सत्यमेव जयते

EnviStats-India 2024
Environment Accounts

NSO INDIA
Data for Development

GOVERNMENT OF INDIA
MINISTRY OF STATISTICS & PROGRAMME IMPLEMENTATION
NATIONAL STATISTICAL OFFICE
SOCIAL STATISTICS DIVISION
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Access

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INDEX

LIST OF ANNEXURES

ACRONYMS and ABBREVIATIONS

A	ABS	Access and Benefit Sharing
B	BBL	Barrel
	BHS	Biodiversity Heritage Sites
	BMCs	Biodiversity Management Committees
	BSI	Botanical Survey of India
C	CBD	Convention on Biological Diversity
	CBG	Compressed Biogas
	CF	Central Framework
	CITES	Convention on International Trade in Endangered Species of Wild Fauna and Flora
	CNG	Compressed Natural Gas
	CO_2	Carbon Dioxide
	COP	Conference of the Parties
	CRZ	Coastal Regulation Zone
	CWQI	Coastal Water Quality Index
D	DMC	Domestic Material Consumption
	DNA	Deoxyribonucleic acid
	DOM	Deep Ocean Mission
E	EA	Ecosystem Accounting
	EC	Electrical Conductivity
	EEZ	Exclusive Economic Zone
	ESD	Economic Statistics Division
	EU	European Union
F	FAO	Food and Agriculture Organization
	FSI	Forest Survey of India
G	GBF	Global Biodiversity Framework
	GCS	Geographic Coordinate System
	GDP	Gross Domestic Product
	GIS	Geographic Information System
	GOAP	Global Ocean Accounts Partnership
	GSI	Geological Survey of India
	GSLEP	Global Snow Leopard and Ecosystem Protection Program
	GVA	Gross Value Added
	GW	Gigawatt
I	ICAR	Indian Council of Agricultural Research
	ICZMP	Integrated Coastal Zone Management Project
	IISc	Indian Institute of Science
	INM	Integrated Nutrient Management

	IRES	International Recommendation for Energy Statistics
	IUCN	International Union for Conservation of Nature
L	LNG	Liquified Natural Gas
	LOSC	Law of Sea Convention
	LPG	Liquified Petroleum Gas
	LULC	Land Use – Land Cover
M	MEAs	Multi-lateral Environmental Agreements
	MMSCM	Million Standard Cubic Metre
	MoAFW	Ministry of Agriculture and Farmers Welfare
	MoEF&CC	Ministry of Environment, Forest and Climate Change
	MoSPI	Ministry of Statistics & Programme Implementation
	MSUT	Monetary Supply and Use Tables
	MT	Metric Ton
N	NBAGR	National Bureau of Animal Genetic Resources
	NBFGR	National Bureau of Fish Genetic Resources
	NBPGR	National Bureau of Plant Genetic Resources
	NCAVES	Natural Capital Accounting and Valuation of Ecosystem services
	NCCR	National Centre for Coastal Research
	NDC	Nationally Determined Contribution
	NDZ	No Development Zones
	NEP	National Environment Policy
	NGO	Non-Governmental Organization
	NI	Nutrient Index
	NRSC	National Remote Sensing Centre
	NSO	National Statistical Office
	NTCA	National Tiger Conservation Authority
	NTFP	Non-Timber Forest Products
O	OC	Organic Carbon
	ONGC	Oil and Natural Gas Corporation Limited
	O-SMART	Ocean-Services, Modelling, Application, Resources and Technology
P	PAWS	Population Assessment of the World's Snow Leopards
	PBR	People's Biodiversity Registers
	PLI	Production Linked Incentive
	PMKUSUM	Pradhan Mantri Kisan Urja Suraksha evam Utthaan Mahabhiyan
	PNG	Piped Natural Gas
	PRMS	Petroleum Resources Management System
	PSU	Practical Salinity Unit
	PSUT	Physical Supply and Use Tables
	PV	Photovoltaic Cells
R	RE	Renewable Energy

