.67	
Proportion of small patches (≥0.01sq km to≤1 sq km)	%	98.04	
Patch Size Range (in sq. km)	**No. of Patches**	**Area (Sq km)**	**Percentage**
>=0.01 <=1.0	34,725	2,247	9.54
>1.0 <=10	597	1,684	7.14
>10 <=100	73	2,055	8.73
>100 <=500	19	5,209	22.12
>500 <=1000	1	965	4.10
>1000 <=5000	3	11,393	48.37
>5000 <=10000			
>10000			
Total	**35,418**	**23,553**	**100**

Country	**India**
State	**Jammu & Kashmir**
Ecosystem type	Forests, by type of forests

Note:
* signifies that adequate number of sample plots are not available
** Data from ISFR 2017

Indicator	*Unit*	*Value*	
Extent			
Geographical Area(GA)	sq km	222,236	
	% of Total GA	6.76	
Type of Protection			
Recorded Forest Area (RFA)	sq km	20,230	
% of GA		*9.10*	
Reserved Forests (RF)	sq km	17,643	
Protected Forest (PF)	sq km	2,551	
Unclassed Forests	sq km	36	
Growing Stock			
Volume of Growing Stock	million cum	291.63	
% of country's Growing Stock		6.82	
Growing Stock in Forest	cum/ha	144.16	
Carbon Stock			
Total	'000 tonnes	390,195	
AGB	'000 tonnes	170,222	
BGB	'000 tonnes	47,806	
Dead Wood	'000 tonnes	3,813	
Litter	'000 tonnes	3,706	
SOC	'000 tonnes	164,648	
Carbon Stock per hectare			
Total	per hectare stock in tonnes	165.25	
AGB	per hectare stock in tonnes	72.09	
BGB	per hectare stock in tonnes	20.25	
Dead Wood	per hectare stock in tonnes	1.62	
Litter	per hectare stock in tonnes	1.57	
SOC	per hectare stock in tonnes	69.73	
Wetlands Within RFA	Number	481	
	Area (in ha)	36,262	
	% of RFA	1.31	

Biodiversity Assessment			
	Herbs	***Shrubs***	***Trees***
Total Number of species	272	133	73
Shannon Weiner Index	***Herbs***	***Shrubs***	***Trees***
Tropical Dry Deciduous Forests	2.04	3.00	2.28
Subtropical Pine Forests	1.97	3.37	2.43
Subtropical Dry Evergreen Forests	2.46	2.64	0.69
Himalayan Moist Temperate Forests	4.10	3.26	1.98
Himalayan Dry Temperate Forests	3.68	2.49	1.53
Sub-Alpine Forests	3.52	2.96	1.58
Moist Alpine Scrub	2.77	1.30	1.25
Dry Alpine Scrub	*	*	1.05
Effective number of species (ENC)	***Herbs***	***Shrubs***	***Trees***
Tropical Dry Deciduous Forests	7.69	20.09	9.78
Subtropical Pine Forests	7.17	29.08	11.36
Subtropical Dry Evergreen Forests	11.70	14.01	1.99
Himalayan Moist Temperate Forests	60.34	26.05	7.24
Himalayan Dry Temperate Forests	39.65	12.06	4.62
Sub-Alpine Forests	33.78	19.30	4.85
Moist Alpine Scrub	15.96	3.67	3.49
Dry Alpine Scrub			2.86

Forest Fragmentation**			
Average Patch Size	Sq km	0.54	
Proportion of small patches (≥0.01sq km to≤1 sq km)	%	97.85	
Patch Size Range (in sq. km)	**No. of Patches**	**Area (Sq km)**	**Percentage**
>=0.01 <=1.0	41,872	2,900	12.48
>1.0 <=10	798	2,067	8.89
>10 <=100	97	2,754	11.85
>100 <=500	15	3,120	13.42
>500 <=1000	4	2,874	12.37
>1000 <=5000	5	9,526	40.99
>5000 <=10000			
>10000			
Total	**42,791**	**23,241**	**100**

Country	**India**
State	**Himachal Pradesh**
Ecosystem type	Forests, by type of forests

Note:
* signifies that adequate number of sample plots are not available
** Data from ISFR 2017

Indicator	*Unit*	*Value*	
Extent			
Geographical Area(GA)	sq km	55,673	
	% of Total GA	1.69	
Type of Protection			
Recorded Forest Area (RFA)	sq km	37,033	
% of GA		*66.52*	
Reserved Forests (RF)	sq km	1,898	
Protected Forest (PF)	sq km	33,130	
Unclassed Forests	sq km	2,005	
Growing Stock			
Volume of Growing Stock	million cum	347.07	
% of country's Growing Stock		8.12	
Growing Stock in Forest	cum/ha	93.72	
Carbon Stock			
Total	'000 tonnes	252,360	
AGB	'000 tonnes	110,045	
BGB	'000 tonnes	30,745	
Dead Wood	'000 tonnes	2,559	
Litter	'000 tonnes	2,711	
SOC	'000 tonnes	106,300	
Carbon Stock per hectare			
Total	per hectare stock in tonnes	163.51	
AGB	per hectare stock in tonnes	71.30	
BGB	per hectare stock in tonnes	19.92	
Dead Wood	per hectare stock in tonnes	1.66	
Litter	per hectare stock in tonnes	1.76	
SOC	per hectare stock in tonnes	68.87	
Wetlands Within RFA	Number	113	
	Area (in ha)	8,221	
	% of RFA	0.59	
Biodiversity Assessment			
	Herbs	***Shrubs***	***Trees***
Total Number of species	109	99	116
Shannon Weiner Index	***Herbs***	***Shrubs***	***Trees***
Tropical Moist Deciduous Forests	1.71	2.15	1.95
Tropical Dry Deciduous Forests	1.95	2.13	2.87
Subtropical Pine Forests	1.89	2.17	2.63
Himalayan Moist Temperate Forests	3.48	3.25	2.95
Himalayan Dry Temperate Forests	2.51	2.56	2.03
Sub-Alpine Forests	1.87	1.83	1.64
Dry Alpine Scrub	2.30	2.34	0.87
Moist Alpine Scrub	*	*	0.17
Effective number of species (ENC)	***Herbs***	***Shrubs***	***Trees***
Tropical Moist Deciduous Forests	5.53	8.58	7.03
Tropical Dry Deciduous Forests	7.03	8.41	17.64
Subtropical Pine Forests	6.62	8.76	13.87
Himalayan Moist Temperate Forests	32.46	25.79	19.11
Himalayan Dry Temperate Forests	12.30	12.94	7.61
Sub-Alpine Forests	6.49	6.23	5.16
Dry Alpine Scrub	9.97	10.38	2.39
Moist Alpine Scrub			1.19
Forest Fragmentation**			
Average Patch Size	Sq km	0.66	
Proportion of small patches (≥0.01sq km to≤1 sq km)	%	97.15	
Patch Size Range (in sq. km)	**No. of Patches**	**Area (Sq km)**	**Percentage**
>=0.01 <=1.0	22,082	1,578	10.45
>1.0 <=10	554	1,482	9.82
>10 <=100	76	2,276	15.07
>100 <=500	9	1,635	10.83
>500 <=1000	4	3,020	20.00
>1000 <=5000	4	5,109	33.83
>5000 <=10000			
>10000			
Total	**22,729**	**15,100**	**100**

Country	**India**
State	**Haryana**
Ecosystem type	Forests, by type of forests

Note:
* signifies that adequate number of sample plots are not available
** Data from ISFR 2017

Indicator	*Unit*	*Value*	
Extent			
Geographical Area(GA)	sq km	44,212	
	% of Total GA	1.34	
Type of Protection			
Recorded Forest Area (RFA)	sq km	1,559	
% of GA		*3.53*	
Reserved Forests (RF)	sq km	249	
Protected Forest (PF)	sq km	1,158	
Unclassed Forests	sq km	152	
Growing Stock			
Volume of Growing Stock	million cum	4.22	
% of country's Growing Stock		0.10	
Growing Stock in Forest	cum/ha	27.07	
Carbon Stock			
Total	'000 tonnes	10,466	
AGB	'000 tonnes	2,455	
BGB	'000 tonnes	929	
Dead Wood	'000 tonnes	18	
Litter	'000 tonnes	137	
SOC	'000 tonnes	6,927	
Carbon Stock per hectare			
Total	per hectare stock in tonnes	65.31	
AGB	per hectare stock in tonnes	15.32	
BGB	per hectare stock in tonnes	5.8	
Dead Wood	per hectare stock in tonnes	0.11	
Litter	per hectare stock in tonnes	0.86	
SOC	per hectare stock in tonnes	43.23	
Wetlands Within RFA	Number	78	
	Area (in ha)	18,885	
	% of RFA	3.33	

Biodiversity Assessment			
	Herbs	***Shrubs***	***Trees***
Total Number of species	50	43	45
Shannon Weiner Index	***Herbs***	***Shrubs***	***Trees***
Tropical Dry Deciduous Forests	1.70	1.88	2.69
Tropical Thorn Forests	2.24	1.96	1.94
Subtropical Pine Forests	2.23	2.62	*
Effective number of species (ENC)	***Herbs***	***Shrubs***	***Trees***
Tropical Dry Deciduous Forests	5.47	6.55	14.73
Tropical Thorn Forests	9.39	7.10	6.96
Subtropical Pine Forests	9.30	13.74	

Forest Fragmentation**			
Average Patch Size	Sq km	0.27	
Proportion of small patches (≥0.01sq km to≤1 sq km)	%	98.01	
Patch Size Range (in sq. km)	**No. of Patches**	**Area (Sq km)**	**Percentage**
>=0.01 <=1.0	5,822	557	35.08
>1.0 <=10	104	235	14.80
>10 <=100	12	466	29.34
>100 <=500	2	330	20.78
>500 <=1000			
>1000 <=5000			
>5000 <=10000			
>10000			
Total	**5,940**	**1,588**	**100**

Country	**India**
State	**Gujarat**
Ecosystem type	Forests, by type of forests

Note:
* signifies that adequate number of sample plots are not available
** Data from ISFR 2017

Indicator	*Unit*	*Value*	
Extent			
Geographical Area(GA)	sq km	196,244	
	% of Total GA	5.97	
Type of Protection			
Recorded Forest Area (RFA)	sq km	21,647	
% of GA		*11.03*	
Reserved Forests (RF)	sq km	14,373	
Protected Forest (PF)	sq km	2,886	
Unclassed Forests	sq km	4,388	
Growing Stock			
Volume of Growing Stock	million cum	48.31	
% of country's Growing Stock		1.13	
Growing Stock in Forest	cum/ha	22.32	
Carbon Stock			
Total	'000 tonnes	107,247	
AGB	'000 tonnes	27,737	
BGB	'000 tonnes	9,636	
Dead Wood	'000 tonnes	315	
Litter	'000 tonnes	1,556	
SOC	'000 tonnes	68,003	
Carbon Stock per hectare			
Total	per hectare stock in tonnes	72.18	
AGB	per hectare stock in tonnes	18.67	
BGB	per hectare stock in tonnes	6.49	
Dead Wood	per hectare stock in tonnes	0.21	
Litter	per hectare stock in tonnes	1.05	
SOC	per hectare stock in tonnes	45.77	
Wetlands Within RFA	Number	3,529	
	Area (in ha)	1,210,675	
	% of RFA	39.88	

Biodiversity Assessment			
	Herbs	***Shrubs***	***Trees***
Total Number of species	73	37	102
Shannon Weiner Index	***Herbs***	***Shrubs***	***Trees***
Tropical Moist Deciduous Forests	2.02	2.40	2.80
Littoral and Swamp Forests	1.80	0.86	*
Tropical Dry Deciduous Forests	3.30	2.14	3.09
Tropical Thorn Forests	2.58	1.44	1.93
Effective number of species (ENC)	***Herbs***	***Shrubs***	***Trees***
Tropical Moist Deciduous Forests	7.54	11.02	16.44
Littoral and Swamp Forests	6.05	2.36	
Tropical Dry Deciduous Forests	27.11	8.50	21.98
Tropical Thorn Forests	13.20	4.22	6.89

Forest Fragmentation**			
Average Patch Size	Sq km	0.21	
Proportion of small patches (≥0.01sq km to≤1 sq km)	%	97.43	
Patch Size Range (in sq. km)	**No. of Patches**	**Area (Sq km)**	**Percentage**
>=0.01 <=1.0	69,749	5,051	34.23
>1.0 <=10	1,676	3,998	27.09
>10 <=100	159	3,659	24.79
>100 <=500	6	1,263	8.56
>500 <=1000	1	786	5.33
>1000 <=5000			
>5000 <=10000			
>10000			
Total	**71,591**	**14,757**	**100**

Country	**India**
State	**Goa**
Ecosystem type	Forests, by type of forests

Note:
* signifies that adequate number of sample plots are not available
** Data from ISFR 2017

Indicator	*Unit*	*Value*	
Extent			
Geographical Area(GA)	sq km	3,702	
	% of Total GA	0.11	
Type of Protection			
Recorded Forest Area (RFA)	sq km	1,225	
% of GA		*33.09*	
Reserved Forests (RF)	sq km	253	
Protected Forest (PF)	sq km	0	
Unclassed Forests	sq km	972	
Growing Stock			
Volume of Growing Stock	million cum	11.16	
% of country's Growing Stock		0.26	
Growing Stock in Forest	cum/ha	91.10	
Carbon Stock			
Total	'000 tonnes	25,338	
AGB	'000 tonnes	9,010	
BGB	'000 tonnes	2,617	
Dead Wood	'000 tonnes	172	
Litter	'000 tonnes	665	
SOC	'000 tonnes	12,874	
Carbon Stock per hectare			
Total	per hectare stock in tonnes	113.24	
AGB	per hectare stock in tonnes	40.27	
BGB	per hectare stock in tonnes	11.7	
Dead Wood	per hectare stock in tonnes	0.77	
Litter	per hectare stock in tonnes	2.97	
SOC	per hectare stock in tonnes	57.54	
Wetlands Within RFA	Number	71	
	Area (in ha)	1,025	
	% of RFA	0.78	
Biodiversity Assessment			
	Herbs	***Shrubs***	***Trees***
Total Number of species	38	50	118
Shannon Weiner Index	***Herbs***	***Shrubs***	***Trees***
Tropical Wet Evergreen Forests	2.61	2.54	2.86
Tropical Semi-Evergreen Forests	2.28	2.16	3.14
Tropical Moist Deciduous Forests	1.83	2.65	3.13
Littoral and Swamp Forests	0.67	0.23	*
Tropical Dry Deciduous Forests	0.41	1.23	*
Effective number of species (ENC)	***Herbs***	***Shrubs***	***Trees***
Tropical Wet Evergreen Forests	13.60	12.68	17.46
Tropical Semi-Evergreen Forests	9.78	8.67	23.10
Tropical Moist Deciduous Forests	6.23	14.15	22.87
Littoral and Swamp Forests	1.95	1.26	
Tropical Dry Deciduous Forests	1.51	3.42	
Forest Fragmentation**			
Average Patch Size	Sq km	1.06	
Proportion of small patches (≥0.01sq km to≤1 sq km)	%	96.87	
Patch Size Range (in sq. km)	**No. of Patches**	**Area (Sq km)**	**Percentage**
>=0.01 <=1.0	2,045	186	8.34
>1.0 <=10	52	113	5.07
>10 <=100	13	210	9.42
>100 <=500	0	0	0.00
>500 <=1000	0	0	0.00
>1000 <=5000	1	1,720	77.17
>5000 <=10000			
>10000			
Total	**2,111**	**2,229**	**100**

Country	**India**
State	**Dehli**
Ecosystem type	Forests, by type of forests

Note:
* signifies that adequate number of sample plots are not available
** Data from ISFR 2017

Indicator	*Unit*	*Value*	
Extent			
Geographical Area(GA)	sq km	1,483	
	% of Total GA	0.05	
Type of Protection			
Recorded Forest Area (RFA)	sq km	102	
% of GA		*6.88*	
Reserved Forests (RF)	sq km	78	
Protected Forest (PF)	sq km	24	
Unclassed Forests	sq km	0	
Growing Stock			
Volume of Growing Stock	million cum	0.54	
% of country's Growing Stock		0.01	
Growing Stock in Forest	cum/ha	52.94	
Carbon Stock			
Total	'000 tonnes	1,236	
AGB	'000 tonnes	277	
BGB	'000 tonnes	98	
Dead Wood	'000 tonnes	2	
Litter	'000 tonnes	21	
SOC	'000 tonnes	838	
Carbon Stock per hectare			
Total	per hectare stock in tonnes	63.26	
AGB	per hectare stock in tonnes	14.19	
BGB	per hectare stock in tonnes	5.03	
Dead Wood	per hectare stock in tonnes	0.11	
Litter	per hectare stock in tonnes	1.06	
SOC	per hectare stock in tonnes	42.86	
Wetlands Within RFA	Number	17	
	Area (in ha)	18	
	% of RFA	0.18	
Biodiversity Assessment			
	Herbs	***Shrubs***	***Trees***
Total Number of species	36	11	16
Shannon Weiner Index	***Herbs***	***Shrubs***	***Trees***
Tropical Thorn Forests	3.38	2.07	0.99
Tropical Dry Deciduous Forests	*	*	1.56
Effective number of species (ENC)	***Herbs***	***Shrubs***	***Trees***
Tropical Thorn Forests	29.37	7.92	2.69
Tropical Dry Deciduous Forests			4.76
Forest Fragmentation**			
Average Patch Size	Sq km	0.18	
Proportion of small patches (≥0.01sq km to≤1 sq km)	%	98.36	
Patch Size Range (in sq. km)	**No. of Patches**	**Area (Sq km)**	**Percentage**
>=0.01 <=1.0	1,081	78	40.44
>1.0 <=10	15	44	22.90
>10 <=100	3	71	36.66
>100 <=500			
>500 <=1000			
>1000 <=5000			
>5000 <=10000			
>10000			
Total	**1,099**	**193**	**100**

Country	**India**
State	**Chhattisgarh**
Ecosystem type	Forests, by type of forests

Note:
* signifies that adequate number of sample plots are not available
** Data from ISFR 2017

Indicator	*Unit*	*Value*	
Extent			
Geographical Area(GA)	sq km	135,192	
	% of Total GA	4.11	
Type of Protection			
Recorded Forest Area (RFA)	sq km	59,772	
% of GA		*44.21*	
Reserved Forests (RF)	sq km	25,782	
Protected Forest (PF)	sq km	24,036	
Unclassed Forests	sq km	9,954	
Growing Stock			
Volume of Growing Stock	million cum	358.96	
% of country's Growing Stock		8.40	
Growing Stock in Forest	cum/ha	60.05	
Carbon Stock			
Total	'000 tonnes	480,250	
AGB	'000 tonnes	145,912	
BGB	'000 tonnes	46,908	
Dead Wood	'000 tonnes	1,858	
Litter	'000 tonnes	9,969	
SOC	'000 tonnes	275,603	
Carbon Stock per hectare			
Total	per hectare stock in tonnes	86.36	
AGB	per hectare stock in tonnes	26.24	
BGB	per hectare stock in tonnes	8.43	
Dead Wood	per hectare stock in tonnes	0.33	
Litter	per hectare stock in tonnes	1.79	
SOC	per hectare stock in tonnes	49.56	
Wetlands Within RFA	Number	3,698	
	Area (in ha)	64,398	
	% of RFA	1.22	
Biodiversity Assessment			
	Herbs	***Shrubs***	***Trees***
Total Number of species	50	48	129
Shannon Weiner Index	***Herbs***	***Shrubs***	***Trees***
Tropical Moist Deciduous Forests	2.59	2.62	3.17
Tropical Dry Deciduous Forests	2.61	2.89	3.07
Effective number of species (ENC)	***Herbs***	***Shrubs***	***Trees***
Tropical Moist Deciduous Forests	13.33	13.74	23.81
Tropical Dry Deciduous Forests	13.60	17.99	21.54
Forest Fragmentation**			
Average Patch Size	Sq km	1.70	
Proportion of small patches (≥0.01sq km to≤1 sq km)	%	96.23	
Patch Size Range (in sq. km)	**No. of Patches**	**Area (Sq km)**	**Percentage**
>=0.01 <=1.0	31,468	2,510	4.52
>1.0 <=10	1,033	2,746	4.94
>10 <=100	165	4,686	8.44
>100 <=500	23	4,813	8.67
>500 <=1000	3	2,390	4.3
>1000 <=5000	8	20,787	37.42
>5000 <=10000	2	17,615	31.71
>10000			
Total	**32,702**	**55,547**	**100**

Country	**India**
State	**Bihar**
Ecosystem type	Forests, by type of forests

Note:
* signifies that adequate number of sample plots are not available
** Data from ISFR 2017

Indicator	*Unit*	*Value*	
Extent			
Geographical Area(GA)	sq km	94,163	
	% of Total GA	2.86	
Type of Protection			
Recorded Forest Area (RFA)	sq km	6,877	
% of GA		*7.30*	
Reserved Forests (RF)	sq km	693	
Protected Forest (PF)	sq km	6,183	
Unclassed Forests	sq km	1	
Growing Stock			
Volume of Growing Stock	million cum	26.73	
% of country's Growing Stock		0.63	
Growing Stock in Forest	cum/ha	38.87	
Carbon Stock			
Total	'000 tonnes	55,239	
AGB	'000 tonnes	15,007	
BGB	'000 tonnes	5,428	
Dead Wood	'000 tonnes	127	
Litter	'000 tonnes	746	
SOC	'000 tonnes	33,931	
Carbon Stock per hectare			
Total	per hectare stock in tonnes	75.61	
AGB	per hectare stock in tonnes	20.54	
BGB	per hectare stock in tonnes	7.43	
Dead Wood	per hectare stock in tonnes	0.17	
Litter	per hectare stock in tonnes	1.02	
SOC	per hectare stock in tonnes	46.44	
Wetlands Within RFA	Number	285	
	Area (in ha)	3,992	
	% of RFA	0.63	
Biodiversity Assessment			
	Herbs	***Shrubs***	***Trees***
Total Number of species	52	42	113
Shannon Weiner Index	***Herbs***	***Shrubs***	***Trees***
Tropical Semi-Evergreen Forests	2.85	2.22	*
Tropical Moist Deciduous Forests	2.02	2.65	3.10
Littoral and Swamp Forests	2.72	1.58	*
Tropical Dry Deciduous Forests	1.21	2.25	3.42
Effective number of species (ENC)	***Herbs***	***Shrubs***	***Trees***
Tropical Semi-Evergreen Forests	17.29	9.21	
Tropical Moist Deciduous Forests	7.54	14.15	22.20
Littoral and Swamp Forests	15.18	4.85	
Tropical Dry Deciduous Forests	3.35	9.49	30.57
Forest Fragmentation**			
Average Patch Size	Sq km	0.25	
Proportion of small patches (≥0.01sq km to≤1 sq km)	%	99.38	
Patch Size Range (in sq. km)	**No. of Patches**	**Area (Sq km)**	**Percentage**
>=0.01 <=1.0	29,504	2,028	27.78
>1.0 <=10	162	358	4.90
>10 <=100	14	315	4.32
>100 <=500	6	1,481	20.30
>500 <=1000	2	1,366	18.71
>1000 <=5000	1	1,751	23.99
>5000 <=10000			
>10000			
Total	**29,689**	**7,299**	**100**

Country	**India**
State	**Assam**
Ecosystem type	Forests, by type of forests

Note:
* signifies that adequate number of sample plots are not available
** Data from ISFR 2017

Indicator	*Unit*	*Value*	
Extent			
Geographical Area(GA)	sq km	78,438	
	% of Total GA	2.39	
Type of Protection			
Recorded Forest Area (RFA)	sq km	26,832	
% of GA		*34.21*	
Reserved Forests (RF)	sq km	17,864	
Protected Forest (PF)	sq km	0	
Unclassed Forests	sq km	8,968	
Growing Stock			
Volume of Growing Stock	million cum	115.40	
% of country's Growing Stock		2.70	
Growing Stock in Forest	cum/ha	43.01	
Carbon Stock			
Total	'000 tonnes	270,149	
AGB	'000 tonnes	85,844	
BGB	'000 tonnes	21,148	
Dead Wood	'000 tonnes	1,102	
Litter	'000 tonnes	7,223	
SOC	'000 tonnes	154,832	
Carbon Stock per hectare			
Total	per hectare stock in tonnes	95.37	
AGB	per hectare stock in tonnes	30.30	
BGB	per hectare stock in tonnes	7.47	
Dead Wood	per hectare stock in tonnes	0.39	
Litter	per hectare stock in tonnes	2.55	
SOC	per hectare stock in tonnes	54.66	
Wetlands Within RFA	Number	1,584	
	Area (in ha)	67,857	
	% of RFA	2.46	
Biodiversity Assessment			
	Herbs	***Shrubs***	***Trees***
Total Number of species	153	149	143
Shannon Weiner Index	***Herbs***	***Shrubs***	***Trees***
Tropical Wet Evergreen Forests	3.16	2.99	2.63
Tropical Semi-Evergreen Forests	3.47	3.17	3.50
Tropical Moist Deciduous Forests	2.85	2.64	3.58
Littoral and Swamp Forests	2.38	2.20	1.37
Tropical Dry Deciduous Forests	2.82	2.77	*
Subtropical Broadleaved Hill Forests	2.25	2.44	0.50
Subtropical Pine Forests	3.07	2.54	1.56
Effective number of species (ENC)	***Herbs***	***Shrubs***	***Trees***
Tropical Wet Evergreen Forests	23.57	19.89	13.87
Tropical Semi-Evergreen Forests	32.14	23.81	33.12
Tropical Moist Deciduous Forests	17.29	14.01	35.87
Littoral and Swamp Forests	10.80	9.03	3.94
Tropical Dry Deciduous Forests	16.78	15.96	
Subtropical Broadleaved Hill Forests	9.49	11.47	1.65
Subtropical Pine Forests	21.54	12.68	4.76
Forest Fragmentation**			
Average Patch Size	Sq km	0.58	
Proportion of small patches (≥0.01sq km to≤1 sq km)	%	98.14	
Patch Size Range (in sq. km)	**No. of Patches**	**Area (Sq km)**	**Percentage**
>=0.01 <=1.0	47,610	3,423	12.18
>1.0 <=10	764	2,090	7.44
>10 <=100	111	3,247	11.55
>100 <=500	22	5,005	17.81
>500 <=1000	1	637	2.27
>1000 <=5000	1	2,150	7.65
>5000 <=10000	0	0	0.00
>10000	1	11,553	41.10
Total	**48,510**	**28,105**	**100**