	RKVY	Rashtriya Krishi Vikas Yojana
S	SBB	State Biodiversity Board
	SDGs	Sustainable Development Goals
	SEEA	System of Environmental Economic Accounting
	SHC	Soil Health Cards
	SHM	Soil Health Management
	SIEC	Standard International Energy Product Classification
	SLUSI	Soil and Land Use Survey of India
	SNA	System of National Accounts
	SPAI	Snow Leopard Population Assessment in India
	Sq km	Square Kilometre
U	UN	United Nations
	UNEP	United Nations Environment Programme
	UNFC	United Nations Framework Classification
	UNSC	United Nations Security Council
	UNSD	United Nations Statistics Division
	UT	Union Territory
W	WAVES	Wealth Accounting and the Valuation of Ecosystem Services
	WII	Wildlife Institute of India
Z	ZSI	Zoological Survey of India

Chapter 1

Introduction

Chapter 1

Introduction

The World is not to be put in order.
The World is in order. It is for us to put ourselves in unison with this order.
-Henry Miller

Background

1.1 Natural resources are fundamental to the economy and human welfare. They provide raw materials, energy, food, water and land as well as environmental and social services. All economic activities either affect or are affected by natural and environmental resources[1]. Activities such as extraction, processing, manufacturing, transport, consumption and disposal change the stocks of the natural resources, add stress to the environmental systems and introduce wastes to the environment. Ensuring that the natural resources are suitably managed and used effectively is the key to economic growth, environmental quality and sustainable development.

1.2 The general narrative of growth and development is usually linked with the pace of economic growth, due to which, natural resources are being used extensively thus adversely affecting the environment and biodiversity. Therefore, the way natural resources are used and managed has economic, social and environmental consequences that often extend beyond the borders of countries or regions and affect future generations. It has consequences on[2]

(i) The rate of exploitation and the productivity of natural resource stocks.
(ii) The environmental pressures associated with the extraction, processing, use and disposal of materials.
(iii) International trade and market prices of raw materials and other goods.
(iv) The productivity and the competitiveness of the economy.

1.3 Therefore, economic development without environmental considerations can cause serious environmental damage thus impairing the quality of life of present and future generations. So, managing natural resources sustainably allows to establish the foundation for long-term development and human well-being.

[1] https://www.indiabudget.gov.in/budget_archive/es98-99/chap1102.pdf
[2] https://www.oecd.org/environment/indicators-modelling-outlooks/MFA-Guide.pdf

1.4 As far as India is concerned, it exhibits immense diversity, not only in terms of its climate, physio-geography and ecological regime but also in its people and culture. The country has an abundance of natural resources and biodiversity wealth that is closely interlinked with the lives and livelihoods of the people, especially in the rural and remote areas. Since time immemorial, living in harmony with nature has been ingrained in the culture of India. The conservation, preservation and protection of the environment have indeed been prioritized by lawmakers in India and this commitment is reflected in various provisions embedded in the Constitution of India. The Article 48A under the Directive Principles of State Policy reads as "The State shall endeavour to protect and improve the environment and to safeguard the forests and wildlife of the country". Further, the Article 51A(g) under fundamental duty states that "It should be the duty of every citizen of India to protect and improve the natural environment including forests, lakes, rivers and wildlife, and to have compassion for the living creatures".

1.5 Today the cross-linkages between the resource use, climate change, land degradation and biodiversity loss have been scientifically well established. Concerns about rapidly depleting vital resources and adverse impacts on the natural environment have lately gained prominence, resulting in an increased focus on judicious use of the resources through a combination of conservation and efficiency measures and advocating transition towards a circular economy.