Country	**India**
State	**Arunachal Pradesh**
Ecosystem type	Forests, by type of forests

Note:
* signifies that adequate number of sample plots are not available
** Data from ISFR 2017

Indicator	*Unit*	*Value*	
Extent			
Geographical Area(GA)	sq km	83,743	
	% of Total GA	2.55	
Type of Protection			
Recorded Forest Area (RFA)	sq km	51,407	
% of GA		*61.39*	
Reserved Forests (RF)	sq km	10,589	
Protected Forest (PF)	sq km	9,779	
Unclassed Forests	sq km	31,039	
Growing Stock			
Volume of Growing Stock	million cum	458.00	
% of country's Growing Stock		10.72	
Growing Stock in Forest	cum/ha	89.09	
Carbon Stock			
Total	'000 tonnes	1,051,323	
AGB	'000 tonnes	330,856	
BGB	'000 tonnes	100,379	
Dead Wood	'000 tonnes	7,816	
Litter	'000 tonnes	15,436	
SOC	'000 tonnes	596,836	
Carbon Stock per hectare			
Total	per hectare stock in tonnes	157.65	
AGB	per hectare stock in tonnes	49.61	
BGB	per hectare stock in tonnes	15.05	
Dead Wood	per hectare stock in tonnes	1.17	
Litter	per hectare stock in tonnes	2.31	
SOC	per hectare stock in tonnes	89.50	
Wetlands Within RFA	Number	1,343	
	Area (in ha)	68,022	
	% of RFA	1.07	

Biodiversity Assessment			
	Herbs	***Shrubs***	***Trees***
Total Number of species	192	435	110
Shannon Weiner Index	***Herbs***	***Shrubs***	***Trees***
Tropical Wet Evergreen Forests	2.99	3.62	3.18
Tropical Semi-Evergreen Forests	4.05	4.50	3.33
Tropical Moist Deciduous Forests	3.09	3.81	2.13
Subtropical Broadleaved Hill Forests	2.96	3.57	1.49
Subtropical Pine Forests	2.01	3.09	*
Himalayan Moist Temperate Forests	2.41	3.11	2.06
Himalayan Dry Temperate Forests	1.76	2.80	*
Sub-Alpine Forests	1.88	3.16	*
Moist Alpine Scrub	*	1.60	*
Montane Wet Temperate Forests	*	*	0.93
Effective number of species (ENC)	***Herbs***	***Shrubs***	***Trees***
Tropical Wet Evergreen Forests	19.89	37.34	24.05
Tropical Semi-Evergreen Forests	57.40	90.02	27.94
Tropical Moist Deciduous Forests	21.98	45.15	8.41
Subtropical Broadleaved Hill Forests	19.30	35.52	4.44
Subtropical Pine Forests	7.46	21.98	
Himalayan Moist Temperate Forests	11.13	22.42	7.85
Himalayan Dry Temperate Forests	5.81	16.44	
Sub-Alpine Forests	6.55	23.57	
Moist Alpine Scrub		4.95	
Montane Wet Temperate Forests			2.53

Forest Fragmentation**			
Average Patch Size	Sq km	2.15	
Proportion of small patches (≥0.01sq km to≤1 sq km)	%	98.18	
Patch Size Range (in sq. km)	**No. of Patches**	**Area (Sq km)**	**Percentage**
>=0.01 <=1.0	30,524	2,019	3.02
>1.0 <=10	509	1,500	2.24
>10 <=100	51	1,470	2.19
>100 <=500	2	846	1.26
>500 <=1000	1	585	0.87
>1000 <=5000	2	3,070	4.59
>5000 <=10000	0	0	0.00
>10000	2	57,474	85.83
Total	**31,091**	**66,964**	**100**

Country	**India**
State	**Andhra Pradesh**
Ecosystem type	Forests, by type of forests

Note:
* signifies that adequate number of sample plots are not available
** Data from ISFR 2017

Indicator	*Unit*	*Value*	
Extent			
Geographical Area(GA)	sq km	162,968	
	% of Total GA	4.96	
Type of Protection			
Recorded Forest Area (RFA)	sq km	37,258	
% of GA		*22.86*	
Reserved Forests (RF)	sq km	31,959	
Protected Forest (PF)	sq km	5,069	
Unclassed Forests	sq km	230	
Growing Stock			
Volume of Growing Stock	million cum	119.02	
% of country's Growing Stock		2.79	
Growing Stock in Forest	cum/ha	31.94	
Carbon Stock			
Total	'000 tonnes	219,528	
AGB	'000 tonnes	60,972	
BGB	'000 tonnes	24,206	
Dead Wood	'000 tonnes	629	
Litter	'000 tonnes	3,074	
SOC	'000 tonnes	130,647	
Carbon Stock per hectare			
Total	per hectare stock in tonnes	75.34	
AGB	per hectare stock in tonnes	20.93	
BGB	per hectare stock in tonnes	8.31	
Dead Wood	per hectare stock in tonnes	0.22	
Litter	per hectare stock in tonnes	1.05	
SOC	per hectare stock in tonnes	44.84	
Wetlands Within RFA	Number	1,174	
	Area (in ha)	72,358	
	% of RFA	1.91	
Biodiversity Assessment			
	Herbs	***Shrubs***	***Trees***
Total Number of species	58	64	242
Shannon Weiner Index	***Herbs***	***Shrubs***	***Trees***
Tropical Moist Deciduous Forests	2.89	2.13	3.15
Tropical Dry Deciduous Forests	2.63	2.92	4.07
Tropical Thorn Forest	2.25	2.37	3.74
Tropical Dry Evergreen Forests	2.07	2.55	3.28
Littoral and Swamp Forests	*	1.43	*
Effective number of species (ENC)	***Herbs***	***Shrubs***	***Trees***
Tropical Moist Deciduous Forests	17.99	8.41	23.34
Tropical Dry Deciduous Forests	13.87	18.54	58.56
Tropical Thorn Forest	9.49	10.70	42.10
Tropical Dry Evergreen Forests	7.92	12.81	26.58
Littoral and Swamp Forests		4.18	
Forest Fragmentation**			
Average Patch Size	Sq km	1.55	
Proportion of small patches (≥0.01sq km to≤1 sq km)	%	95.60	
Patch Size Range (in sq. km)	**No. of Patches**	**Area (Sq km)**	**Percentage**
>=0.01 <=1.0	17,409	1,425	5.06
>1.0 <=10	644	1,894	6.73
>10 <=100	132	4,063	14.44
>100 <=500	18	3,183	11.31
>500 <=1000	3	2,467	8.76
>1000 <=5000	2	3,537	12.57
>5000 <=10000	2	11,578	41.13
>10000			
Total	**18,210**	**28,147**	**100**

Annexure 10.3.5 Crop Diversity

State/UT	Effective Number of Species		
	2005-06	2010-11	2015-16
Andhra Pradesh	14.16	12.81	14.57
Arunachal Pradesh	5.86	5.02	6.51
Assam	5.81	5.85	5.73
Bihar	5.72	6.14	5.73
Chhattisgarh	4.01	3.81	3.80
Delhi	5.11	4.99	4.82
Goa	6.06	5.81	6.07
Gujarat	15.55	14.87	16.03
Haryana	7.37	7.12	6.06
Himachal Pradesh	6.30	6.03	6.28
Jammu & Kashmir	6.66	6.86	6.76
Jharkhand	3.71	4.39	4.76
Karnataka	20.09	21.02	21.04
Kerala	11.24	10.98	10.59
Madhya Pradesh	11.45	10.87	9.74
Maharashtra	15.76	14.71	14.69
Manipur	3.18	4.81	5.73
Meghalaya	11.60	10.81	13.30
Mizoram	5.35	10.77	10.61
Nagaland	10.05	10.16	10.54
Odisha	6.81	2.50	2.13
Punjab	4.52	4.16	4.04
Rajasthan	10.90	12.29	11.66
Sikkim	8.23	11.74	10.87
Tamil Nadu	13.59	14.10	13.25
Telangana			8.50
Tripura	1.64	6.66	7.74
Uttar Pradesh	8.27	8.08	7.92
Uttarakhand	8.52	8.18	8.41
West Bengal	5.10	5.87	6.02
Andaman and Nicobar Islands	5.12	7.16	6.76
Chandigarh	3.06	2.50	1.49
Dadra and Nagar Haveli	6.36	6.13	5.66
Daman and Diu	1.45	3.76	3.63
Lakshadweep	2.20	2.29	1.03
Puducherry	4.54	4.31	4.43

Annexure 10.3.6: Forest type wise carbon stock in different carbon pools (in '000 tonnes of carbon)

Forest type stratum	Above ground biomass (AGB)		Below ground biomass (BGB)		Dead wood		Litter		Soil organic carbon (SOC)		TOTAL CARBON STOCK	
Assessment year	Opening stock	Closing stock	Opening stock	Closing stock	Opening stock	Closing stock	Opening stock	Closing stock	Opening stock	Closing stock	Opening stock	Closing stock
	2017	2019	2017	2019	2017	2019	2017	2019	2017	2019	2017	2019
Tropical wet evergreen forests	100,004	146,982	34,458	54,379	3,567	3,569	9,216	8,764	180,825	130,952	328,070	344,646
Tropical semi-evergreen forests	274,741	248,659	56,508	54,733	5,861	2,504	32,009	21,432	755,307	391,665	1,124,426	718,993
Tropical moist deciduous forests	331,701	416,660	68,224	91,713	10,752	7,128	40,400	37,087	871,939	766,982	1,323,016	1,319,570
Littoral and swamp forests	26,955	16,310	9,324	6,034	14	160	475	382	36,796	32,786	73,564	55,672
Tropical dry deciduous forests	1,042,208	593,848	409,233	249,439	4,638	4,796	28,372	28,622	1,185,892	1,281,417	2,670,343	2,158,122
Tropical thorn forests	9,280	14,659	3,619	6,154	220	132	1,263	1,298	30,102	54,395	44,484	76,638
Tropical dry evergreen forests	2,785	2,689	1,094	1,129	40	198	130	119	4,198	3,427	8,247	7,562
Subtropical broadleaved hill forest	39,623	114,599	14,600	48,132	672	913	4,391	7,233	156,353	273,023	215,639	443,900
Subtropical pine forests	56,838	75,562	14,347	20,409	769	609	2,320	2,047	123,087	126,534	197,361	225,161
Subtropical dry evergreen forest	633	1,040	248	437	5	5	7	6	1,271	1,281	2,164	2,769
Montane wet temperate forests	13,432	69,081	3,391	18,652	338	2,832	1,008	4,335	37,948	260,850	56,117	355,750
Himalayan moist temperate forest	155,932	275,685	39,361	74,432	1,793	6,795	7,407	6,661	210,647	204,222	415,140	567,795
Himalayan dry temperate forests	34,057	63,519	9,234	18,420	277	1,734	696	808	34,582	36,786	78,846	121,267
Sub-alpine forests	57,564	113,005	15,607	32,769	647	3,946	1,384	1,536	88,973	151,081	164,175	302,337
Moist alpine scrubs	3,092	4,046	838	1,173	51	72	88	147	7,163	9,752	11,232	15,190
Dry alpine scrub	5,846	11,855	1,585	3,438	59	49	175	211	8,064	5,980	15,729	21,533
Plantation/TOF	82,854	88,336	17,031	19,384	429	402	6,820	7,214	246,374	272,439	353,508	387,775
Total (India)	**2,237,545**	**2,256,535**	**698,702**	**700,827**	**30,132**	**35,844**	**136,161**	**127,902**	**3,979,521**	**4,003,572**	**7,082,061**	**7,124,680**

Source: India State of Forest Report 2017 and India State of Forest Report 2019, Forest Survey of India

Annexure 10.3.7 State-wise Inland Water Resources

S. No.	States / Union Territories	Rivers & Canals (kms.)	Reservoirs (Lakh Ha)	Tanks & Ponds (Lakh Ha)	Flood plain Derelict Water bodies (Lakh Ha)	Brackish Water (Lakh Ha)	Total Water Bodies (Lakh Ha)
1	Andhra Pradesh*	11,514	2.34	5.17	-	0.6	8.11
2	Arunachal Pradesh	2,000	-	2.76	0.42	-	3.18
3	Assam	4,820	0.02	0.23	1.1	-	1.35
4	Bihar	3,200	0.6	0.95	0.05	-	1.6
5	Chhattisgarh	3,573	0.84	0.63	-	-	1.47
6	Goa	250	0.03	0.03	-	Neg.	0.06
7	Gujarat	3,865	2.43	0.71	0.12	1	4.26
8	Haryana	5,000	Neg.	0.1	0.1	-	0.2
9	Himachal Pradesh	3,000	0.42	0.01	-	-	0.43
10	Jammu & Kashmir	27,781	0.07	0.17	0.06	-	0.3
11	Jharkhand	4,200	0.94	0.29	-	-	1.23
12	Karnataka	9,000	4.4	2.9	-	0.1	7.4
13	Kerala	3,092	0.3	0.3	2.43	2.4	5.43
14	Madhya Pradesh	17,088	2.27	0.6	-	-	2.87
15	Maharashtra	16,000	2.99	0.72	-	0.12	3.83
16	Manipur	3,360	0.01	0.05	0.04	-	0.1
17	Meghalaya	5,600	0.08	0.02	Neg.	-	0.1
18	Mizoram	1,395	-	0.02	-	-	0.02
19	Nagaland	1,600	0.17	0.5	Neg.	-	0.67
20	Odisha	4,500	2.56	1.23	1.8	4.3	9.89
21	Punjab	15,270	Neg.	0.07	-	-	0.07
22	Rajasthan	5,290	1.2	1.8	-	-	3
23	Sikkim	900	-	-	0.03	-	0.03
24	Tamil Nadu	7,420	5.7	0.56	0.07	0.6	6.93
25	Tripura	1,200	0.05	0.13	-	-	0.18
26	Uttar Pradesh	28,500	1.38	1.61	1.33	-	4.32
27	Uttarakhand	2,686	0.2	0.006	0.003	-	0.209
28	West Bengal	2,526	0.17	2.76	0.42	2.1	5.45
29	Andaman & Nicobar Islands	-	0.00367	0.0016	-	0.33	0.33527
30	Chandigarh	2	-	Neg.	Neg.	-	0
31	Dadra & Nagar Haveli	54	0.05	-	-	-	0.05
32	Daman & Diu	12	-	Neg.	-	Neg.	0
33	Delhi	150	0.04	-	-	-	0.04
34	Lakshadweep	-	-	-	-	-	0
35	Puducherry	247	-	Neg.	0.01	Neg.	0.01
Total**		**195,095**	**29.26**	**24.33**	**7.98**	**11.55**	**73.12**

*including Telengana
Note: ** State-wise total (i.e Column total) may not match with the Total.
Source: Annual Report 2016-17, Department of Animal Husbandry, Dairying & Fisheries, Ministry of Agriculture & Farmers Welfare

Annexure 10.3.8: State-wise SDG indicator 15.1.1 for 2008-09 (ISFR 2011)

States/Union Territories	Very dense forest	Moderately dense forest	Open forest	Total forest cover	Total geographic area	SDG 15.1.1
Andhra Pradesh	850	26,242	19,297	**46,389**	**275,069**	*16.86*
Arunachal Pradesh	20,868	31,519	15,023	**67,410**	**83,743**	*80.50*
Assam	1,444	11,404	14,825	**27,673**	**78,438**	*35.28*
Bihar	231	3,280	3,334	**6,845**	**94,163**	*7.27*
Chhattisgarh	4,163	34,911	16,600	**55,674**	**135,191**	*41.18*
Delhi	7	49	120	**176**	**1,483**	*11.87*
Goa	543	585	1,091	**2,219**	**3,702**	*59.94*
Gujarat	376	5,231	9,012	**14,619**	**196,022**	*7.46*
Haryana	27	457	1,124	**1,608**	**44,212**	*3.64*
Himachal Pradesh	3,224	6,381	5,074	**14,679**	**55,673**	*26.37*
Jammu & Kashmir	4,140	8,760	9,639	**22,539**	**222,236**	*10.14*
Jharkhand	2,590	9,917	10,470	**22,977**	**79,714**	*28.82*
Karnataka	1,777	20,179	14,238	**36,194**	**191,791**	*18.87*
Kerala	1,442	9,394	6,464	**17,300**	**38,863**	*44.52*
Madhya Pradesh	6,640	34,986	36,074	**77,700**	**308,245**	*25.21*
Maharashtra	8,736	20,815	21,095	**50,646**	**307,713**	*16.46*
Manipur	730	6,151	10,209	**17,090**	**22,327**	*76.54*
Meghalaya	433	9,775	7,067	**17,275**	**22,429**	*77.02*
Mizoram	134	6,086	12,897	**19,117**	**21,081**	*90.68*
Nagaland	1,293	4,931	7,094	**13,318**	**16,579**	*80.33*
Odisha	7,060	21,366	20,477	**48,903**	**155,707**	*31.41*
Punjab	0	736	1,028	**1,764**	**50,362**	*3.50*
Rajasthan	72	4,448	11,567	**16,087**	**342,239**	*4.70*
Sikkim	500	2,161	698	**3,359**	**7,096**	*47.34*
Tamil Nadu	2,948	10,321	10,356	**23,625**	**130,058**	*18.16*
Telangana	-	-	-	**-**	**-**	*-*
Tripura	109	4,686	3,182	**7,977**	**10,486**	*76.07*
Uttar Pradesh	1,626	4,559	8,153	**14,338**	**240,928**	*5.95*
Uttarakhand	4,762	14,167	5,567	**24,496**	**53,483**	*45.80*
West Bengal	2,984	4,646	5,365	**12,995**	**88,752**	*14.64*
Andaman and Nicobar Islands	3,761	2,416	547	**6,724**	**8,249**	*81.51*

State-wise SDG indicator 15.1.1 for 2017-18 (ISFR 2019)

States/Union Territories		Very dense forest	Moderately dense forest	Open forest	Total forest cover	Scrub	Non-forest **	Total geographic area	SDG 15.1.1
Andhra Pradesh		1,994	13,938	13,205	**29,137**	8,255	125,576	**162,968**	*17.88*
Arunachal Pradesh		21,095	30,557	15,036	**66,688**	229	16,826	**83,743**	*79.63*
Assam		2,795	10,279	15,253	**28,327**	173	49,938	**78,438**	*36.11*
Bihar		333	3,280	3,693	**7,306**	250	86,607	**94,163**	*7.76*
Chhattisgarh		7,068	32,198	16,345	**55,611**	610	78,971	**135,192**	*41.13*
Delhi		6.72	56.42	132.3	**195.44**	0.3	1,287	**1,483**	*13.18*
Goa		538	576	1,123	**2,237**	0	1,465	**3,702**	*60.43*
Gujarat		378	5,092	9,387	**14,857**	2,994	178,393	**196,244**	*7.57*
Haryana		28	451	1,123	**1,602**	154	42,456	**44,212**	*3.62*
Himachal Pradesh		3,113	7,126	5,195	**15,434**	315	39,924	**55,673**	*27.72*
Jammu & Kashmir #	UT of Jammu & Kashmir	4,203	7,952	8,967	**21,122**	250	31,886	**53,258***	*39.66*
	UT of Ladakh	78	660	1,752	**2,490**	298	166,633	**169,421***	*1.47*
	Total	4,281	8,612	10,719	**23,612**	548	198,076	**222,236**	*10.62*
Jharkhand		2,603	9,687	11,321	**23,611**	688	55,417	**79,716**	*29.62*
Karnataka		4,501	21,048	13,026	**38,575**	4,484	148,732	**191,791**	*20.11*
Kerala		1,935	9,508	9,701	**21,144**	13	17,695	**38,852**	*54.42*
Madhya Pradesh		6,676	34,341	36,465	**77,482**	6,002	224,768	**308,252**	*25.14*
Maharashtra		8,721	20,572	21,485	**50,778**	4,256	252,679	**307,713**	*16.50*
Manipur		905	6,386	9,556	**16,847**	1,181	4,299	**22,327**	*75.46*
Meghalaya		489	9,267	7,363	**17,119**	600	4,710	**22,429**	*76.33*
Mizoram		157	5,801	12,048	**18,006**	1	3,074	**21,081**	*85.41*
Nagaland		1,273	4,534	6,679	**12,486**	635	3,458	**16,579**	*75.31*
Odisha		6,970	21,552	23,097	**51,619**	4,327	99,761	**155,707**	*33.15*
Punjab		8	801	1,040	**1,849**	33	48,480	**50,362**	*3.67*
Rajasthan		78	4,342	12,210	**16,630**	4,760	320,849	**342,239**	*4.86*
Sikkim		1,102	1,552	688	**3,342**	307	3,447	**7,096**	*47.10*
Tamil Nadu		3,605	11,030	11,729	**26,364**	715	102,981	**130,060**	*20.27*
Telangana		1,608	8,787	10,187	**20,582**	3,615	87,880	**112,077**	*18.36*
Tripura		654	5,236	1,836	**7,726**	29	2,731	**10,486**	*73.68*
Uttar Pradesh		2,617	4,080	8,109	**14,806**	587	225,535	**240,928**	*6.15*
Uttarakhand		5,047	12,805	6,451	**24,303**	383	28,797	**53,483**	*45.44*
West Bengal		3,019	4,160	9,723	**16,902**	146	71,704	**88,752**	*19.04*
Andaman and Nicobar Islands		5,678	684	381	**6,743**	1	1,505	**8,249**	*81.74*
Chandigarh		1.36	14.24	6.43	**22.03**	0.1	92	**114**	*19.32*
Dadra and Nagar Haveli		0	80	127	**207**	5	279	**491**	*42.16*
Daman and Diu		1.4	5.69	13.4	**20.49**	0.19	90	**111**	*18.46*
Lakshadweep		0	16.09	11.01	**27.1**	0	3	**30**	*90.33*
Puducherry		0	17.66	34.75	**52.41**	0	438	**490**	*10.70*
Total		**99,278**	**308,472**	**304,499**	**712,249**	**46,297**	**2,528,923**	**3,287,469**	*21.67*

Note: # Includes Jammu & Kashmir area outside Line of Control that is under illegal occupation of Pakistan and China.
* Area of shape file provided by Survey of India (December, 2019). Notified geographical area from SOI awaited.
** Non-forest = Total geographical area- (total forest cover + scrubs)

Annexure 10.3.9 SDG 6.6.1

Account for Wetlands/ Water bodies in India **(Area in sq. km)**

L1	L2	Opening Stock (2011-12)	Addition to Stock	Reduction in Stock	Closing Stock (2015-16)
Wet lands / Water bodies	Inland Wetland	8,175	458	1,027	7,606
	Coastal Wetland	10,719	189	121	10,787
	River/Stream/ Canals	61,032	2,130	2,333	60,829
	Water bodies	58,367	1,478	1,293	58,552
	Total	**138,294**	**4,254**	**4,775**	**137,774**

SDG 6.6.1 (for 2011-12 to 2015-16)	**-0.38%**

State-wise Account for Wetlands/Water bodies in India : (Area in Sq. km)

a) Inland Wetland

States/ UTs	Inland Wetland			
	Opening Stock (2011-12)	Addition to Stock	Reduction in Stock	Closing Stock (2015-16)
Andhra Pradesh	438	19	70	387
Arunachal Pradesh	0	0		0
Assam	1,217	30	95	1,153
Bihar	1,944	252	212	1,984
Chhattisgarh	5			5
Goa	58	16	2	73
Gujarat	222	9	10	222
Haryana	47	17	5	58
Himachal Pradesh	3		0	3
Jammu & Kashmir	461	2	222	240
Jharkhand	13			13
Karnataka	31		1	30
Kerala	222	1	36	187
Madhya Pradesh				0
Maharashtra	7	10		16
Manipur	107	11	0	118
Meghalaya	56			56
Mizoram				0
Nagaland				0
Odisha	357	3	44	317
Punjab	115	13	86	41
Rajasthan	192		17	175
Sikkim				0
Tamil Nadu	130			130
Tripura	6		1	5
Telangana	16	5	2	19
Uttar Pradesh	2,303	70	148	2,225
Uttarakhand	0			0
West Bengal	194	0	77	118
Andaman & Nicobar Islands	18		0	18
Chandigarh				0
Dadar & Nagar Haveli				0
Daman & Diu	8		0	8
Delhi	4	0	0	4
Lakshadweep				0
Puducherry	1			1

Source: Based on NRSC change matrices

State-wise Account for Wetlands/Water bodies in India : (Area in Sq. km)

b) Coastal Wetland

States/ UTs	Coastal Wetland			
	Opening Stock (2011-12)	Addition to Stock	Reduction in Stock	Closing Stock (2015-16)
Andhra Pradesh	888	0	30	858
Arunachal Pradesh		0		0
Assam				0
Bihar				0
Chhattisgarh				0
Goa	25		3	22
Gujarat	6,220	181	11	6,390
Haryana				0
Himachal Pradesh				0
Jammu & Kashmir				0
Jharkhand				0
Karnataka	26		2	24
Kerala	105		3	102
Madhya Pradesh				0
Maharashtra	1,134	1	32	1,104
Manipur				0
Meghalaya				0
Mizoram				0
Nagaland				0
Odisha	1,362	1	24	1,339
Punjab				0
Rajasthan				0
Sikkim				0
Tamil Nadu	714		3	711
Tripura				0
Telangana				0
Uttar Pradesh				0
Uttarakhand				0
West Bengal	94	5	6	93
Andaman & Nicobar Islands	124	0	7	118
Chandigarh				0
Dadar & Nagar Haveli				0
Daman & Diu	19			19
Delhi				
Lakshadweep				0
Puducherry	8		1	7

Source: Based on NRSC change matrices

State-wise Account for Wetlands/Water bodies in India : (Area in Sq. km)

c) Rivers / Streams

States/ UTs	River/Stream/Canals			
	Opening Stock (2011-12)	Addition to Stock	Reduction in Stock	Closing Stock (2015-16)
Andhra Pradesh	3,879	31	11	3,900
Arunachal Pradesh	1,527	6	80	1,453
Assam	6,729	784	767	6,746
Bihar	4,289	331	586	4,034
Chhattisgarh	1,847	3	3	1,847
Goa	69		1	68
Gujarat	3,228	35	2	3,262
Haryana	358	20	19	359
Himachal Pradesh	877	4	4	877
Jammu & Kashmir	1,787	0	111	1,676
Jharkhand	1,372	1		1,374
Karnataka	2,003	1	5	1,999
Kerala	576	0	1	575
Madhya Pradesh	3,216	2	13	3,205
Maharashtra	3,968	2	15	3,955
Manipur	148	0	15	133
Meghalaya	279	1	0	279
Mizoram	125	1	0	126
Nagaland	187			187
Odisha	3,038	7	6	3,039
Punjab	732	41	47	725
Rajasthan	3,284	0	0	3,284
Sikkim	47			47
Tamil Nadu	1,751		1	1,750
Tripura	51		1	50
Telangana	2,190	33	27	2,197
Uttar Pradesh	6,693	704	512	6,886
Uttarakhand	1,063	9	42	1,031
West Bengal	5,616	113	61	5,668
Andaman & Nicobar Islands	53		2	51
Chandigarh	0			0
Dadar & Nagar Haveli	8			8
Daman & Diu	4			4
Delhi	21	2		27
Lakshadweep				0
Puducherry	18		2	16

Source: Based on NRSC change matrices

State-wise Account for Wetlands/Water bodies in India : (Area in Sq. km)

d) Water Bodies

States/ UTs	Water bodies			
	Opening Stock (2011-12)	Addition to Stock	Reduction in Stock	Closing Stock (2015-16)
Andhra Pradesh	6,760	386	91	7,055
Arunachal Pradesh	34	1	3	31
Assam	82	9	3	87
Bihar	182	25	4	203
Chhattisgarh	1,585	20	21	1,583
Goa	30	0	7	23
Gujarat	3,536	10	54	3,492
Haryana	159	20	4	175
Himachal Pradesh	420	12		431
Jammu & Kashmir	6,471	0	76	6,396
Jharkhand	674	5		680
Karnataka	5,305	1	9	5,298
Kerala	630	0	2	629
Madhya Pradesh	5,360	487	133	5,714
Maharashtra	6,017	109	576	5,550
Manipur	304	13	2	315
Meghalaya	18	0		18
Mizoram	27	5	0	31
Nagaland	24			24
Odisha	2,531	39	15	2,554
Punjab	84	35	4	115
Rajasthan	3,129	16	0	3,144
Sikkim	21	2		22
Tamil Nadu	7,065	11	3	7,072
Tripura	57	0	0	57
Telangana	4,734	94	140	4,688
Uttar Pradesh	1,570	28	140	1,458
Uttarakhand	199	1	4	196
West Bengal	1,313	149	1	1,461
Andaman & Nicobar Islands	8		0	8
Chandigarh	2	0		2
Dadar & Nagar Haveli	12	0		12
Daman & Diu	1		0	0
Delhi	3			4
Lakshadweep	0			0
Puducherry	20	0	0	20

Source: Based on NRSC change matrices

State-wise Account for Wetlands/Water bodies in India : (Area in Sq. km)

e) Totals

States/ UTs	Total				SDG 6.6.1 (for 2011-12 to 2015-16)
	Opening Stock (2011-12)	Addition to Stock	Reduction in Stock	Closing Stock (2015-16)	
Andhra Pradesh	11,965	437	202	12,200	*1.96%*
Arunachal Pradesh	1,561	7	82	1,485	*-4.86%*
Assam	8,028	823	865	7,986	*-0.52%*
Bihar	6,415	608	801	6,222	*-3.01%*
Chhattisgarh	3,437	22	24	3,435	*-0.06%*
Goa	182	16	12	186	*2.33%*
Gujarat	13,206	236	77	13,365	*1.20%*
Haryana	563	57	28	592	*5.11%*
Himachal Pradesh	1,299	15	4	1,311	*0.89%*
Jammu & Kashmir	8,719	2	410	8,312	*-4.67%*
Jharkhand	2,059	7		2,066	*0.32%*
Karnataka	7,365	2	16	7,351	*-0.19%*
Kerala	1,533	1	42	1,492	*-2.67%*
Madhya Pradesh	8,576	489	146	8,919	*4.00%*
Maharashtra	11,126	123	623	10,625	*-4.50%*
Manipur	559	24	16	567	*1.37%*
Meghalaya	353	1	0	353	*0.02%*
Mizoram	152	6	0	157	*3.55%*
Nagaland	211	0	0	211	*0.00%*
Odisha	7,288	50	89	7,249	*-0.53%*
Punjab	930	88	137	881	*-5.26%*
Rajasthan	6,605	16	17	6,604	*-0.02%*
Sikkim	68	2	0	69	*2.69%*
Tamil Nadu	9,659	11	7	9,663	*0.04%*
Tripura	114	0	2	112	*-1.64%*
Telangana	6,940	132	169	6,903	*-0.53%*
Uttar Pradesh	10,567	802	800	10,570	*0.02%*
Uttarakhand	1,262	10	46	1,226	*-2.84%*
West Bengal	7,217	267	145	7,339	*1.69%*
Andaman & Nicobar Islands	203	0	9	195	*-4.29%*
Chandigarh	2	0	0	2	*1.62%*
Dadar & Nagar Haveli	20	0	0	20	*0.70%*
Daman & Diu	32	0	0	31	*-0.81%*
Delhi	28	3	0	35	*25.17%*
Lakshadweep	0	0	0	0	*0.00%*
Puducherry	46	0	3	43	*-6.36%*

Note: Totals may not match due to rounding off.
Source: Based on NRSC change matrices

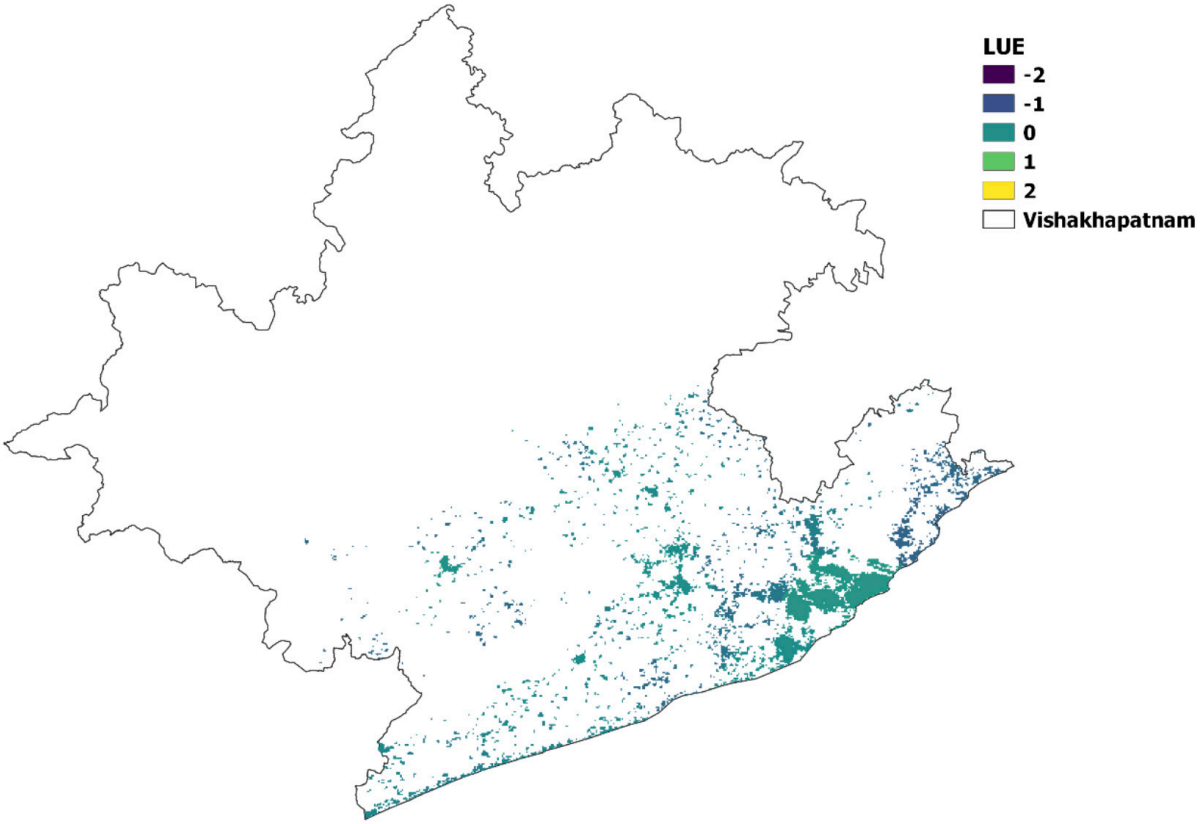
Annexure 10.3.10 SDG 15.3.1 India

Summary of SDG 15.3.1 Indicator		
	Area (sq km)	**Percent of total land area**
Total land area:	3,215,129.6	100.00%
Land area improved:	1,789,096.3	55.65%
Land area stable:	1,077,146.2	33.50%
Land area degraded:	261,197.6	8.12%
Land area with no data:	87,689.5	2.73%

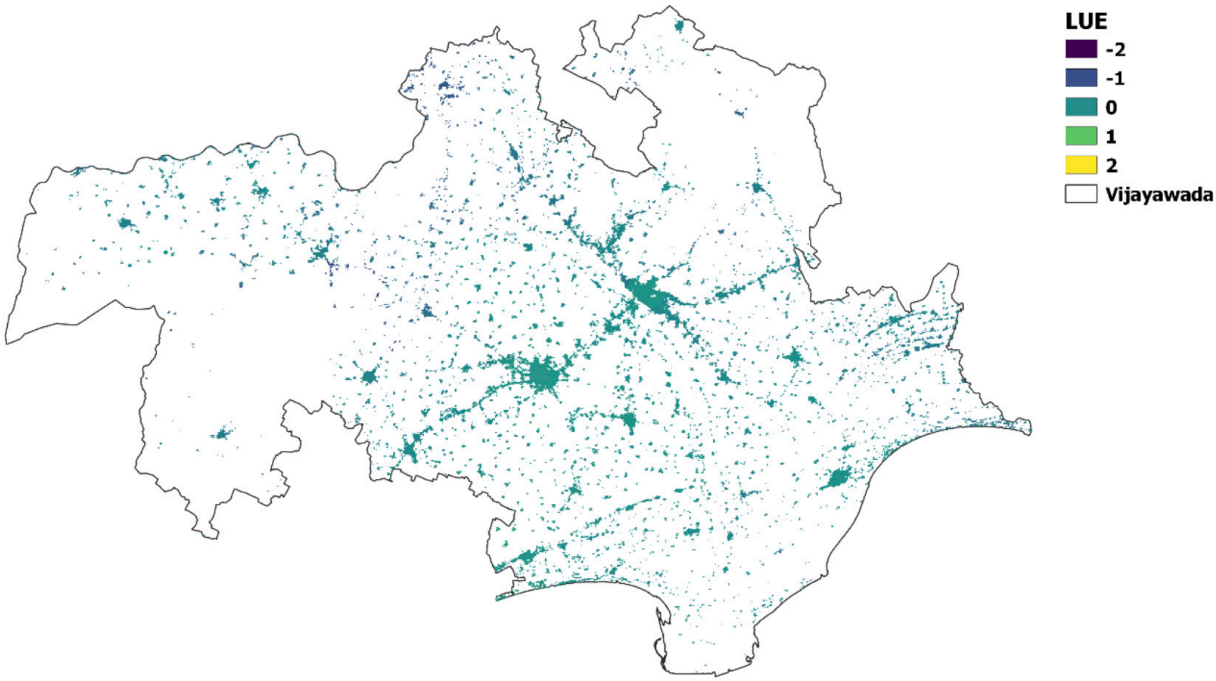
Source: Trends.Earth, see http://trends.earth, or contact the team at trends.earth@conservation.org.