1.6 India has set a target of achieving net zero carbon emission by 2070. Further, the Interim Budget 2024-25 reiterated the commitment to meet 'Net Zero' by 2070. In order to meet the commitments, the following measures will be taken:

i. Viability gap funding will be provided for harnessing offshore wind energy potential for initial capacity of 1 giga-watt.
ii. Coal gasification and liquefaction capacity of 100 MT will be set up by 2030. This will help in reducing imports of natural gas, methanol and ammonia.
iii. Phased mandatory blending of compressed biogas (CBG) in compressed natural gas (CNG) for transport and piped natural gas (PNG) for domestic purposes will be mandated.
iv. Financial assistance will be provided for procurement of biomass aggregation machinery to support collection

The Interim Budget also emphasises rooftop solarization, adoption of e-buses for public transport network, and strengthening of the e-vehicle ecosystem by supporting

manufacturing and charging. In order to promote green growth, a new scheme of bio-manufacturing and bio-foundry will be launched, which will provide environment-friendly alternatives such as biodegradable polymers, bio-plastics, bio-pharmaceuticals and bio-agri inputs. The Union Budget 2024-25 also provisioned for developing a taxonomy for climate finance for enhancing the availability of capital for climate adaptation and mitigation. This will support achievement of the country's climate commitments and green transition.

1.7 India is highly committed towards environment protection and climate change action. India updates its Nationally Determined Contribution (NDC)[3] according to which the target to reduce emission intensity of its GDP has been enhanced to 45% by 2023 from 2005 level and the target on cumulative electric power installed capacity from non-fossil fuel-based energy resources has been enhanced to 50% by 2030.

1.8 For a developing country like India with GDP of ₹269 lakh crore approximately for the year 2022-23 at current prices, it is important to balance economic growth with environmental sustainability. It has become crucial to understand that when economic profits come at the expense of the people and the available natural resources in the country, we are left with an incomplete picture of the true cost of economic growth. It is therefore the need of the hour to think of alternative means of measuring prosperity and progress and go 'Beyond GDP'.

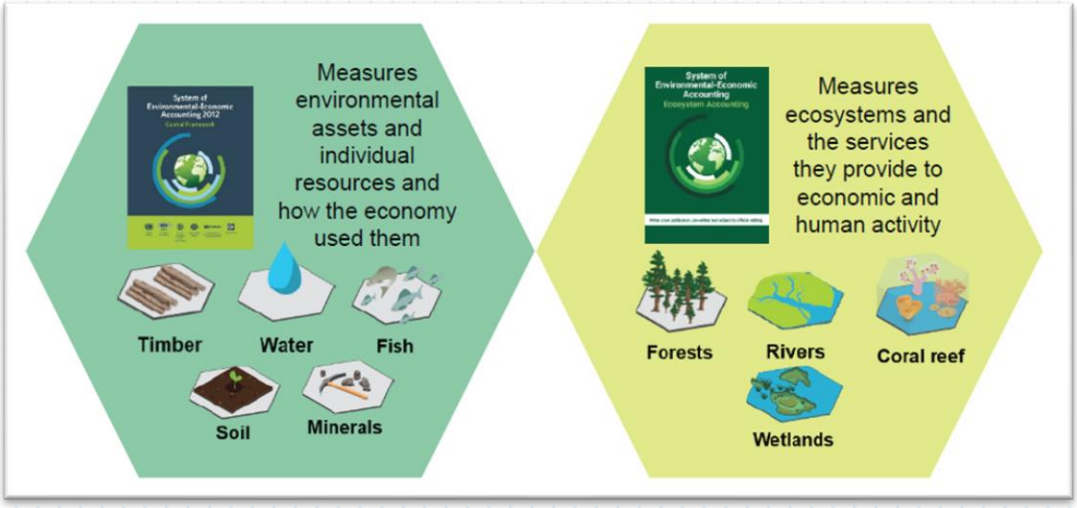
The System of Environmental Economic Accounting (SEEA)

1.9 The System of Environmental-Economic Accounting (SEEA)[4] is an agreed international statistical standard for describing the interaction between the economy and the environment, as well as the stocks and changes in stocks of environmental assets. The SEEA uses a structure and classifications consistent with the System of National Accounts (SNA) to facilitate the development of indicators and analysis of the economy-environment nexus. The SEEA also represents melding of many disciplines (e.g., economics, statistics, energy, hydrology, forestry, fisheries and environmental science etc.), each with its own concepts and structures. Thus, while the underlying structure is the same as that used in the national accounts, the SEEA aims to integrate perspectives from other disciplines and, where relevant, provide an improved body of information for environmental economic accounts. There are two

[3] https://pib.gov.in/PressReleaseIframePage.aspx?PRID=1989495#:~:text=In%20August%202022%2C%20India%20updated,enhanced%20to%2050%25%20by%202030.
[4] https://seea.un.org/

sides of SEEA–the SEEA-Central Framework (SEEA-CF) and the SEEA-Ecosystem Accounting (SEEA-EA) as illustrated in the **Figure-1.1** below.

Figure-1.1: SEEA-CF and SEEA-EA



Source: UN-SIAP

1.10 The SEEA-Central Framework (SEEA-CF), adopted as the International standard in 2012, organizes and integrates the information on the various stocks and flows of the economy and the environment in a series of tables and accounts. The Central Framework covers measurements in three main areas:

(i) **Environment Flows**: The flows of natural inputs, products and residuals between the environment and the economy, and within the economy, both in physical and monetary terms;

(ii) **Stocks of Environmental Assets**: The stocks of individual assets, such as water or energy assets, and how they change over an accounting period due to economic activity and natural processes, both in physical and monetary terms;

(iii) **Economic Activity related to the Environment**: Monetary flows associated with economic activities related to the environment, including spending on environmental protection and resource management, and the production of 'environmental goods and services'.

1.11 In the SEEA-CF, the focus is on the individual components of the environment that provide material and space for all economic activities. However, it does not consider the non-material benefits from the indirect use of environmental assets (e.g., benefits from ecosystem services such as water purification, carbon storage and flood mitigation).

1.12 SEEA-Ecosystem Accounting, a complementary framework of SEEA-CF constitutes an integrated and comprehensive statistical framework for organising data about habitats and landscapes, measuring the ecosystem services, tracking changes in the ecosystem assets, and linking this information to economic and other human activity. SEEA-EA describes the measurement of ecosystems in physical terms and the valuation of ecosystems in so far as it is consistent with the market valuation principles. Adopted by the UNSC in its 54th Session in 2021, SEEA-EA also encompasses the environmental assets but focuses on the interactions between individual environmental assets within ecosystems and on the broad set of material and non-material benefits that accrue to the economy and other human activity from flows of ecosystem services. The SEEA-EA is built on five core accounts:

(i) **Extent Accounts**: Record the total area of each ecosystem, classified by type within a specified area (Ecosystem Accounting Area). Ecosystem Extent Accounts are measured over time in the Ecosystem Accounting Area (e.g., nations, provinces, river basins, protected areas, etc.) by ecosystem type, thus illustrating the changes in extent from one ecosystem type to another over the accounting period;

(ii) **Condition Accounts**: Record the condition of the ecosystem assets in terms of selected characteristics at specific points in time. Over time, they record

the changes to the ecosystems' condition and provide valuable information on the health of the ecosystem;