Annexure 10.3.11: LUE Maps

Vishakhapatnam

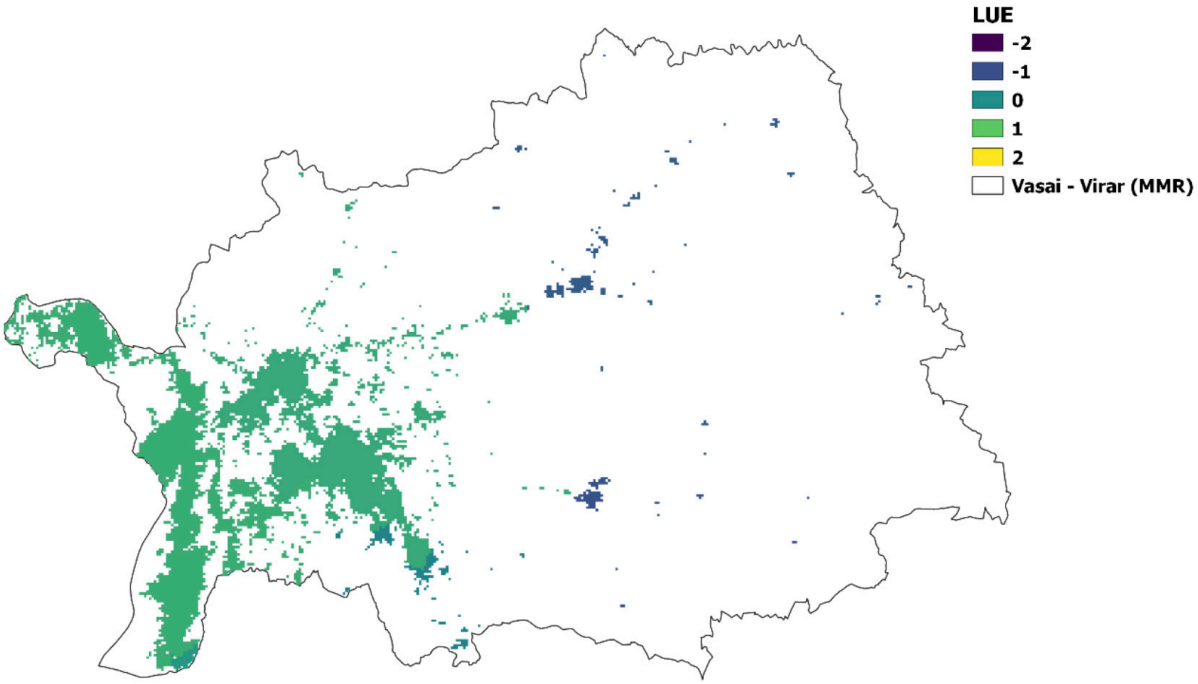


Vijayawada

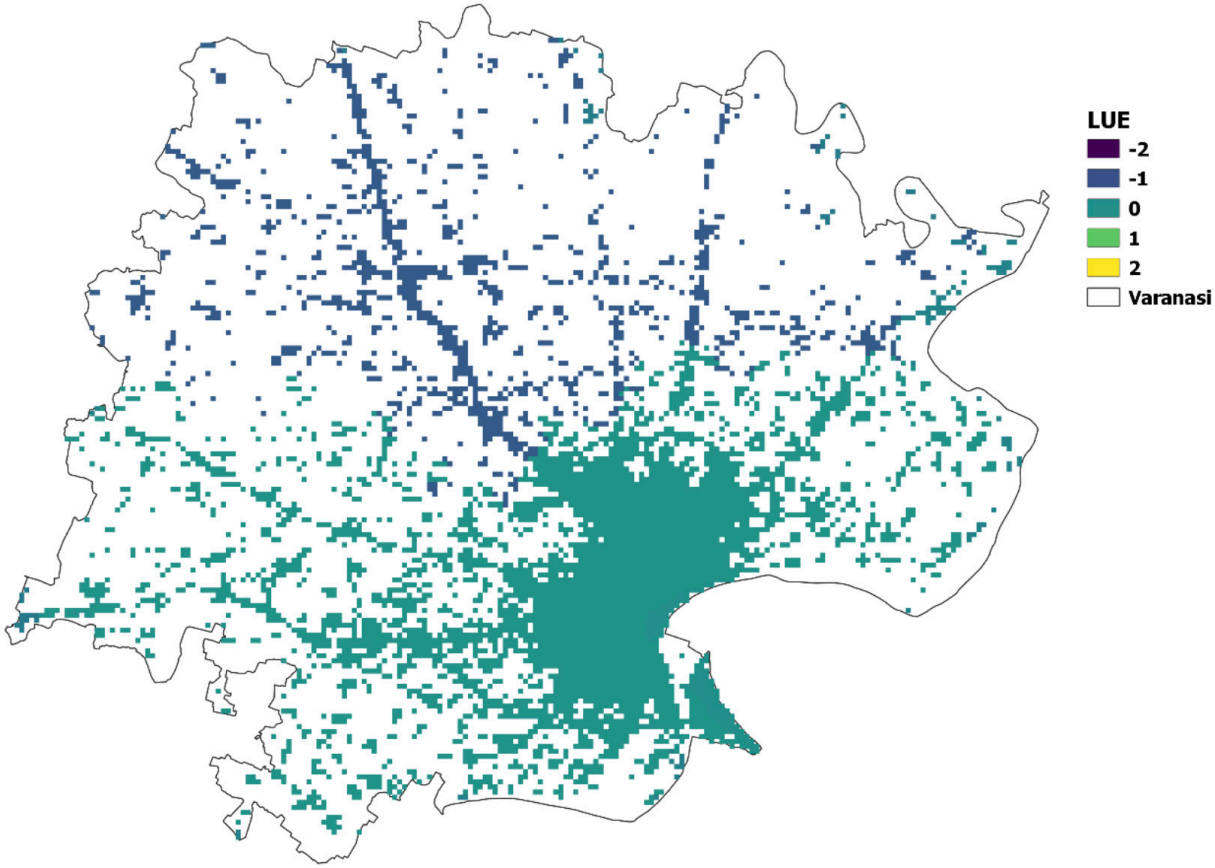


Source: MoSPI

Vasai-Virar

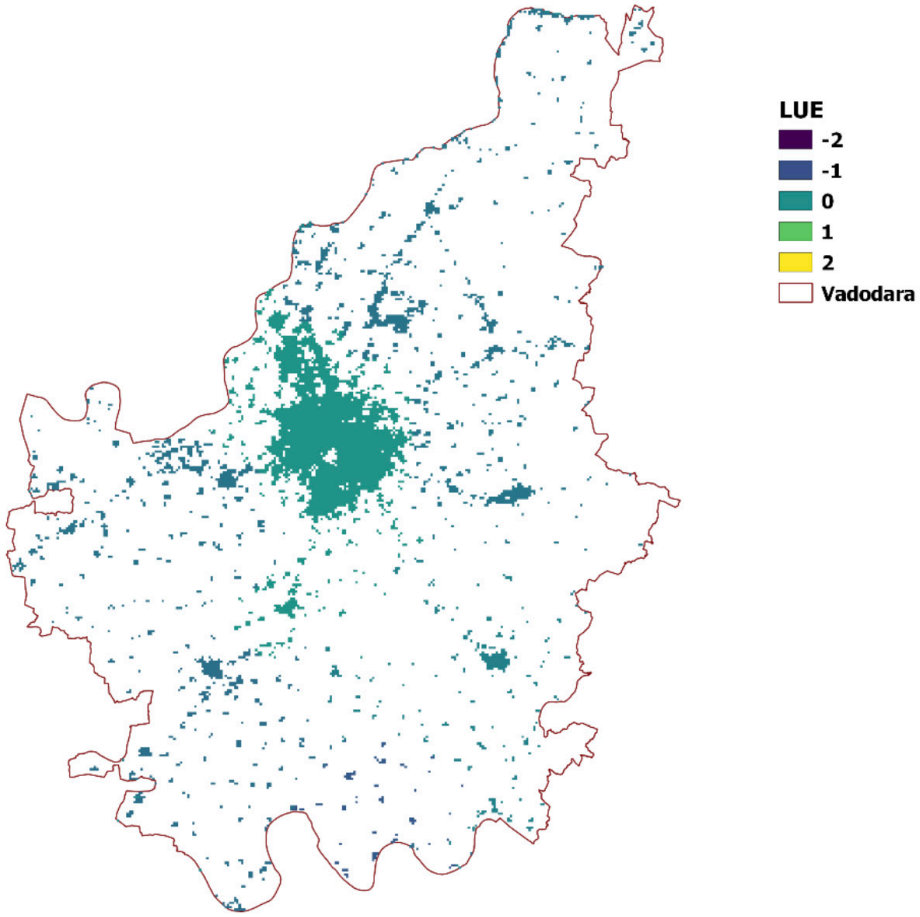


Varanasi

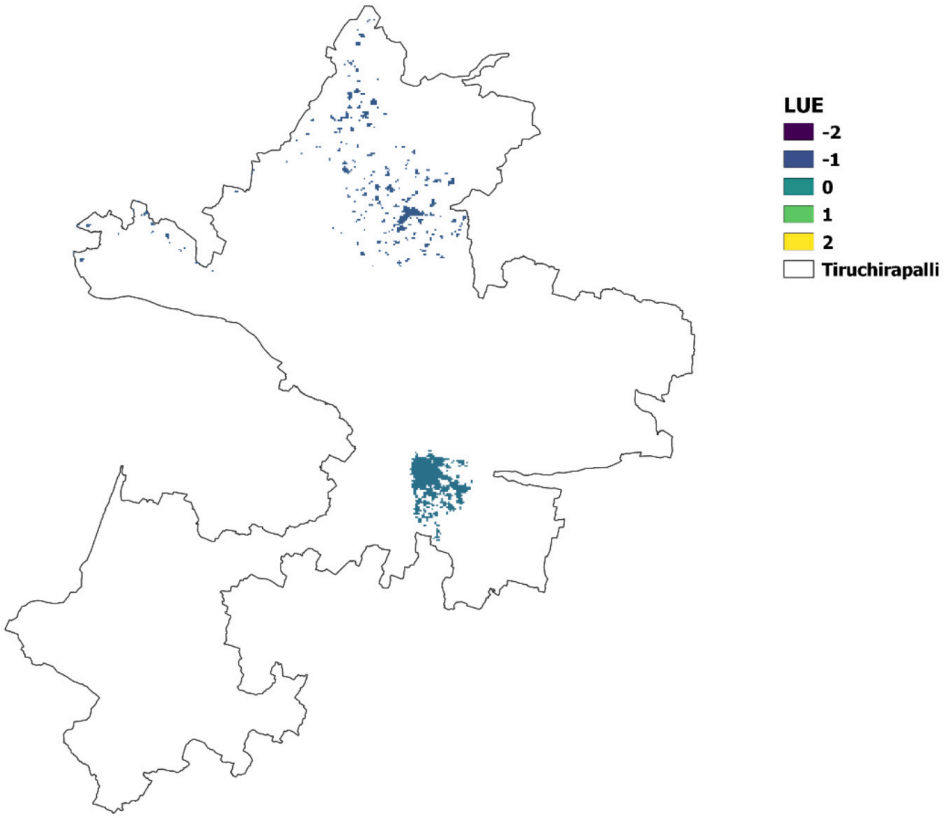


Source: MoSPI

Vadodara

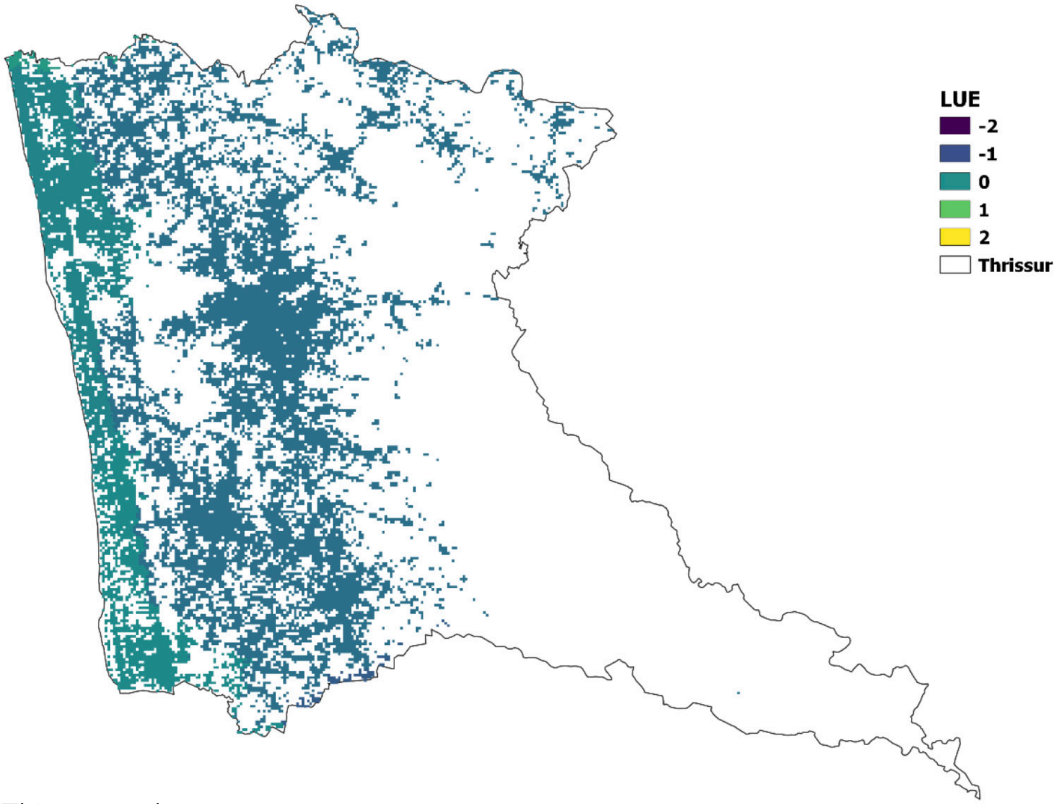


Tiruchirapalli

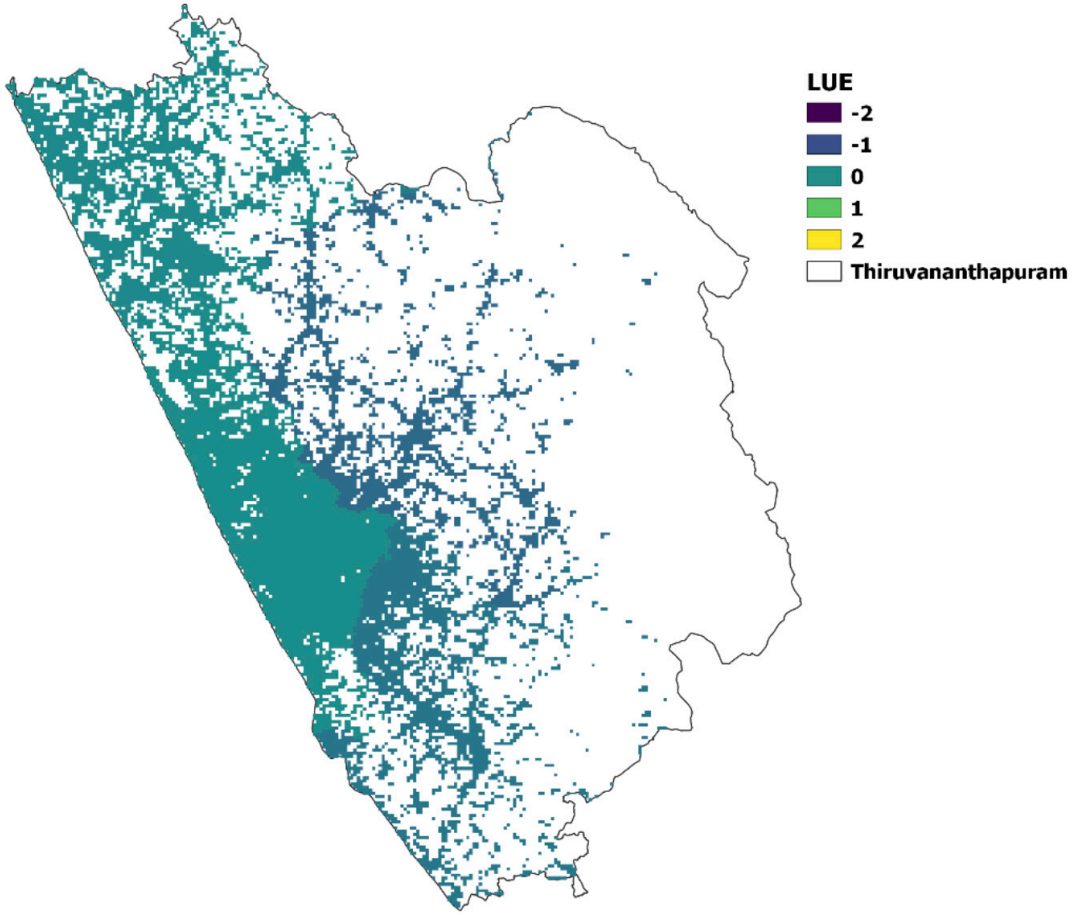


Source: MoSPI

Thrissur

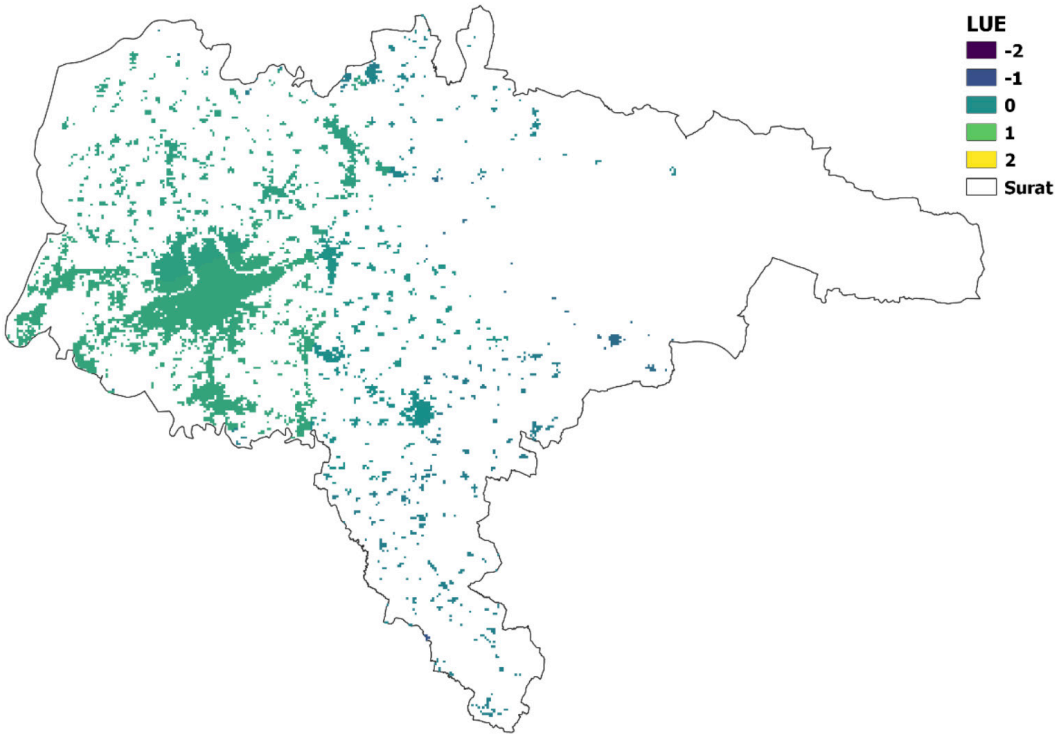


Thiruvananthapuram

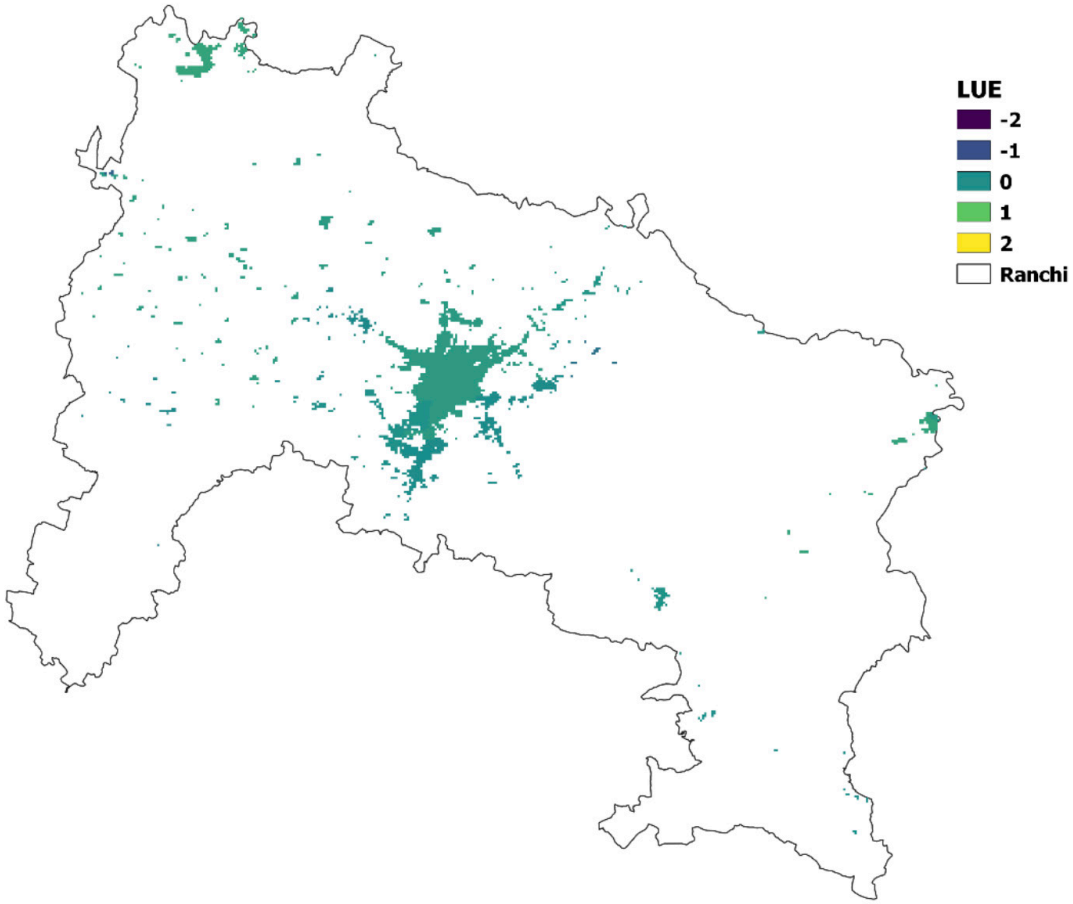


Source: MoSPI

Surat

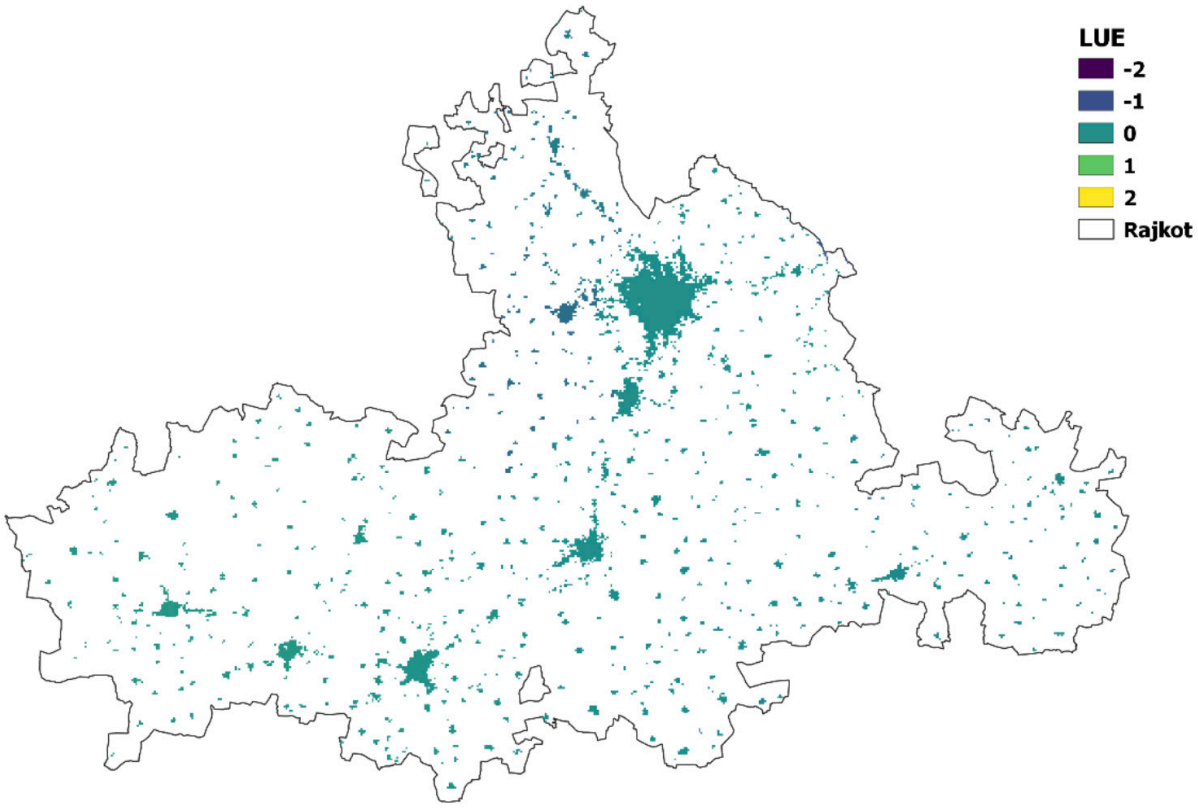


Racnchi