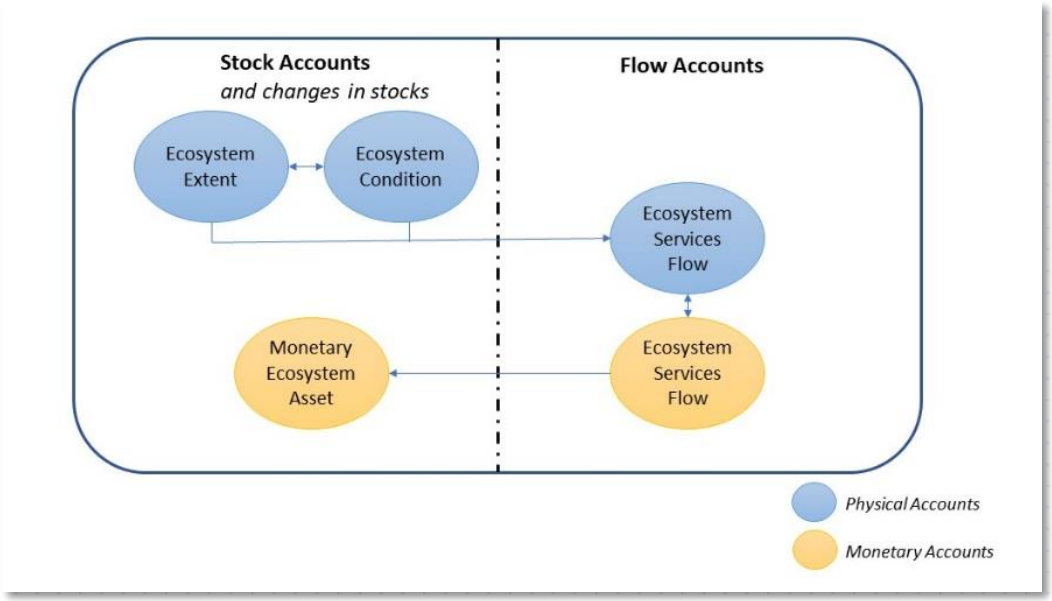
(iii) **Flows of Ecosystem Service (Physical and Monetary)**: Record the supply of ecosystem services by ecosystem assets and the use of those services by economic units, including households;

(iv) **Monetary Ecosystem Asset Accounts**: Record information on stocks and changes in stocks (additions and reductions) of ecosystem assets. This includes accounting for ecosystem degradation and enhancement;

(v) **Thematic accounts**: Organize the data on themes of specific policy relevance. For example, biodiversity, climate change, oceans and urban areas. Other important thematic accounts would include accounting for protected areas, wetlands and forests, etc.

1.13 While the Extent and the Condition Accounts, which describe the spread and health of the ecosystems, are stock variables, the ecosystem service flows that help to understand the benefits derived from the ecosystems in the economy are flow variables. A diagrammatic representation **(Figure 1.2)** of this is presented below for better understanding.

Figure-1.2: Set of Ecosystem Accounts



Source: UN-SIAP

1.14 The supply of ecosystem services and the use of these services by economic units, including households, is one of the central features of ecosystem accounting. Ecosystem services are only recorded in case there are actual beneficiaries for the

services, i.e. when there is a demand. This is similar to the system of national accounts, which is based on transactions or actual exchanges in the economy.

1.15 It is a well-conceived fact that the Nature provides several valuable services to humankind, but despite having immense value in the lives of human beings they are often beyond the scope of valuation. The prime motivation for ecosystem accounting is that the analysis of 'ecosystems' and the 'economy' separately does not reinforce the vital nature of the relationship between mankind and the environment. The standard approaches to the measurement of the economy focus largely on economic and other human activities that are reflected in the transactions of the markets. Ecosystem accounting aims to shed light on the non-market activities that relate to ecosystems and integrate this information with relevant market related data. It is understood that individual and social decisions concerning the use of the environment may be better informed by developing information sets based on recognition of the relationship between ecosystems and economic and other human activities. The contribution of the environmental goods and services duly measured enables robust and sustainable decisions and policies.

1.16 The valuation of ecosystem services and ecosystem assets is a complex process, but it is essential to frame, prioritise, and justify sustainable development policies oriented towards the protection or restoration of the ecosystem. Ecosystem services accounts are a very useful tool that provide pertinent information on the role of ecosystems in delivering services, which in turn benefits society. Ecosystem services contribute to two types of benefits: System of National Accounts (SNA) benefit, or non-SNA benefits.