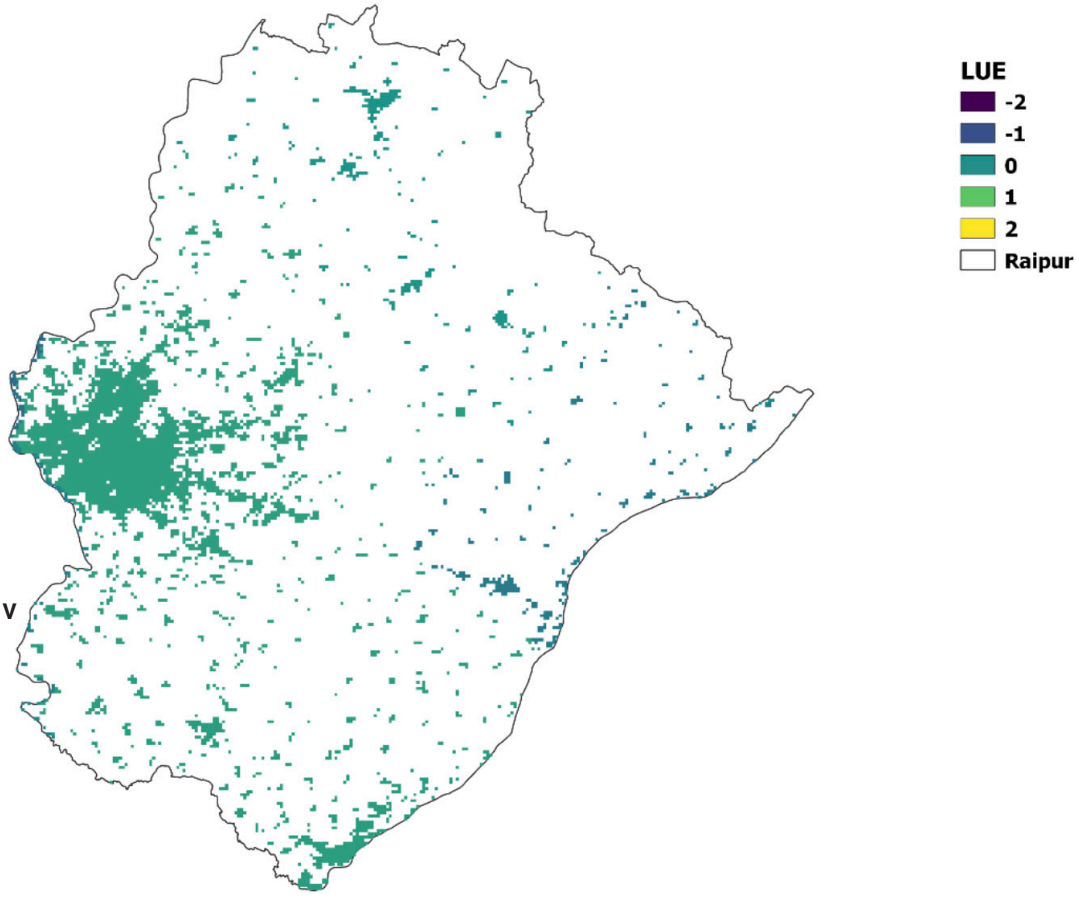


Source: MoSPI

Rajkot

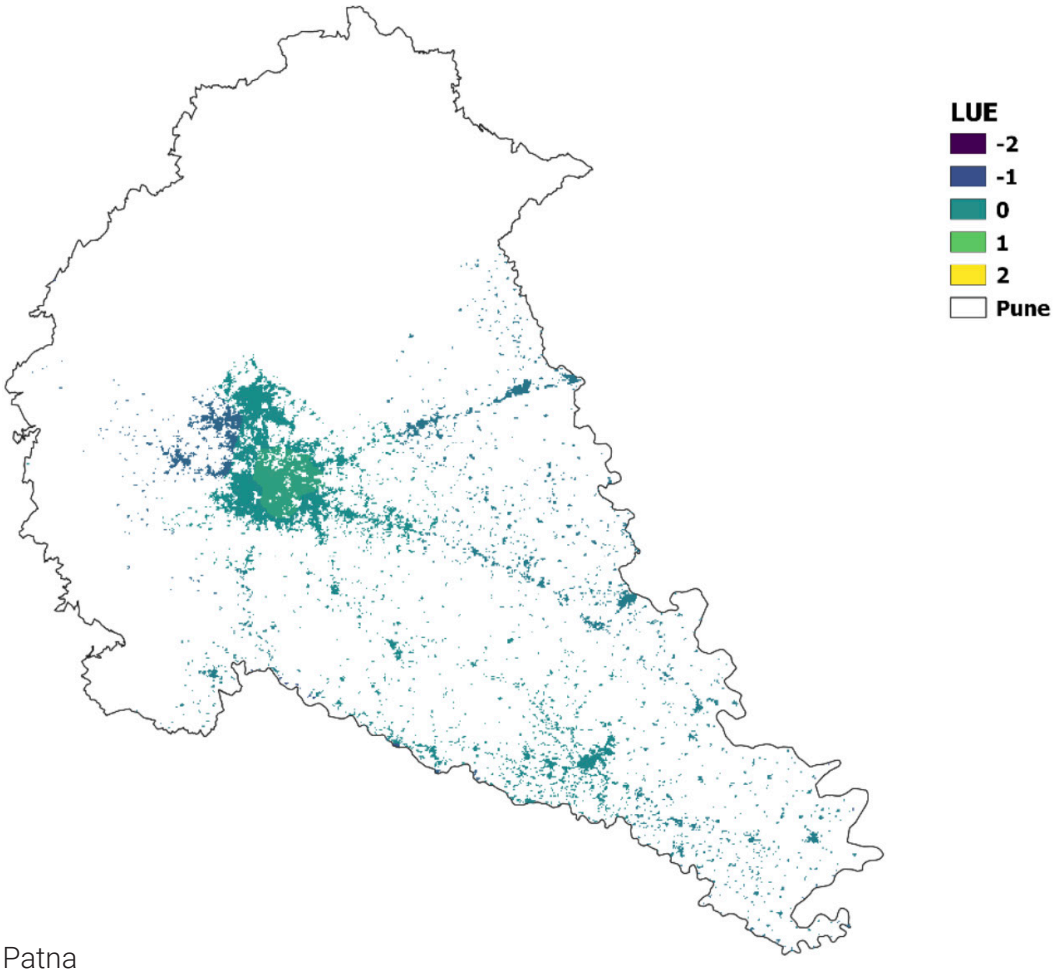


Raipur

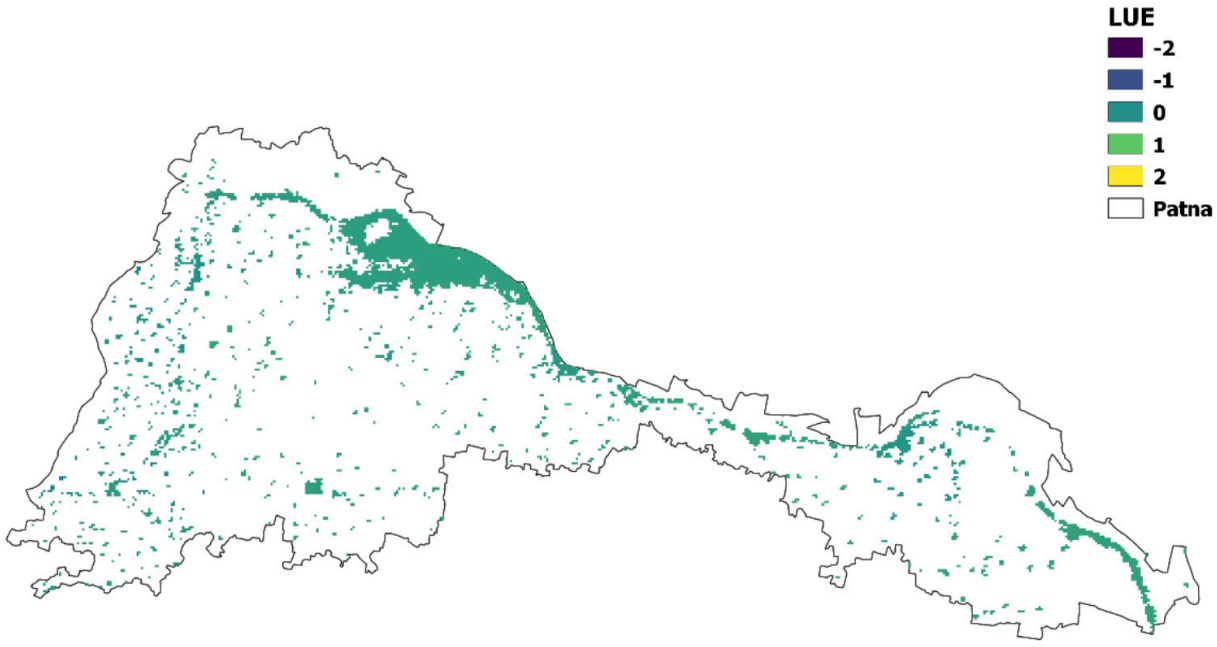


Source: MoSPI

Pune

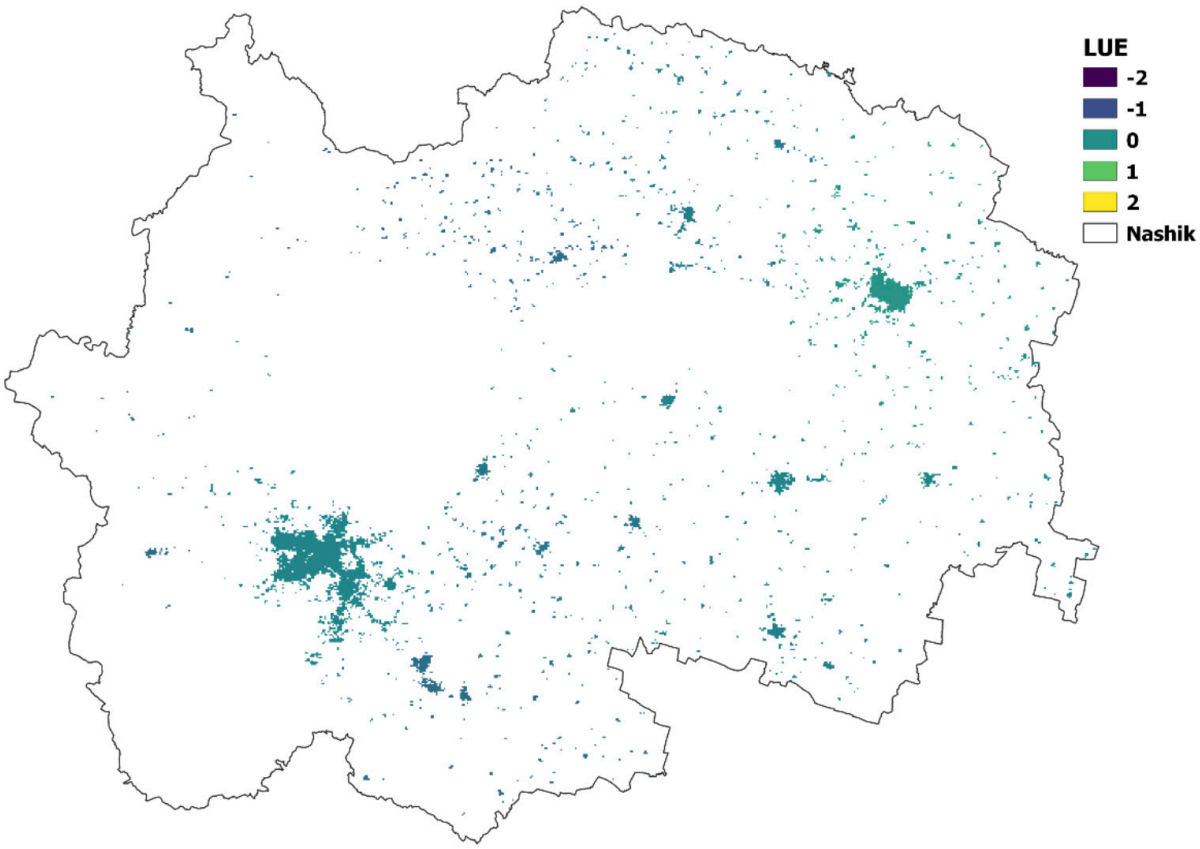


Patna

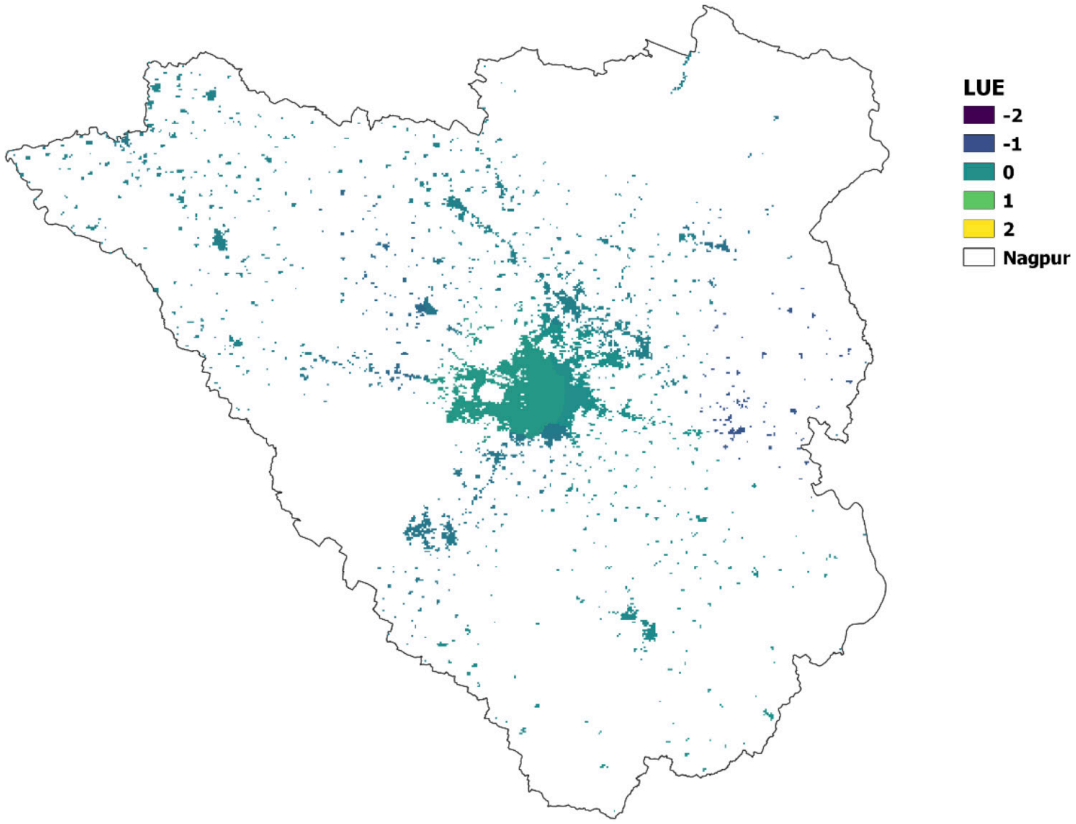


Source: MoSPI

Nashik

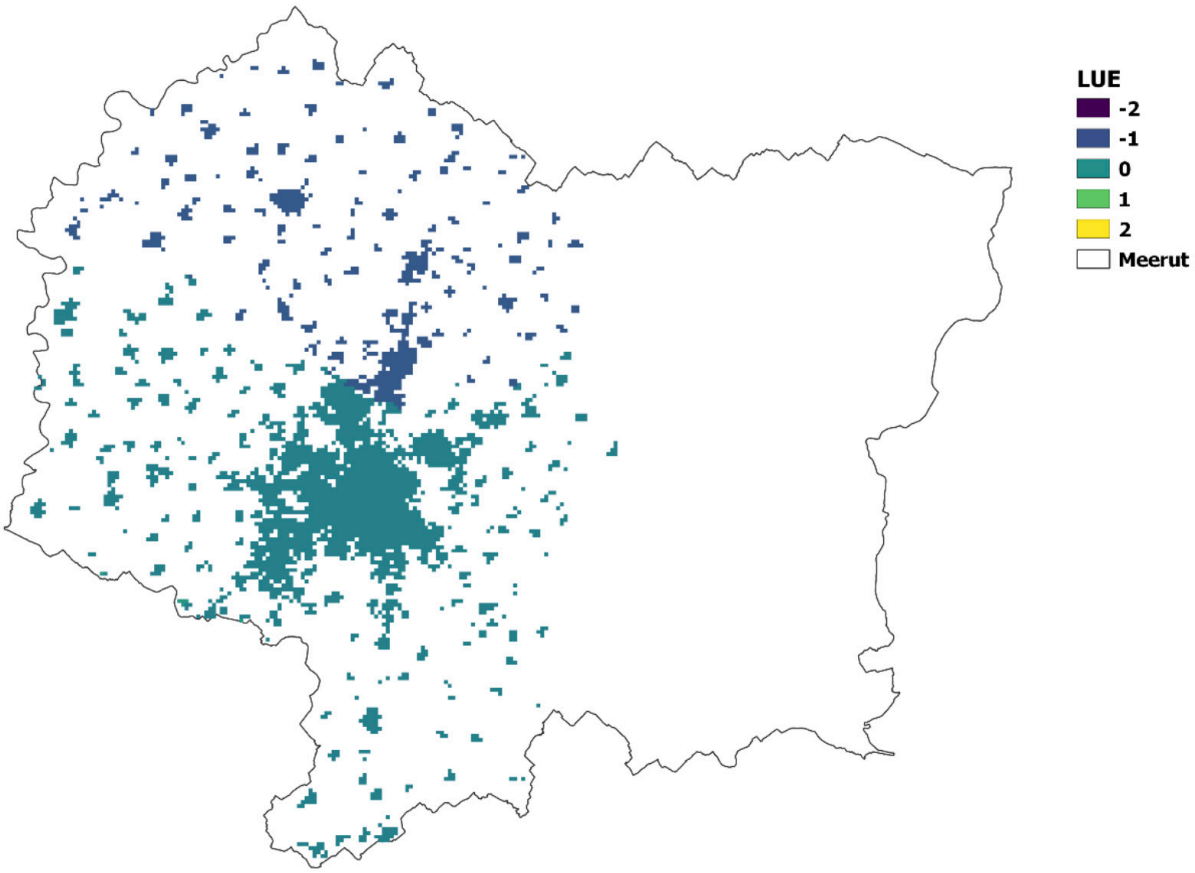


Nagpur

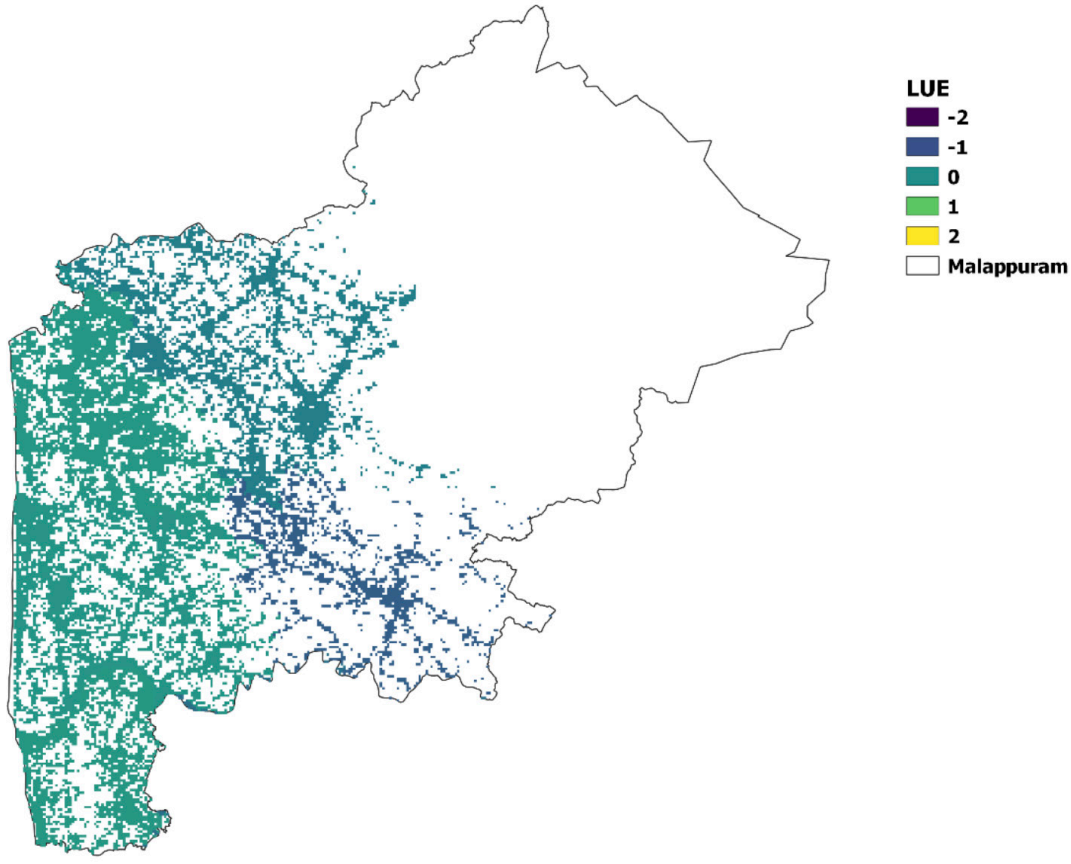


Source: MoSPI

Meerut

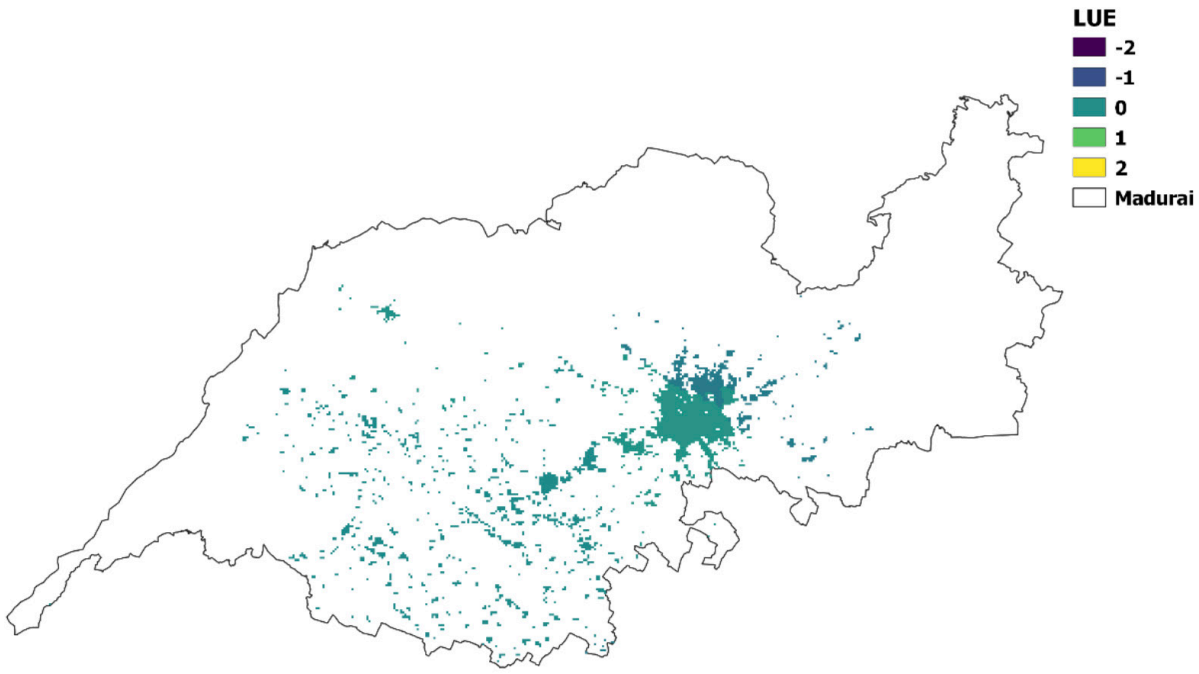


Malappuram



Source: MoSPI

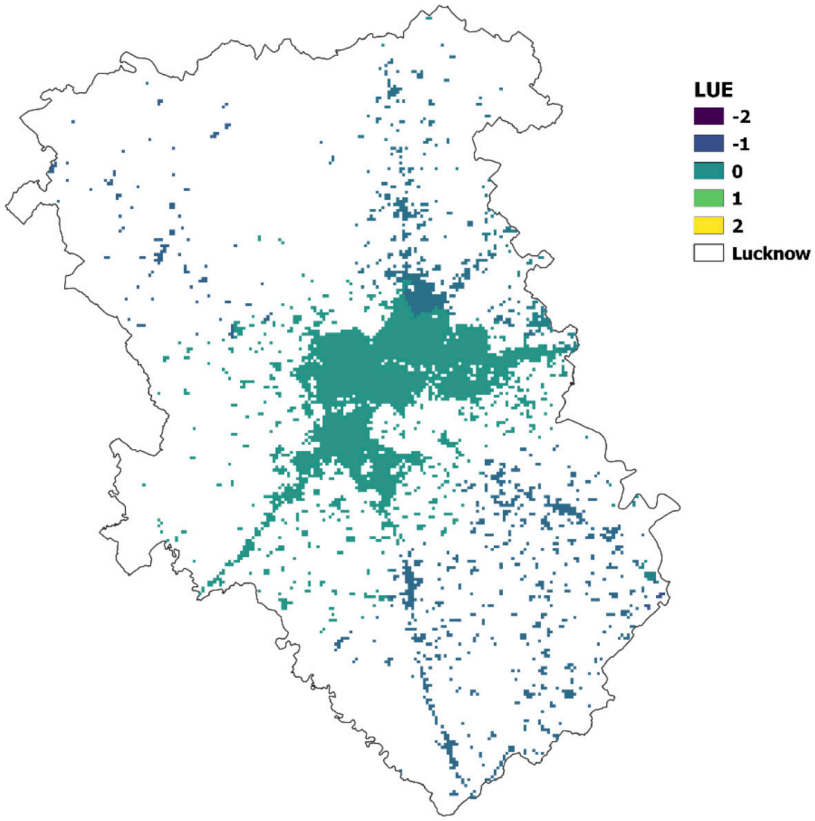
Madurai



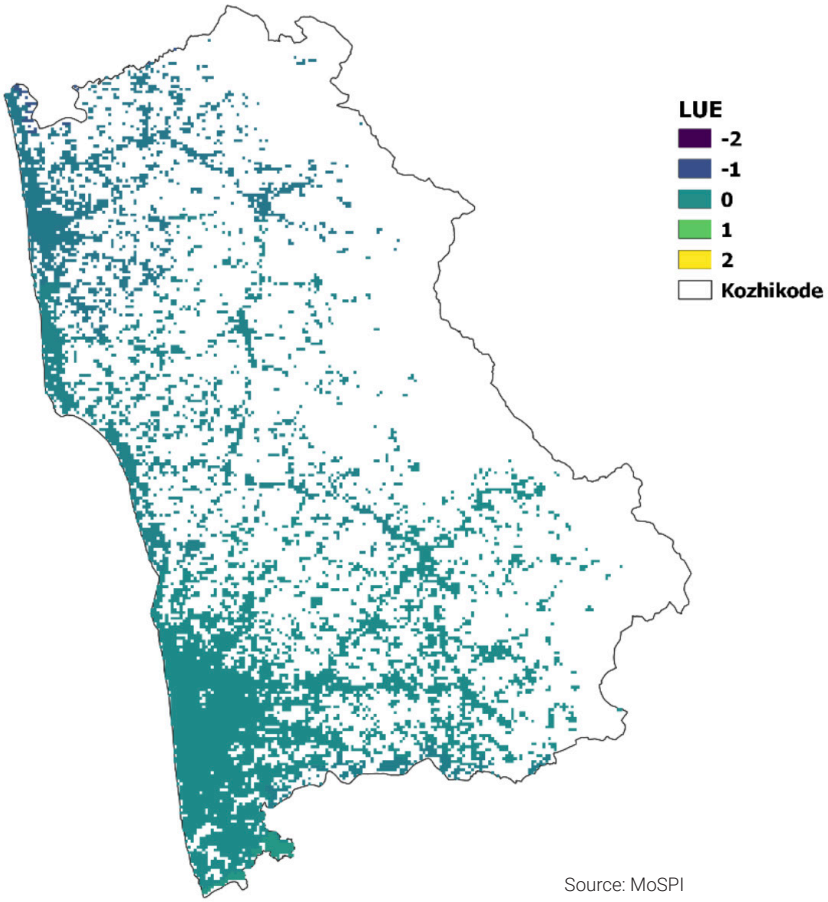
Ladhiana

Source: MoSPI

Lucknow