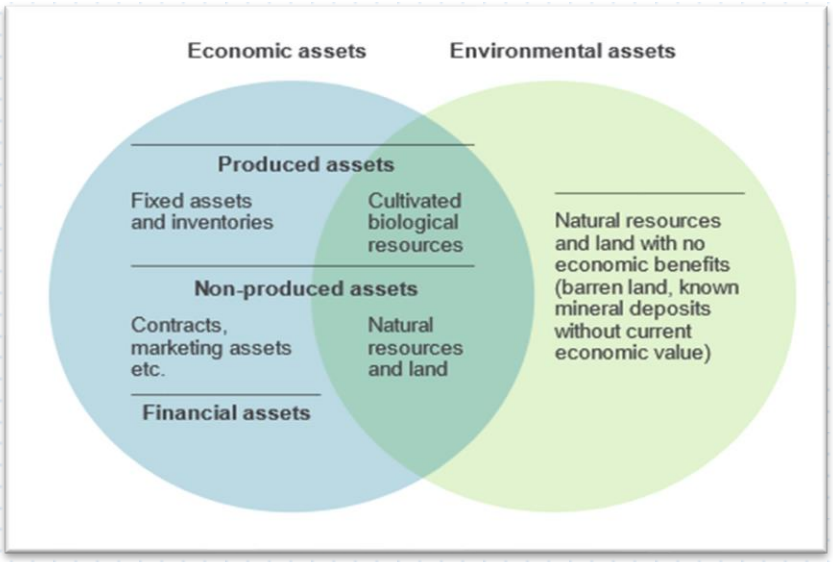
i. The products produced by economic units (e.g., food, water, clothing, shelter, recreation) are referred to as SNA benefits, since the measurement boundary is within the production boundary used to measure Gross Domestic Product (GDP) in the SNA.
ii. The benefits that accrue to individuals that are not produced by economic units (e.g., clean air) are referred to as non-SNA benefits, reflecting the fact that the receipt of these benefits by individuals is not the result of an economic production process defined within the SNA.

1.17 Some ecosystem services are already included in GDP (as they contribute to products, for example timber which fall in the production boundary), but others (e.g., carbon retention) fall outside the SNA production boundary.

Linkages between SEEA and SNA

1.18 The System of National Accounts is an internationally agreed standard set of recommendations on the compilation methodology of the measures of various economic activities. SEEA was initially developed as a satellite account of SNA and therefore the underlying concepts, definitions are the same for both SEEA and SNA. SEEA is similar to SNA in the sense that SEEA organises and integrates the information on various stocks and flows of the economy and the environment in a series of tables and accounts. SEEA has the capacity to coherently present information in both physical and monetary terms. SEEA enables to include all the goods and services which may or may not have a market value and this makes SEEA have a broader scope of coverage as compared to the SNA which is restricted to the SNA production boundary. The following **Figure 1.3** shows the distinction between the economic and the environmental assets:

Figure 1.3: Economic and Environmental Assets



Source: UN-SIAP

Environment Accounts in India

1.19 The National Statistical Office (NSO) under the Ministry of Statistics and Programme Implementation (MoSPI) is mandated with the "Development of Environment Statistics and Development of methodology, concepts and preparation of National Resource Accounts for India". In accordance with this mandate, the Ministry constituted an Expert Group in 2011 under the chairmanship of Prof. Sir

Partha Dasgupta, Frank Ramsey Professor Emeritus of Economics, University of Cambridge, U.K for advising on an implementation plan for compiling "Green National Accounts in India". The Expert Group submitted its report in 2013 and recommended compilation of the accounts following the SEEA Framework in a phased manner, i.e. starting with the asset accounts followed by the physical and the monetary flows.