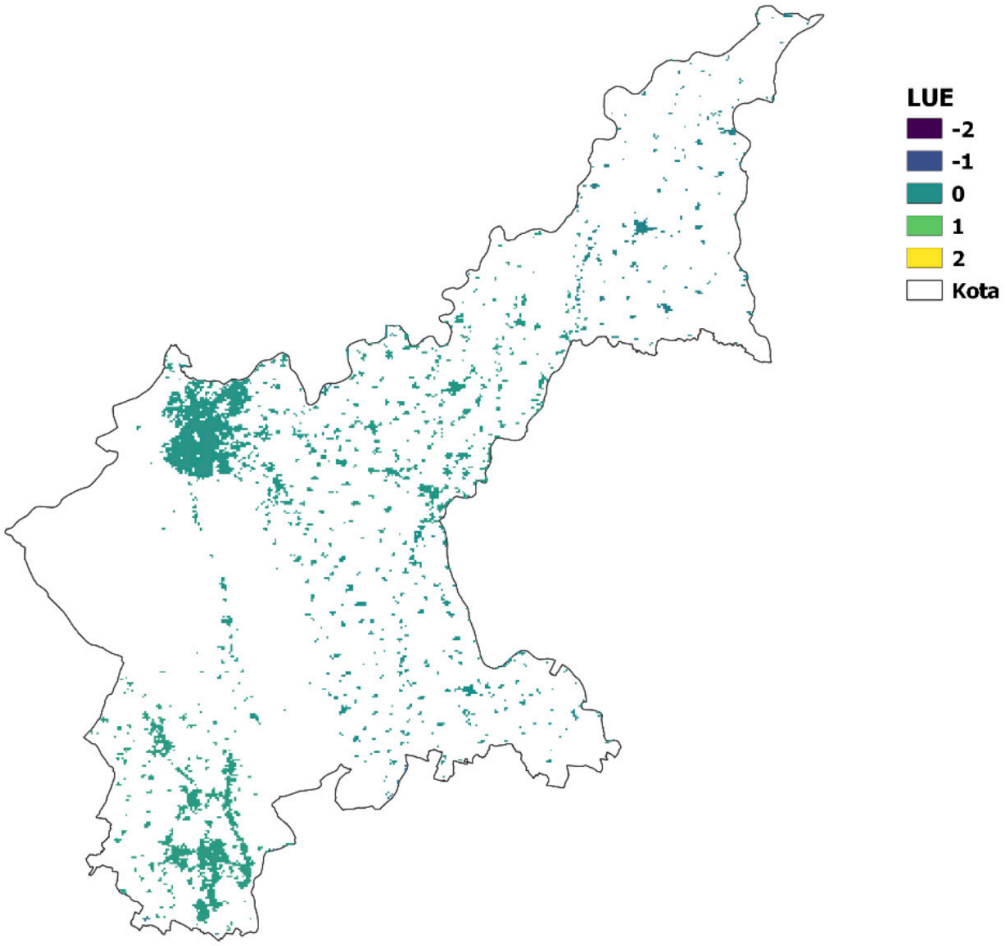


Kozhikode

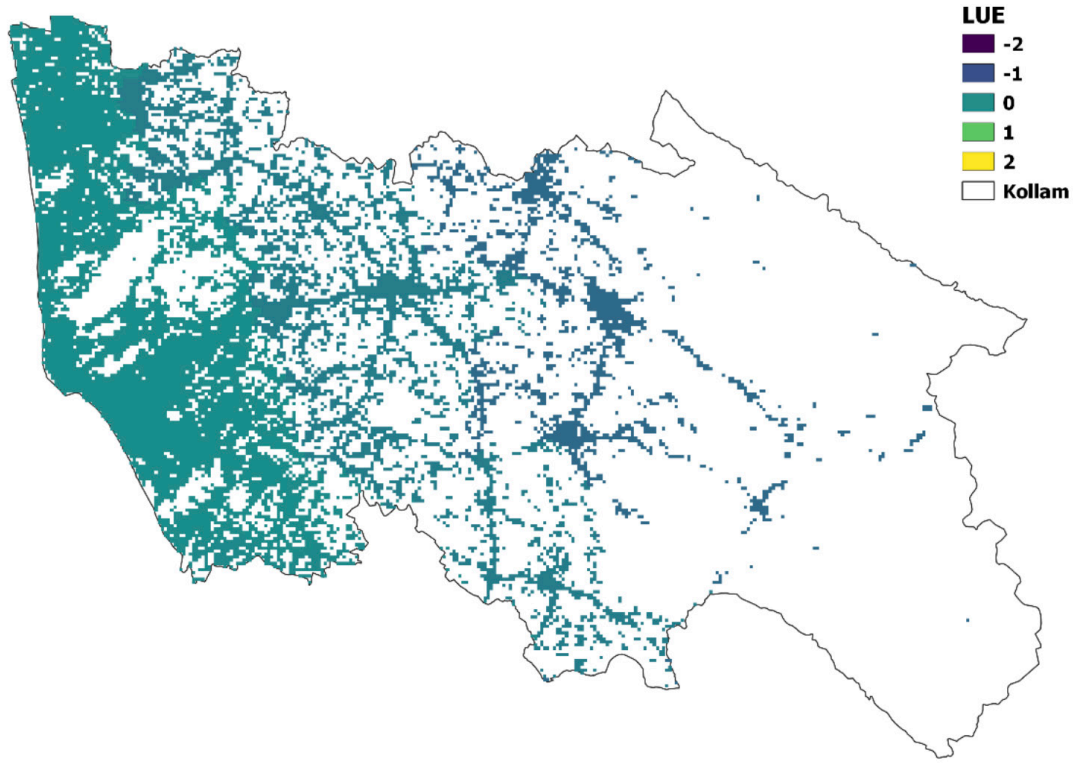


Source: MoSPI

Kota

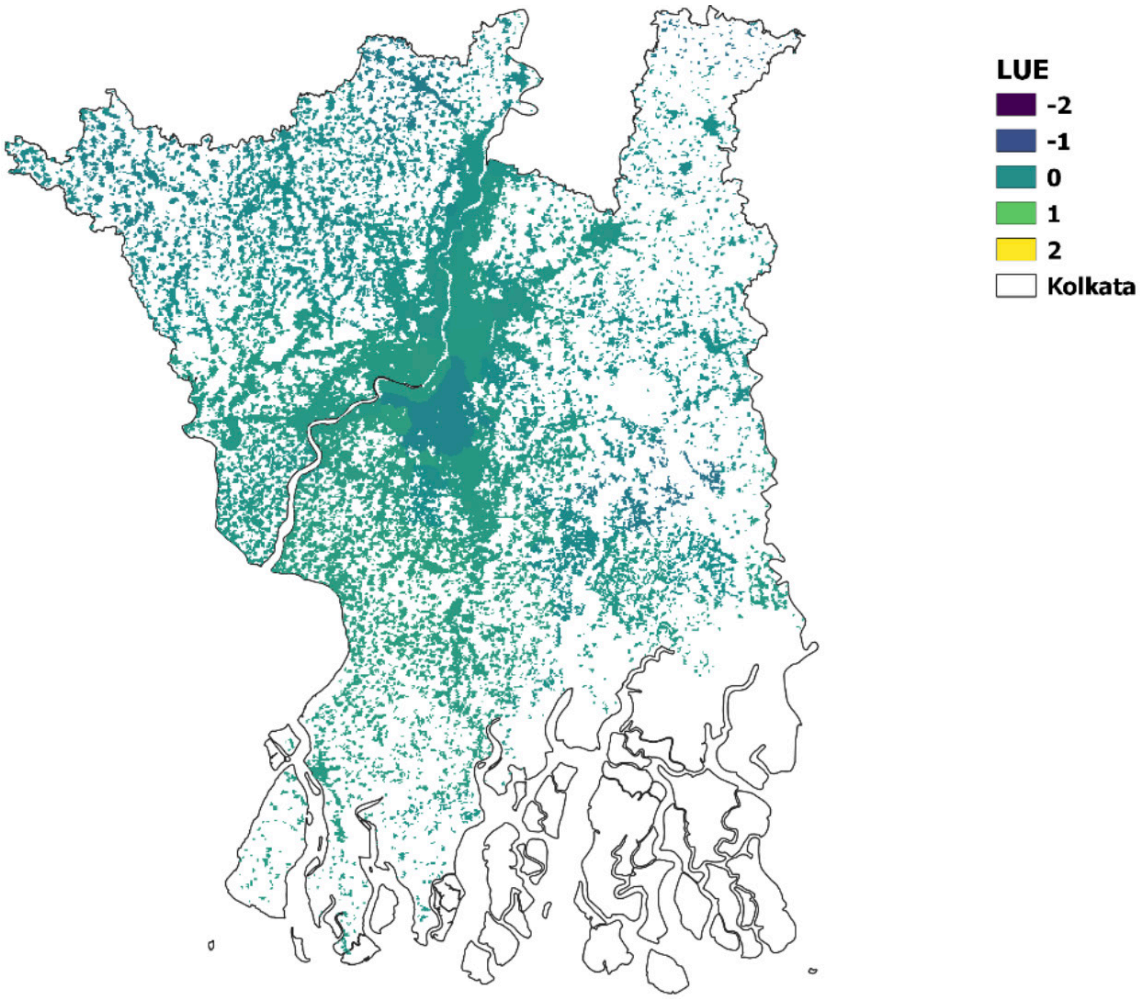


Kollam

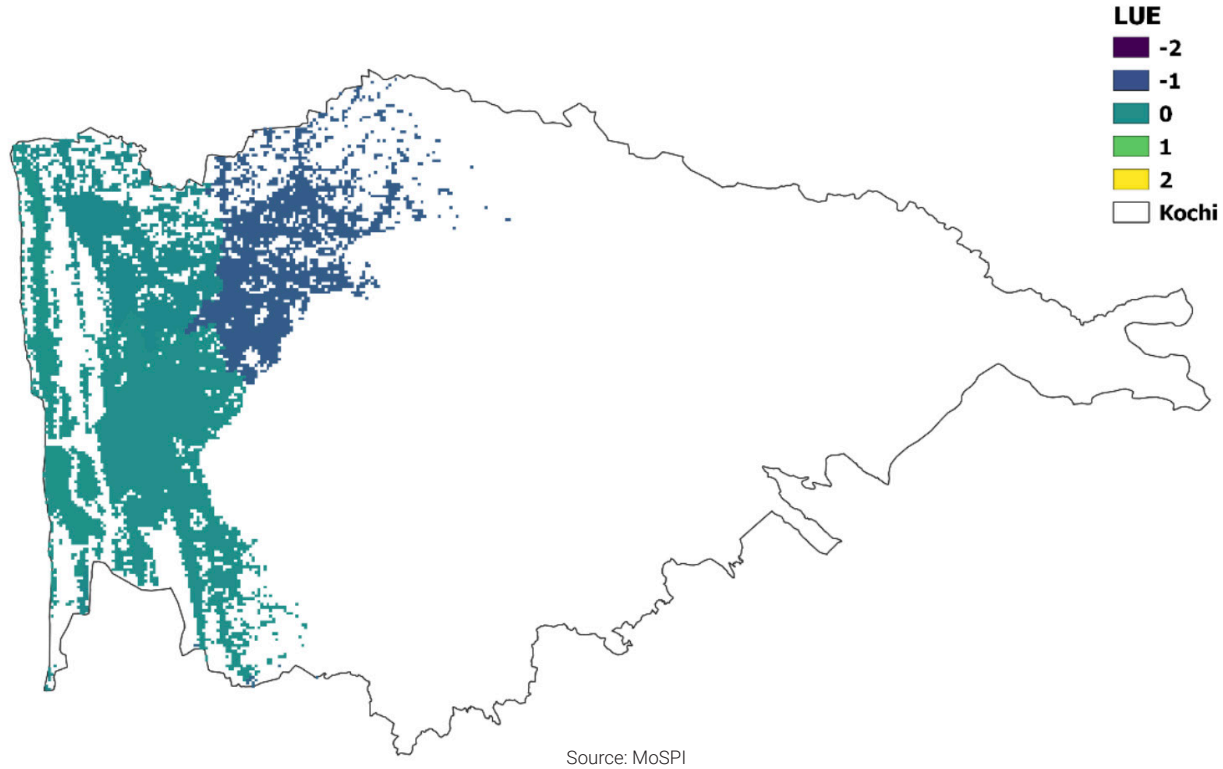


Source: MoSPI

Kolkata

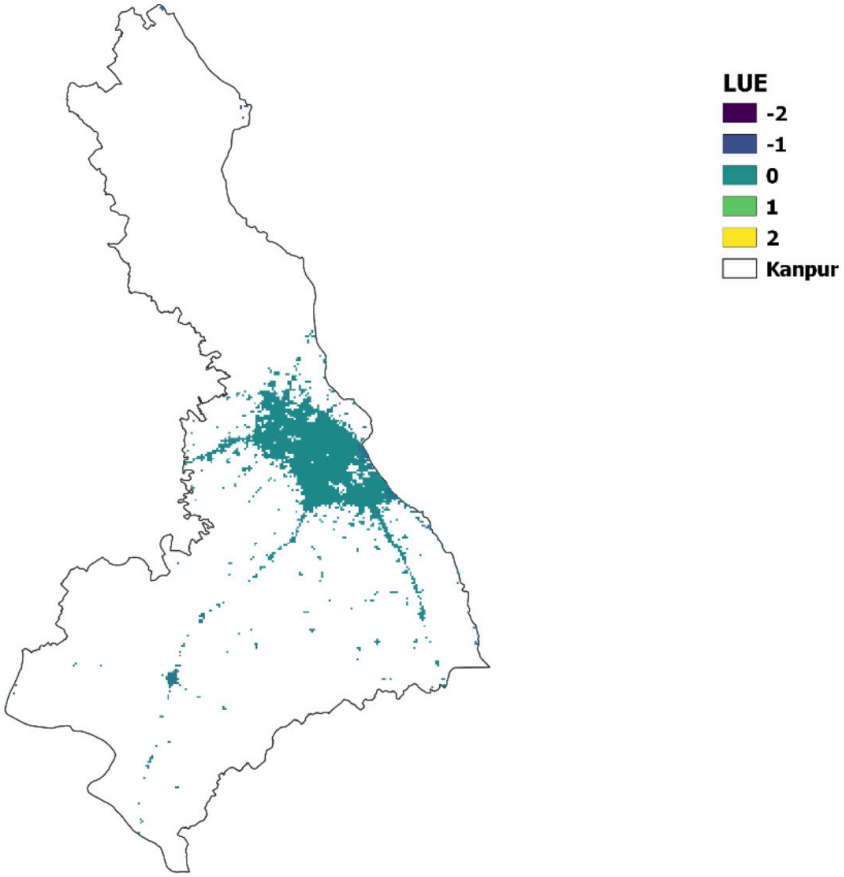


Kochi

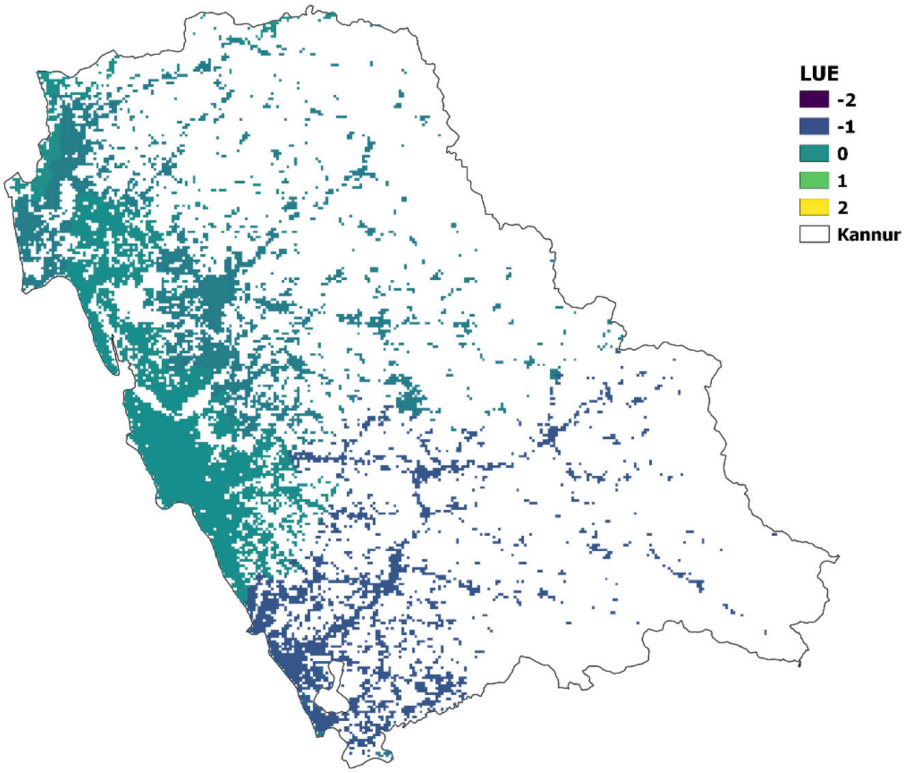


Source: MoSPI

Kanpur

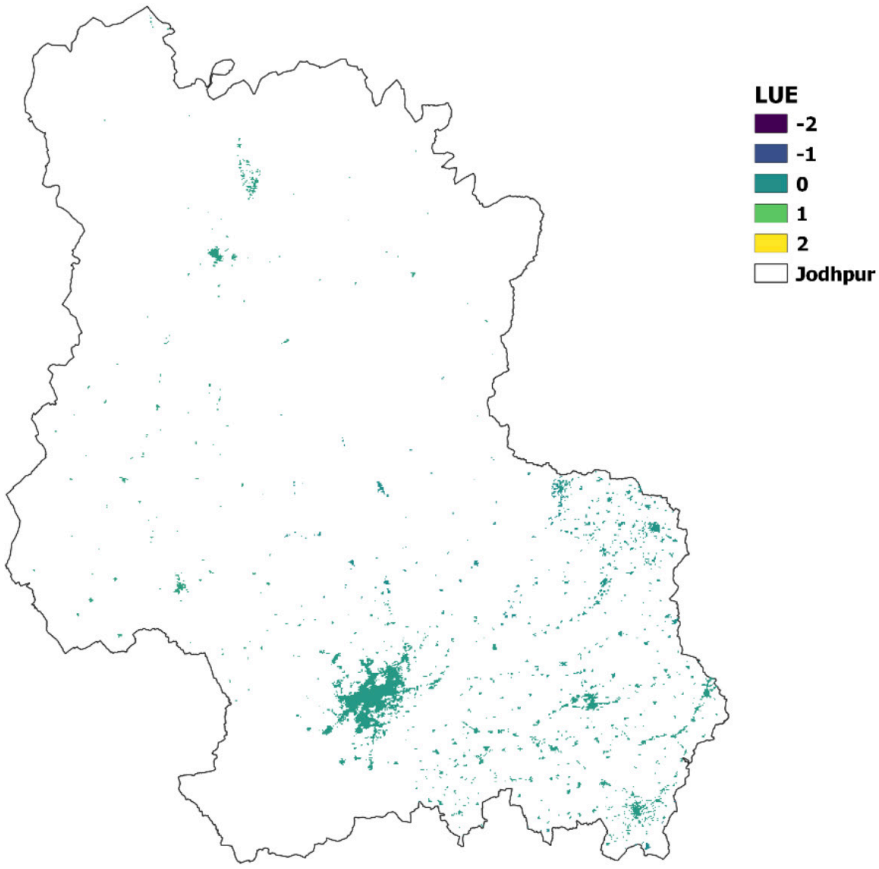


Kannur

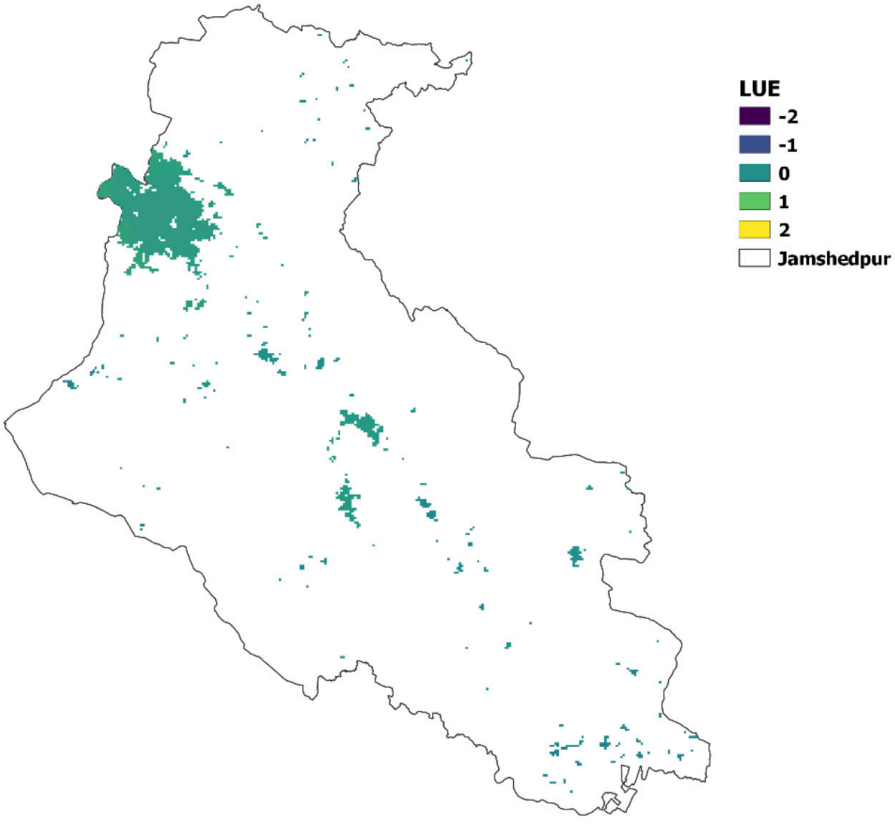


Source: MoSPI

Jodhpur

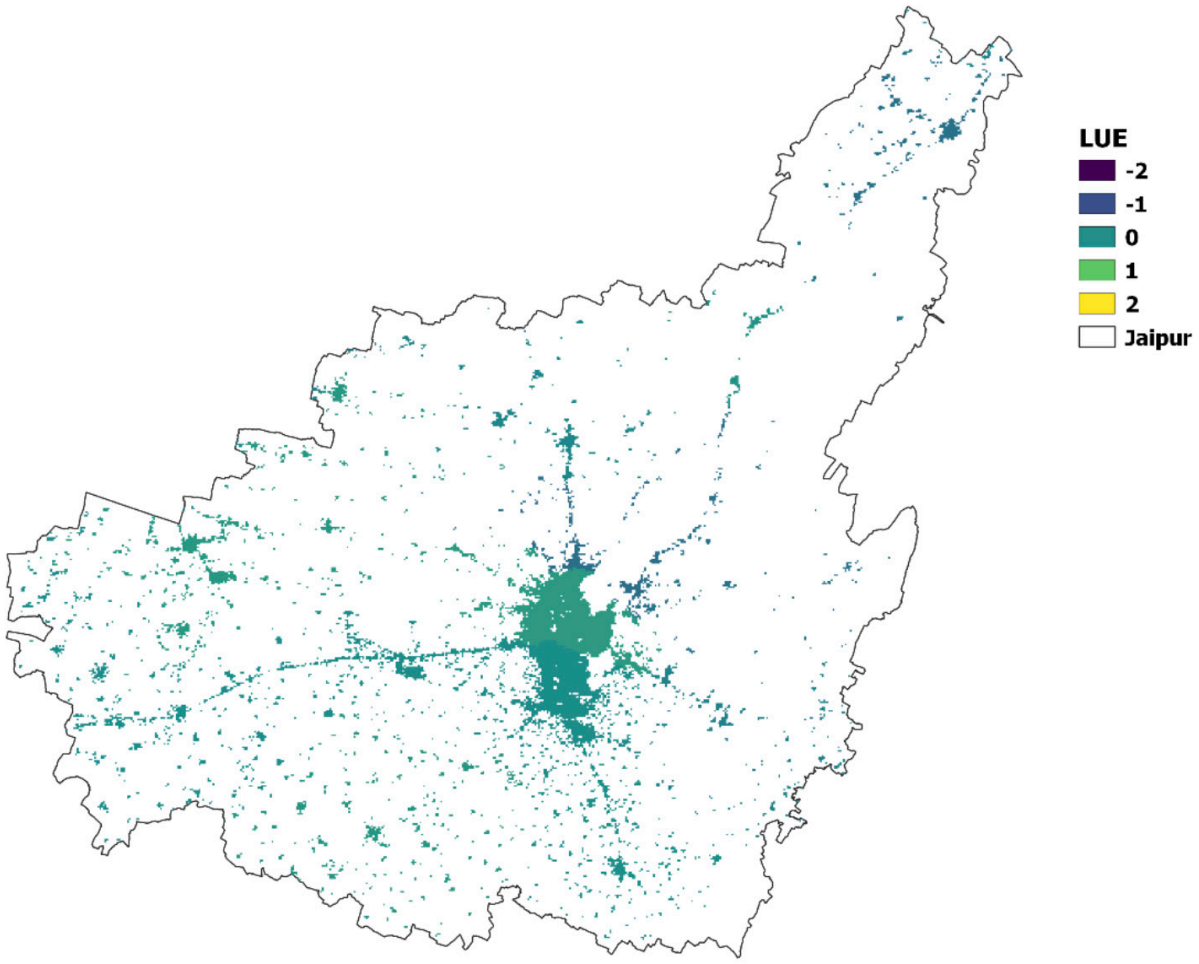


Jamshedpur

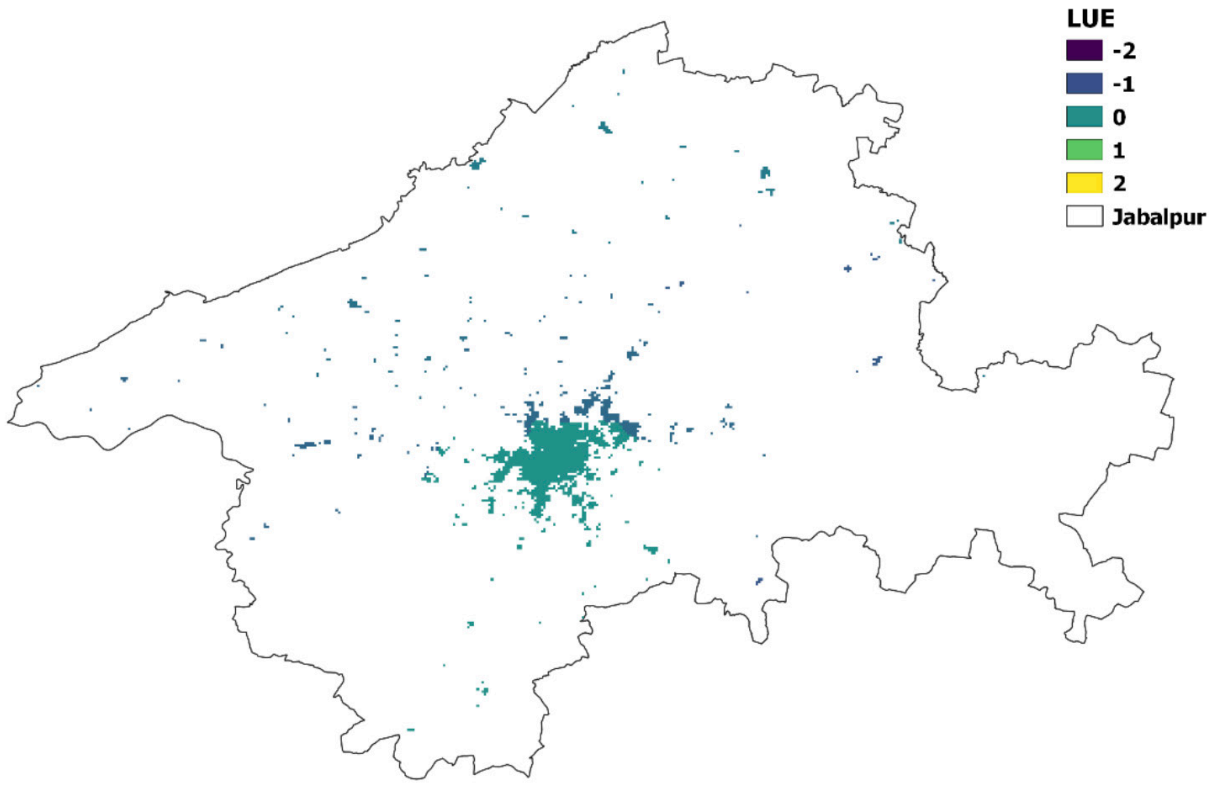


Source: MoSPI

Jaipur

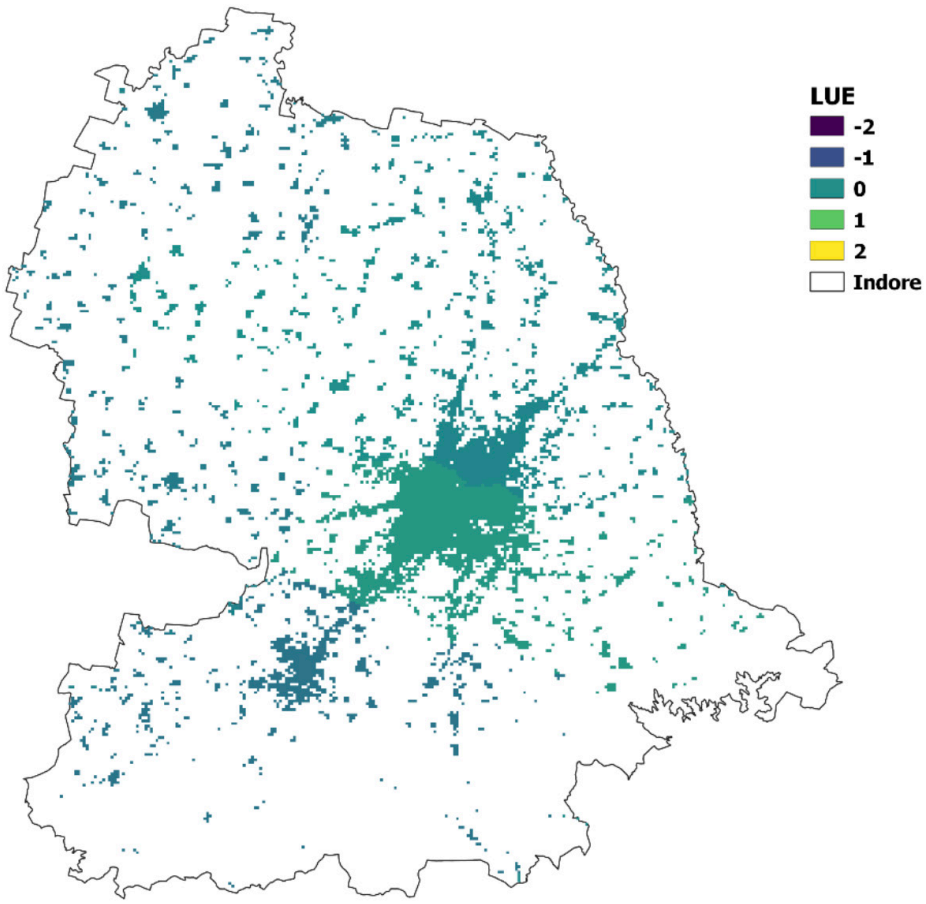


Jabalpur

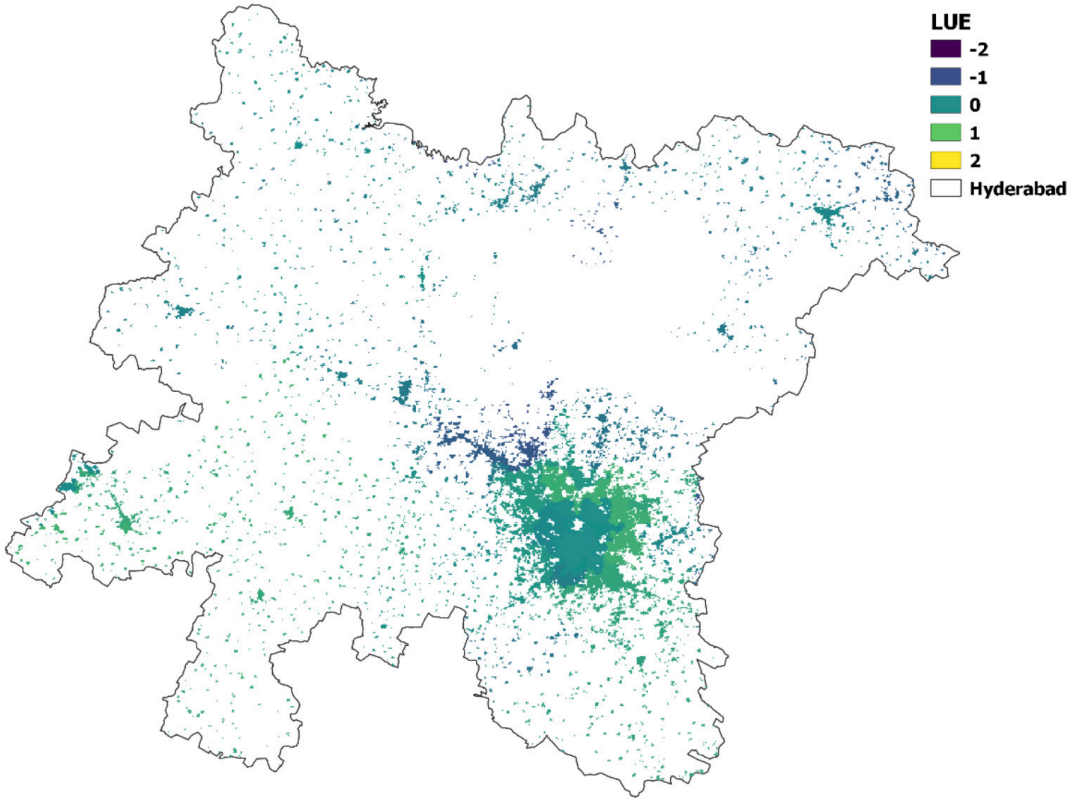


Source: MoSPI

Indore

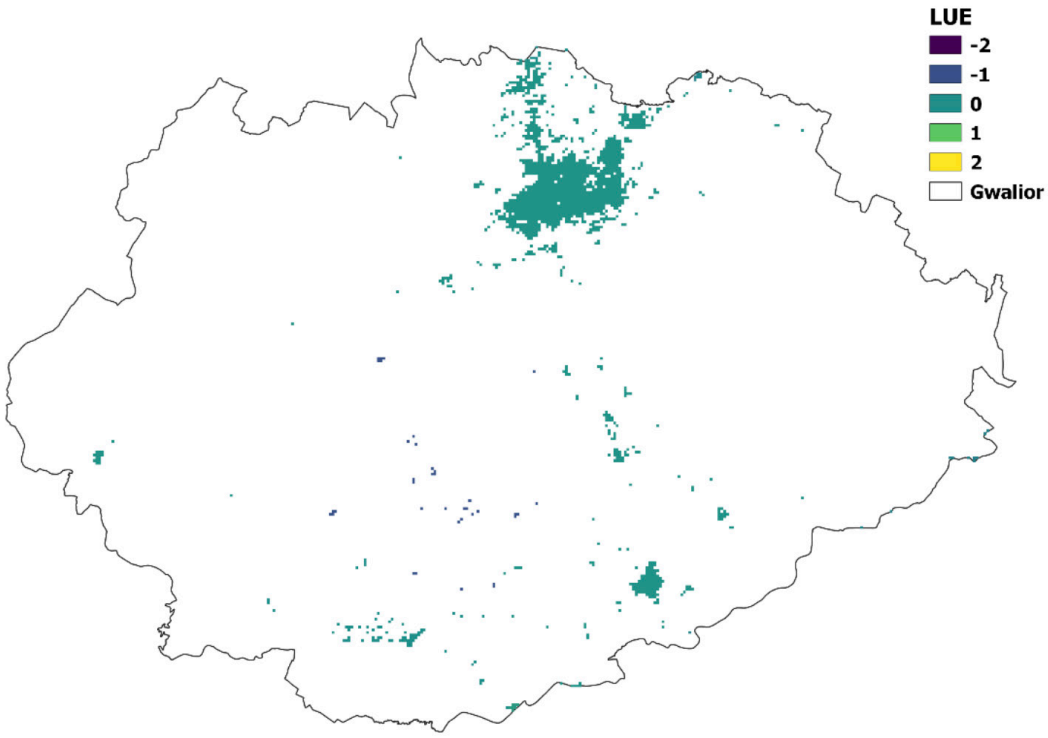


Hyderabad

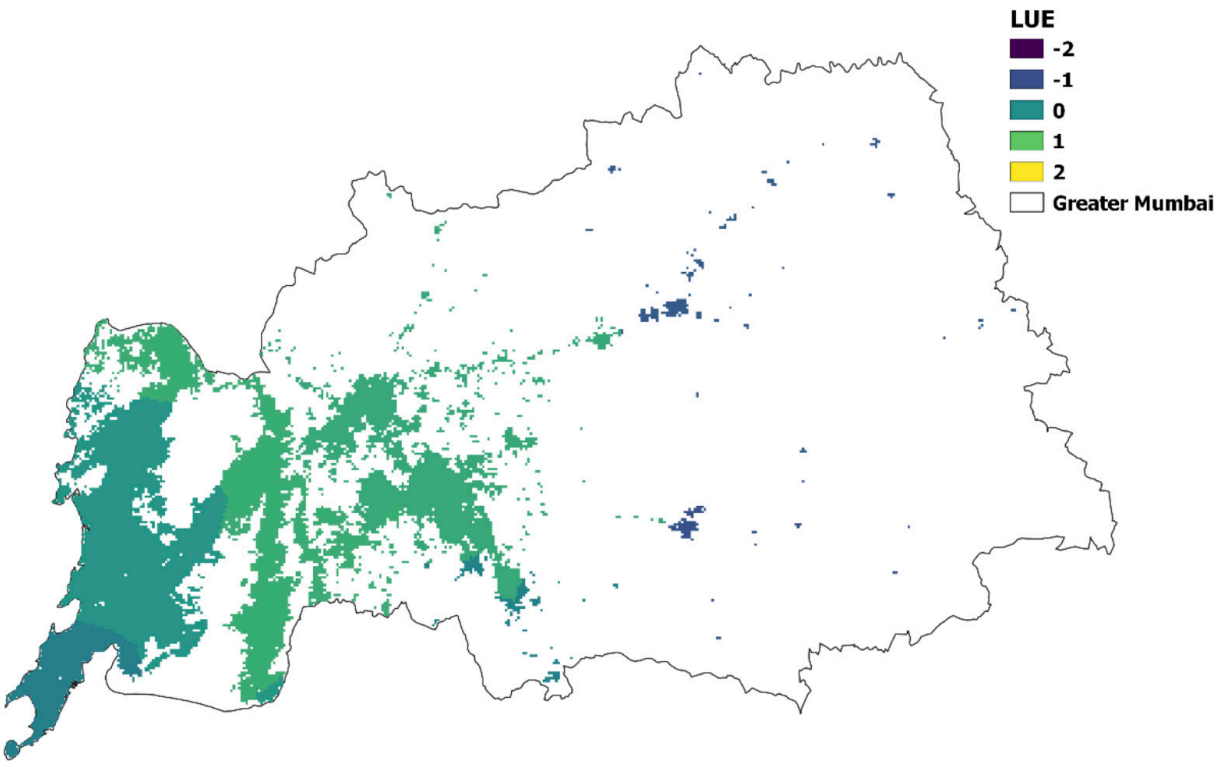


Source: MoSPI

Gwalior

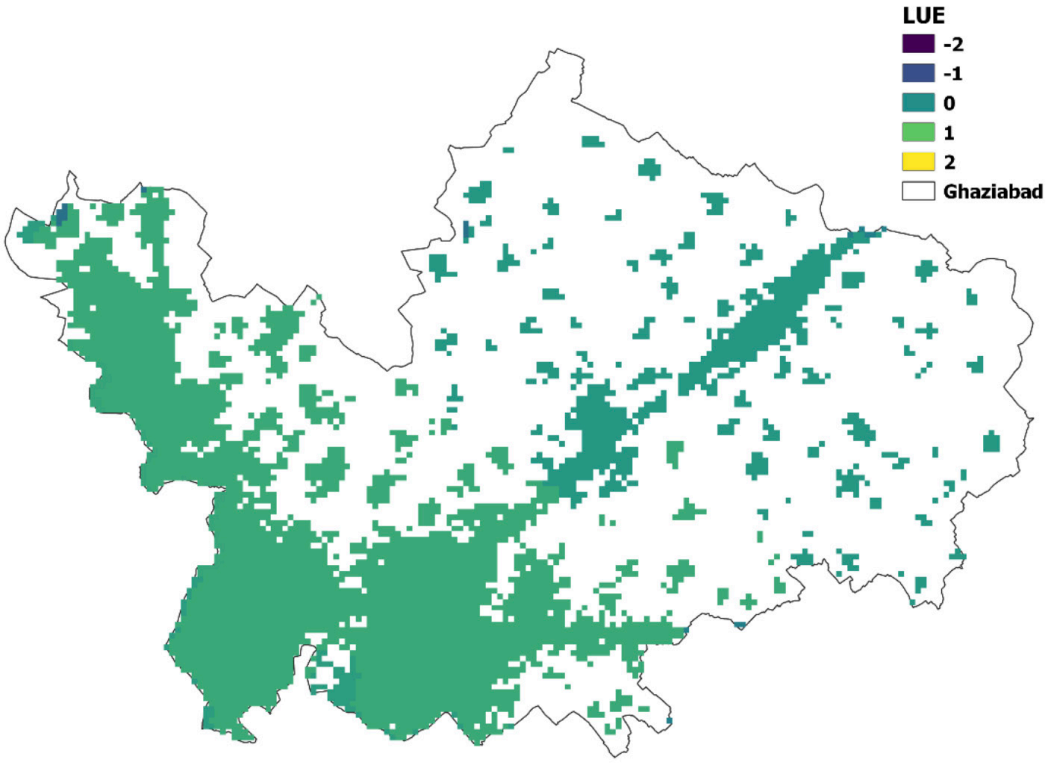


Greater Mumbai

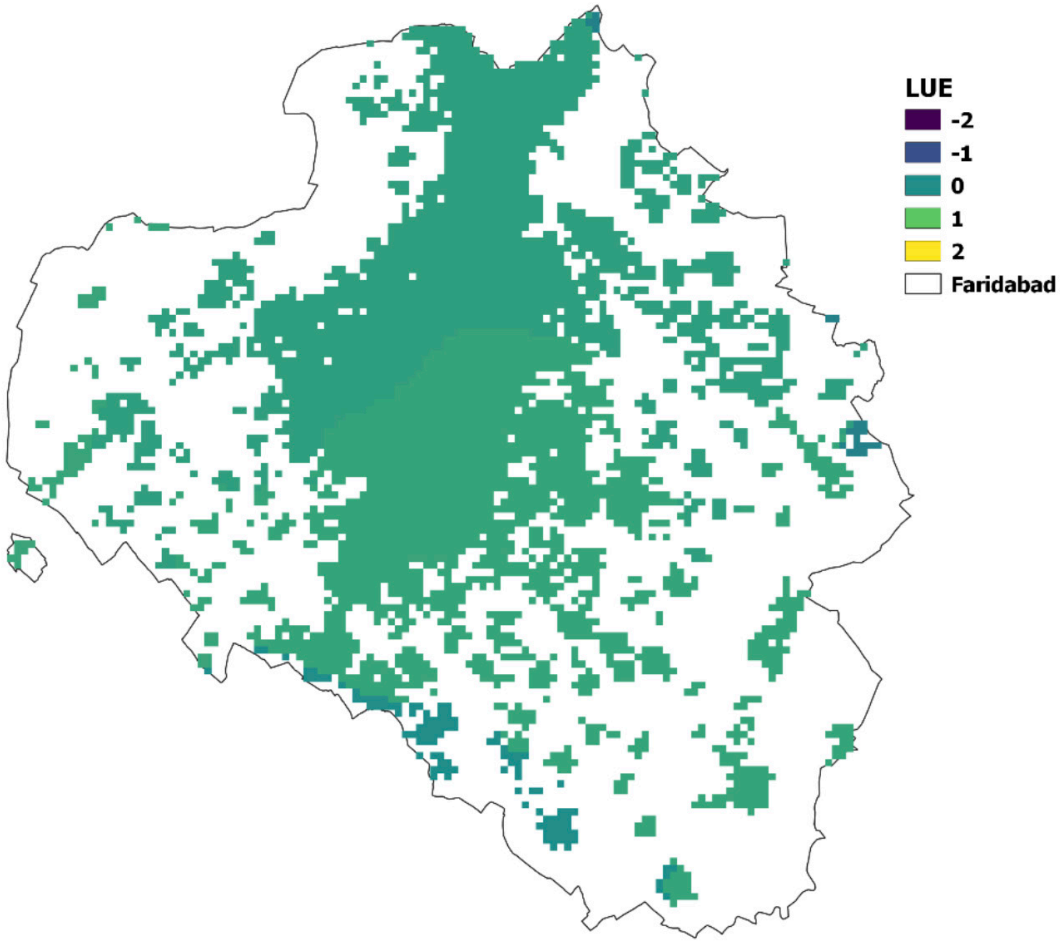


Source: MoSPI

Ghaziabad

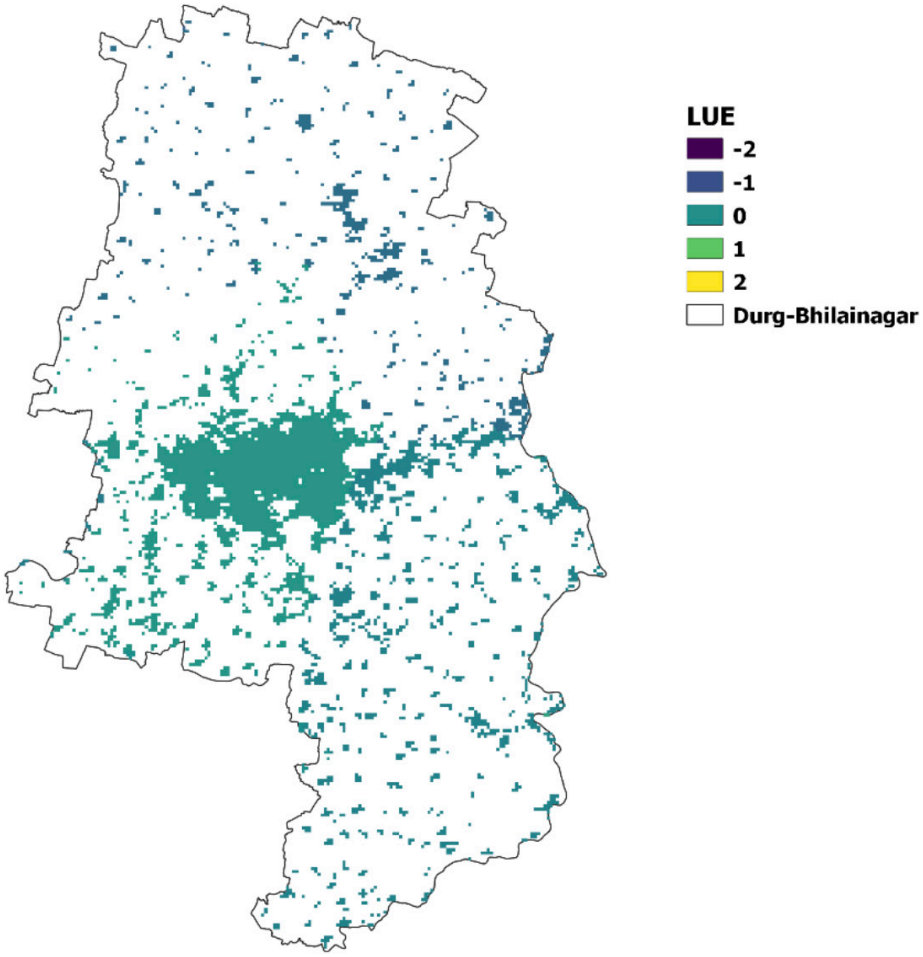


Faridabad

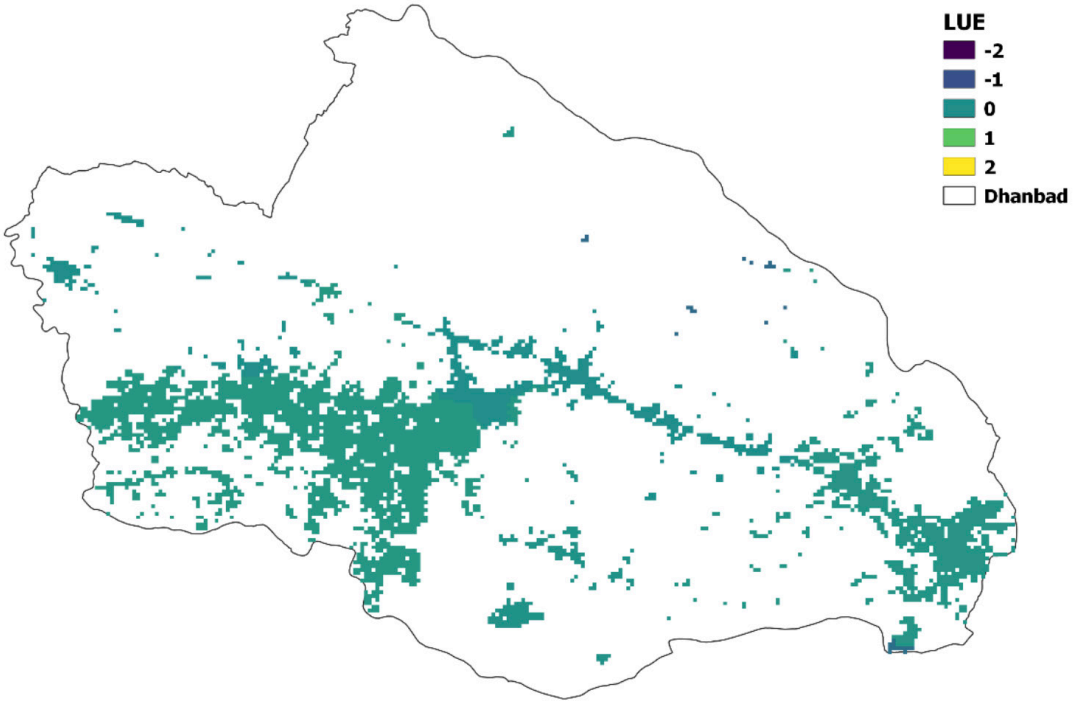


Source: MoSPI

Durg-Bhilainagar

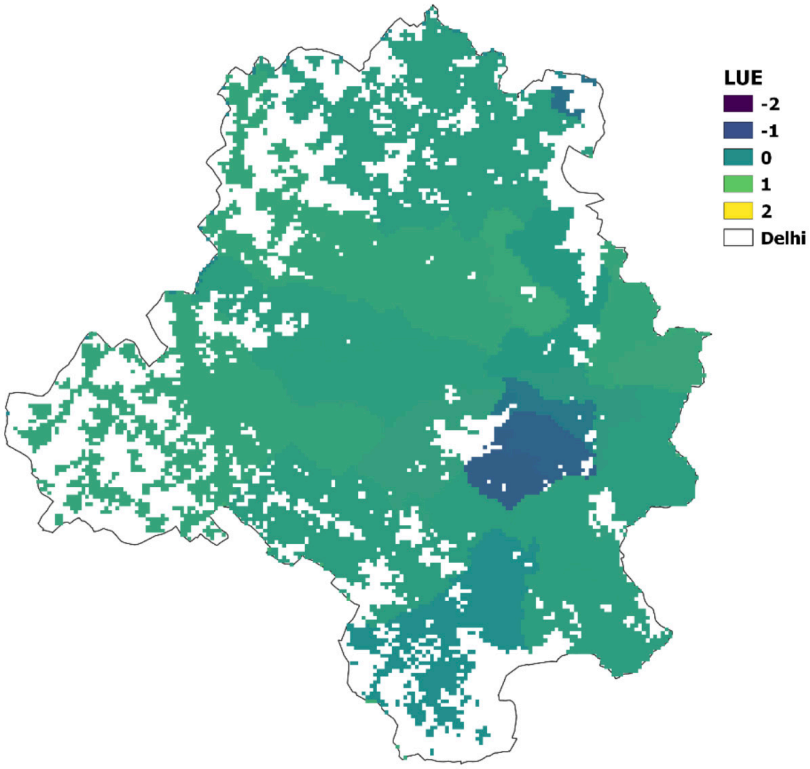


Dhanbad

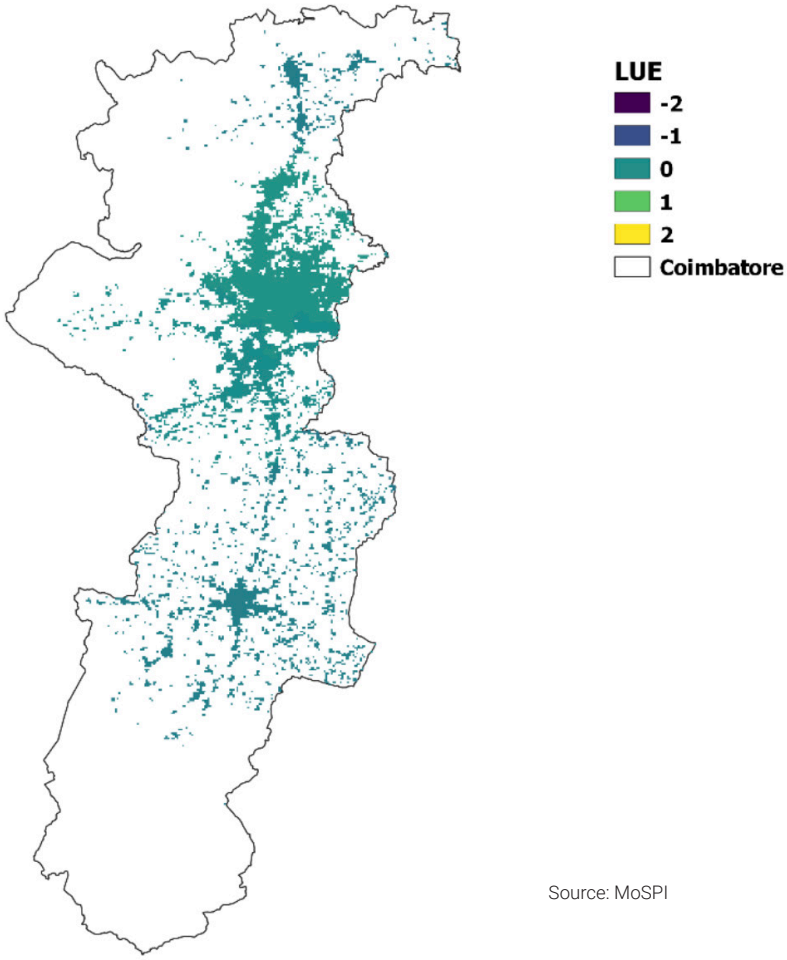


Source: MoSPI

Delhi

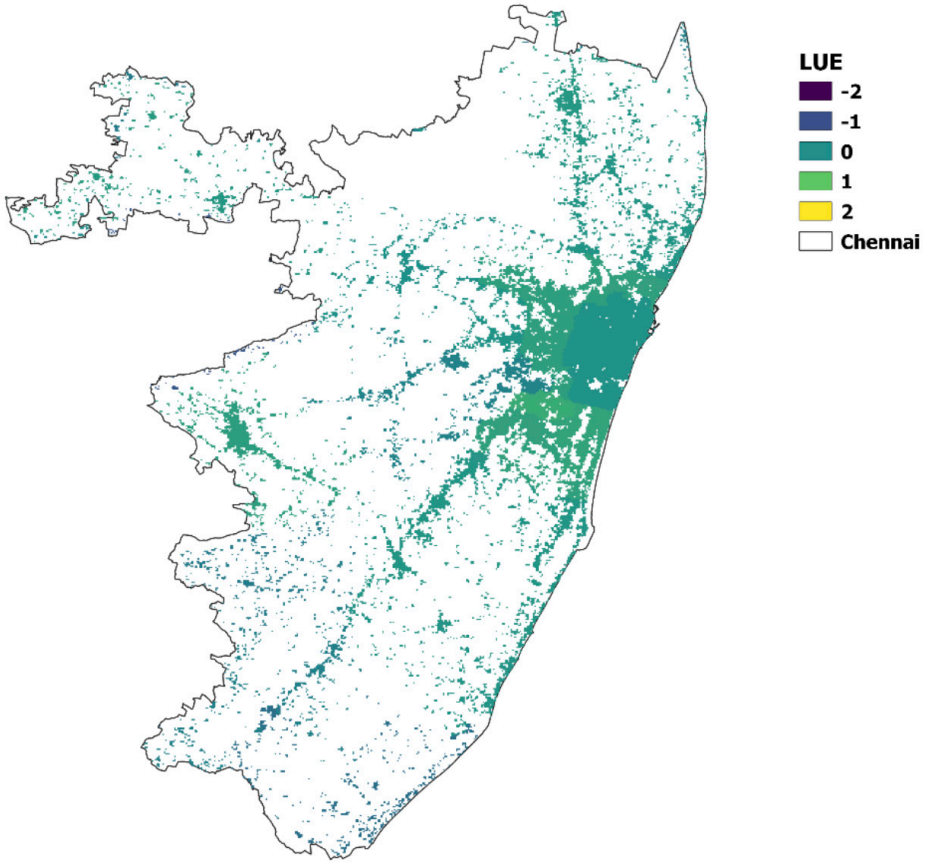


Coimbatore

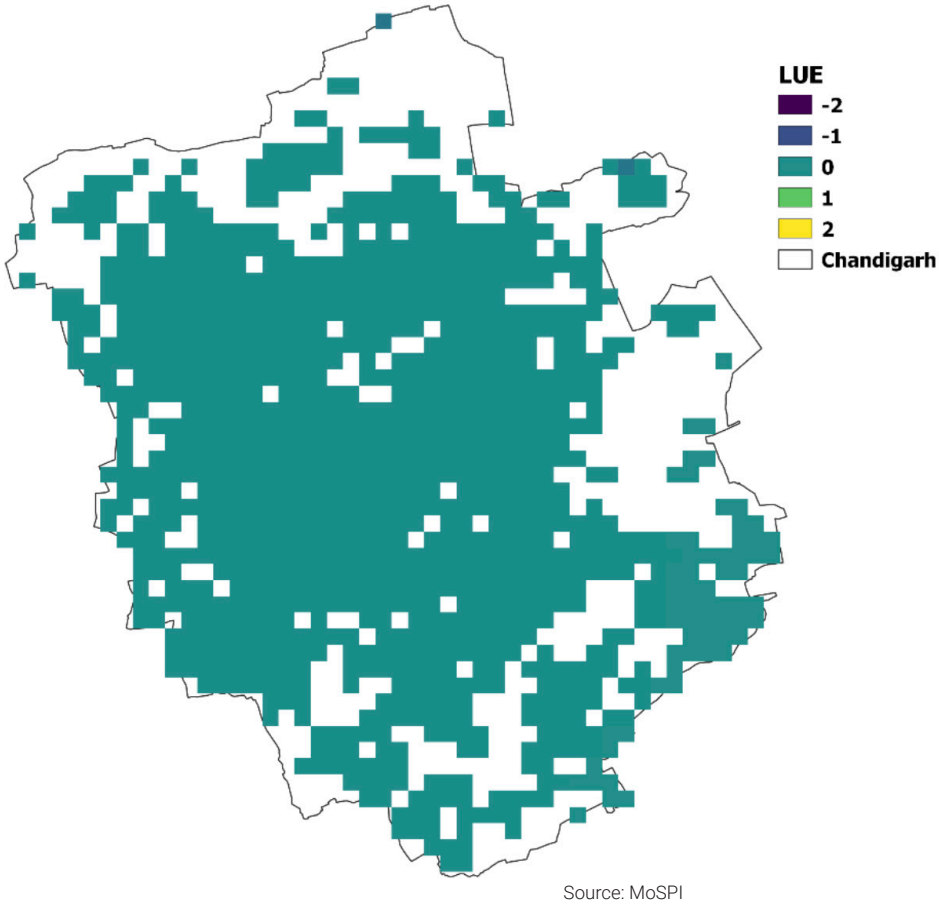


Source: MoSPI

Chennai

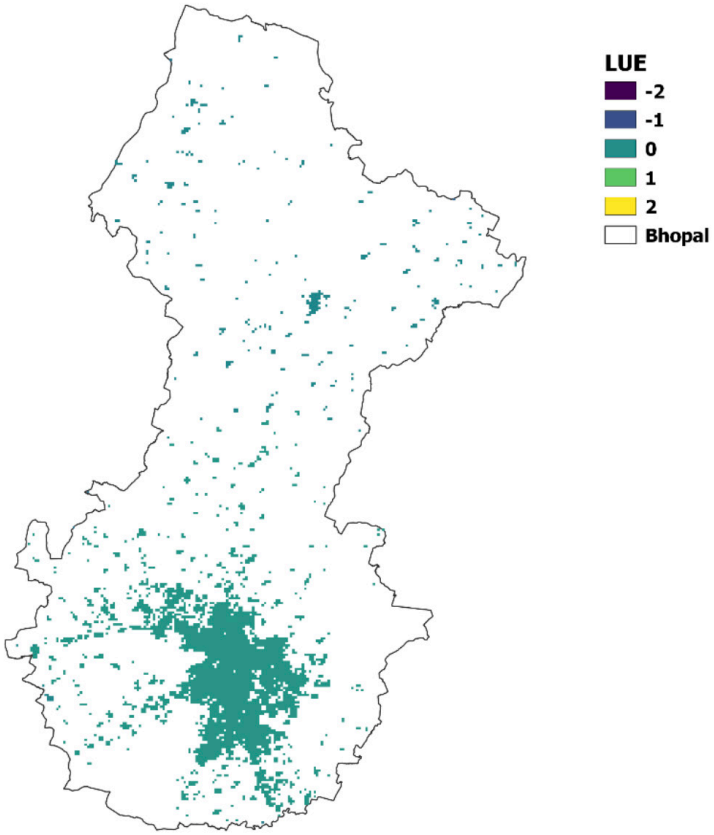


Chandigarh

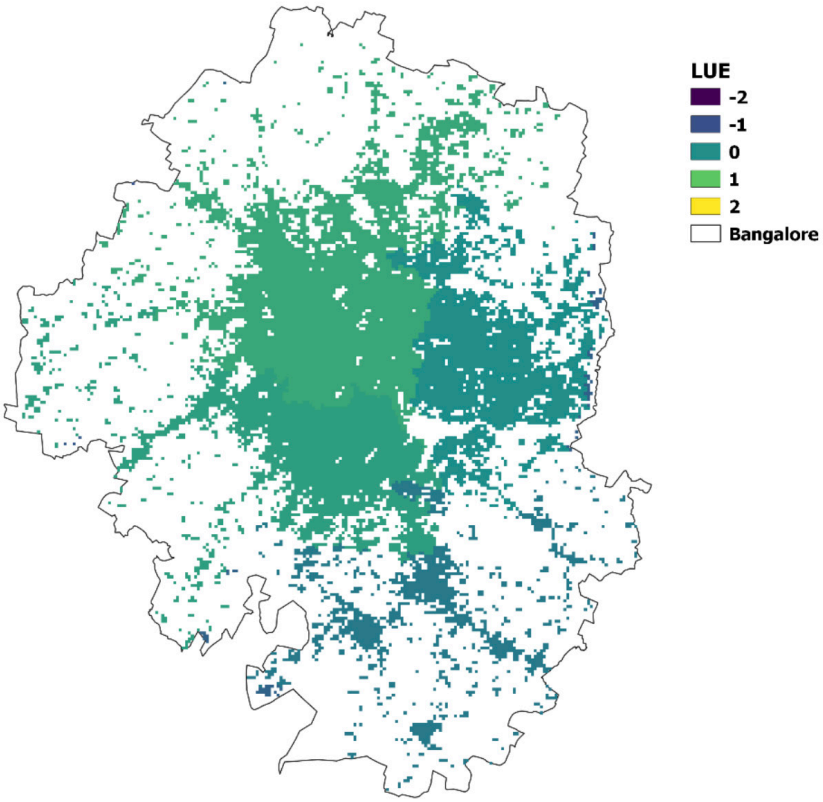


Source: MoSPI

Bhopal

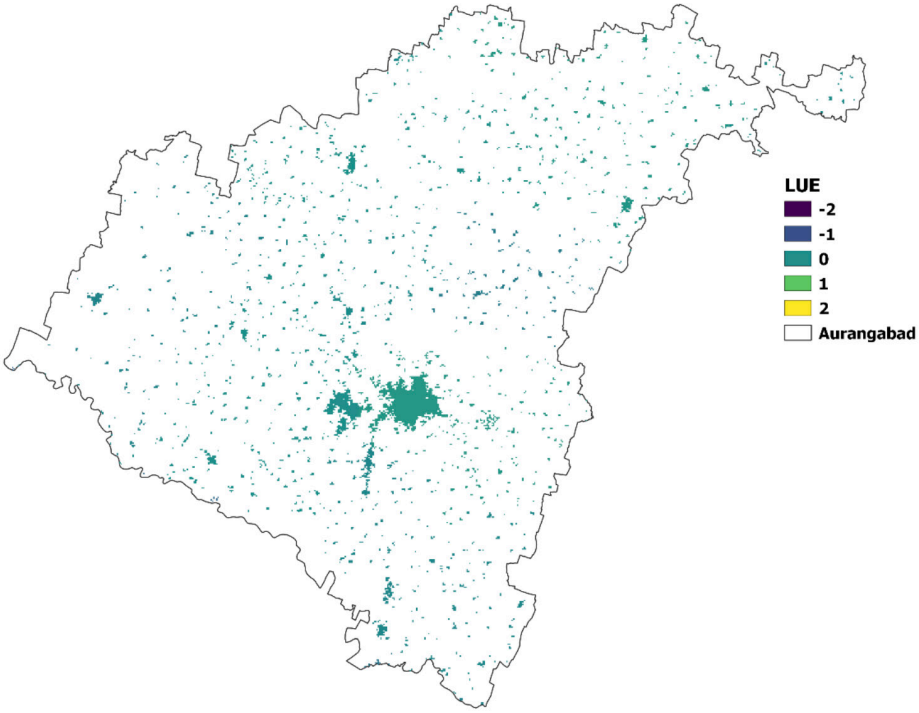


Bangalore

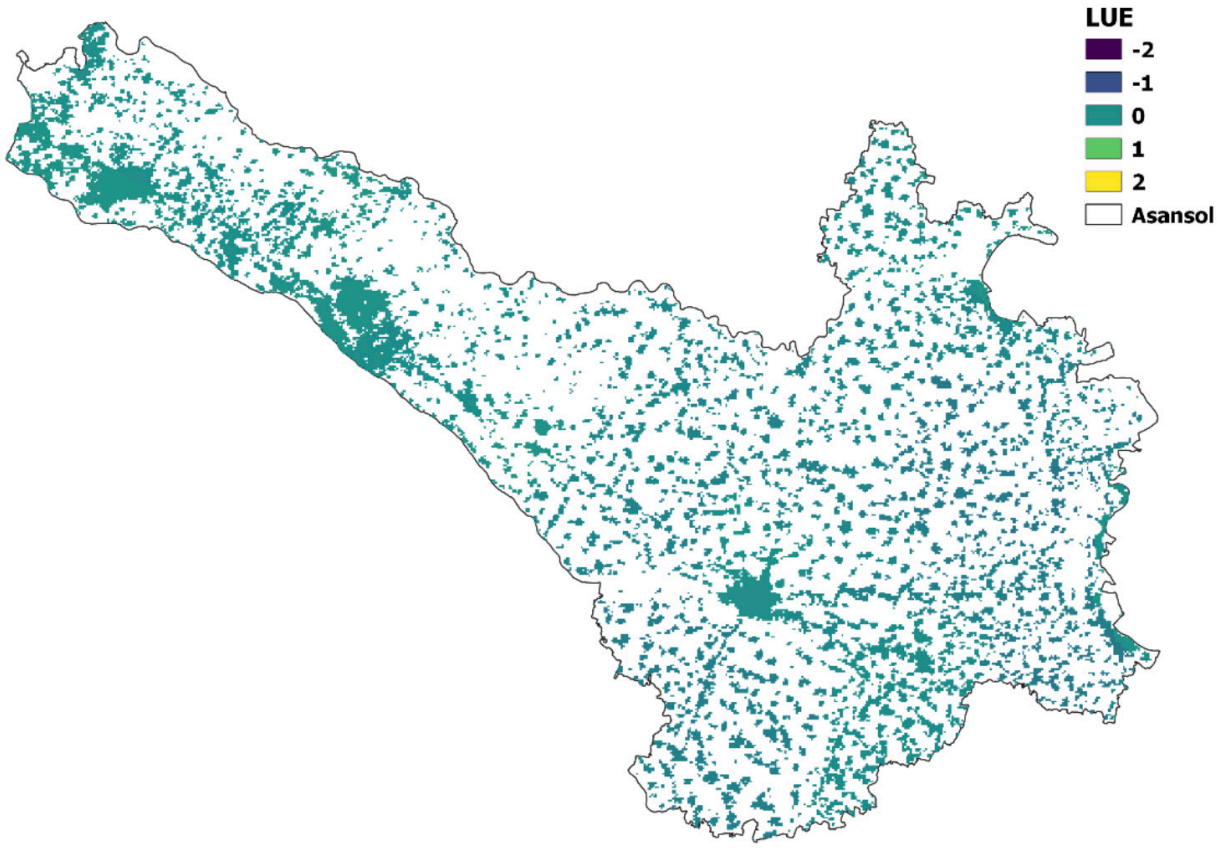


Source: MoSPI

Aurangabad

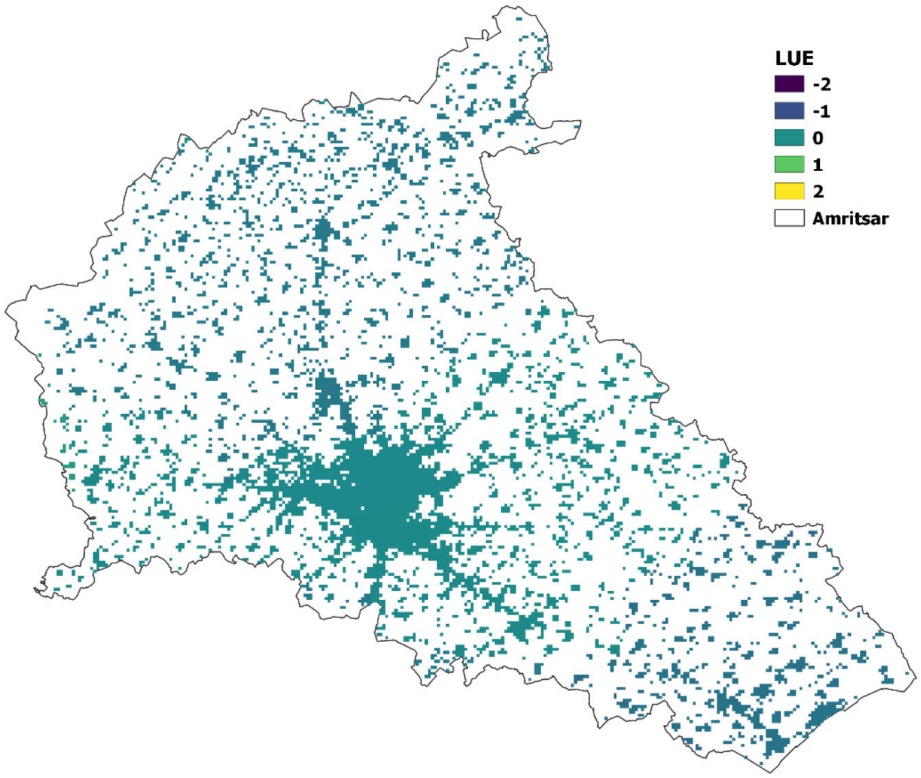


Asansol

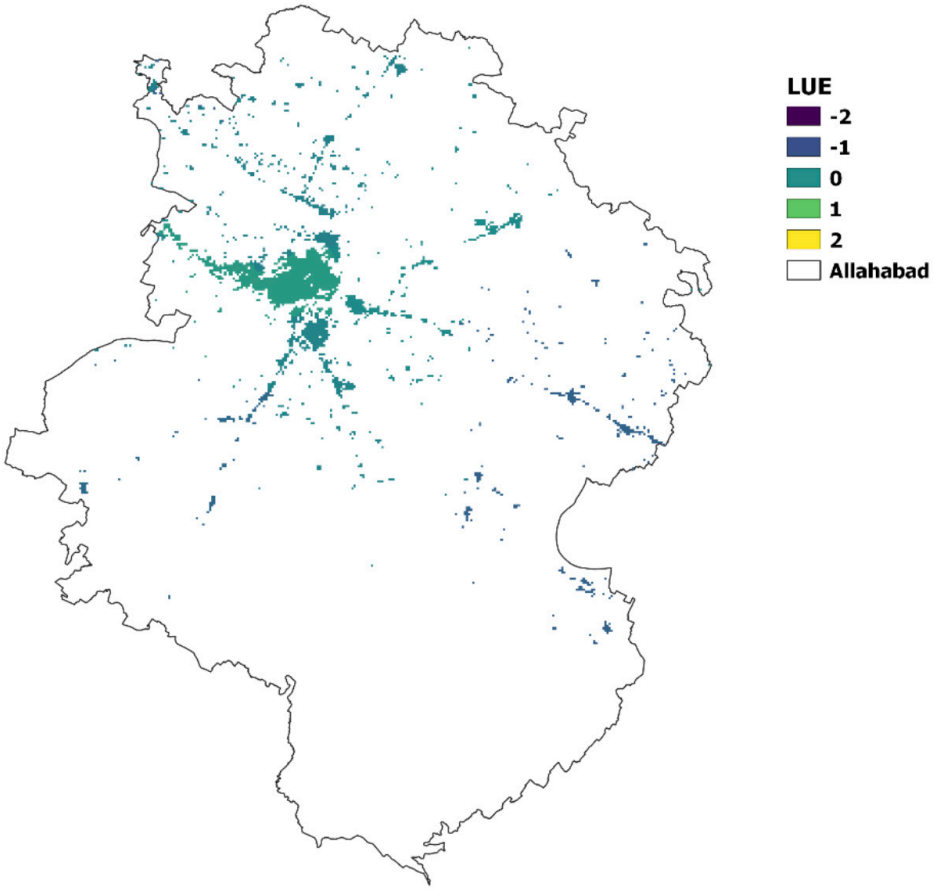


Source: MoSPI

Amritsar

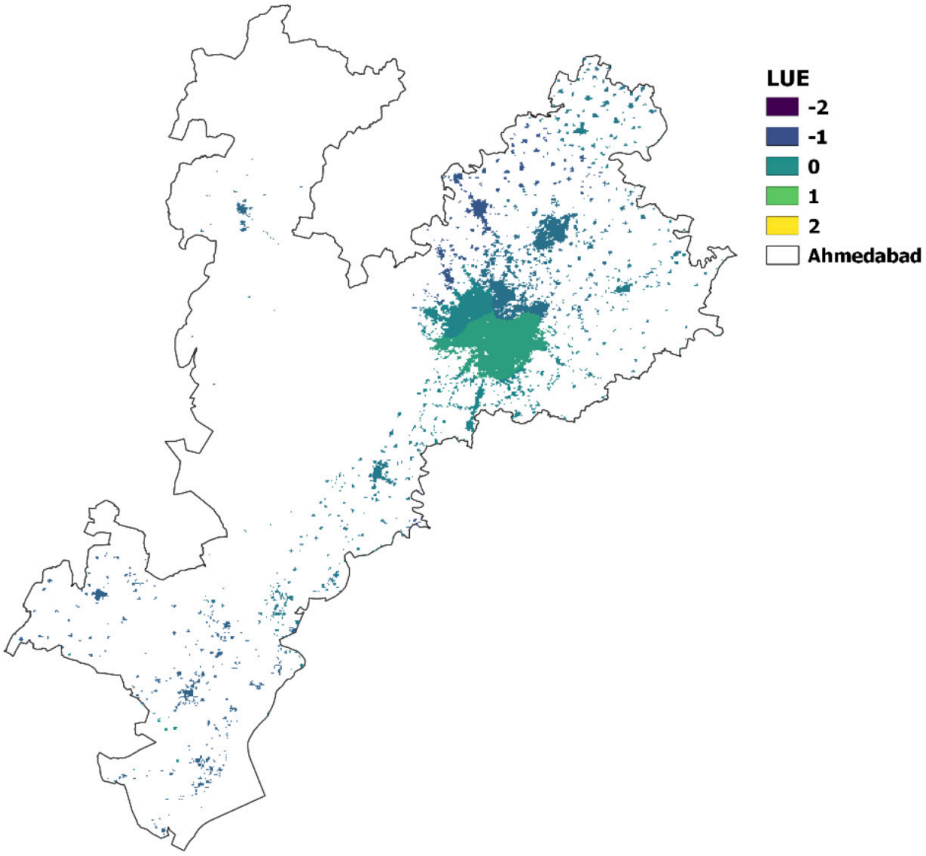


Allahabad

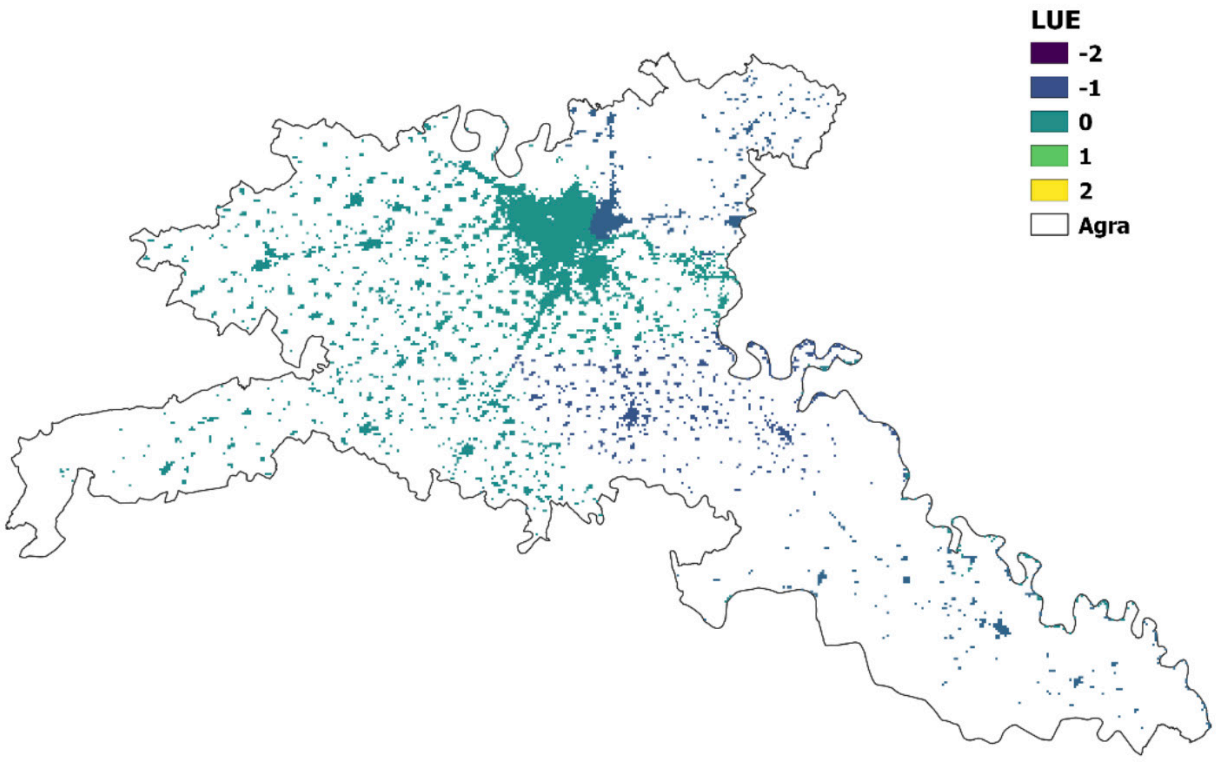


Source: MoSPI

Ahmedabad



Agra



Source: MoSPI