1.20 India also participated in the 'Natural Capital Accounting and Valuation of Ecosystem services (NCAVES)' launched by the United Nations Statistics Division (UNSD), the United Nations Environment Programme (UNEP) and the Secretariat of the Convention of Biological Diversity (CBD) in 2017. This European Union (EU)-funded project, through its partnership instrument, aimed to assist the five participating countries namely Brazil, China, India, Mexico and South Africa, in advancing the knowledge agenda on environmental-economic accounting in particular ecosystem accounting. NSO, MoSPI implemented the NCAVES project 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. Under the NCAVES Project, the NSO, India undertook several activities towards compilation of the Environment Accounts.

1.21 In adherence to the recommendations of the Sir Partha Dasgupta Committee Report, the first layers of the Environment Accounts (i.e., asset accounts) were released in the year 2018, in the publication *EnviStats India 2018 – Supplement on Environment Accounts*[5], detailing the physical asset accounts of land cover, minerals, water and forests, at the state and national levels.

1.22 Since then, the Ministry has continuously strived to enhance the scope and coverage of environmental accounts, including those of extent and condition accounts. Further, in order to translate the physical values using an economic yardstick, the Ministry evaluated some ecosystem services, such as Crop Provisioning Services, Timber and Non-timber Forest Products Provisioning Services, Fish Provisioning Services, Carbon Retention Services provided by Forests and Nature-based Tourism services in monetary terms. These accounts, along with the extent and the condition accounts, present a systematic glimpse of the State of Environment in India in respect of various environmental assets and ecosystems. Several accounts that have been

[5] https://mospi.gov.in/download-reports

released in the form of the annual publication "EnviStats India: Environment Accounts" are presented in **Table 1.1** below:

Table 1.1: List of Accounts Published

Type of account	Topics covered (Year of publication given in parentheses)
Ecosystem extent	• Change matrix of Land Use – Land Cover (LULC) from 2005-06 to 2011-12 and from 2011-12 to 2015-16 (2018, 2020) • Asset Account for Land Use-Land Cover (LULC), 2005-06, 2011-12 and 2015-16 (2018, 2020) • Accounts related to the Land Degradation, 2005-06 and 2015-16 (2020) • Wetland Extent Account: 2006-07, 2016-17 (2020, 2022)
Ecosystem condition	• Soil nutrient indices: 2015-17, 2017- 19 and 2019-20 (2019, 2021) • Water quality accounts: 2015-16 to 2018-19 (2019, 2021) • Forest condition account: 2015-16 and 2017-18 (2020) • Cropland condition account: 2005-06, 2010-11 and 2015-16 (2020) • Wetland condition account: 2019-20 (2020)
Ecosystem services	• Crop provisioning services (monetary) from 2005-06 to 2017-18 (2019, 2021) • Timber provisioning services (monetary): 2011-12 to 2019-20 (2020, 2022) • Non-Timber Forest Products (NTFP) provisioning services (monetary): 2011-12 to 2019-20 (2020, 2022) • Fish Provisioning Services (monetary): 2015-16 to 2021-22 (2022) • Carbon retention services provided by forests (physical and monetary): 2015-16, 2017-18 and 2019-20 (2020, 2022) • Nature-based tourism (monetary): 2008-09 and 2014-15 (2019) • Soil erosion prevention services provided by croplands (physical) for 2005-06, 2011-12 and 2015-16 (2020)
Thematic Accounts	• Biodiversity - The extent of protected areas: 2020 (2020) • State-wise floral and faunal species accounts: 2020 (2020) • Species Richness of IUCN Red List species - versions 2020-2, 2020-3, 2021-1, 2021-2, 2021-3 and 2022-1 (2020, 2021, 2022)

Type of account	Topics covered (Year of publication given in parentheses)
Individual environmental asset accounts (SEEA CF)	• Forests – Growing Stocks of Timber and Carbon: 2006-07, 2010-11, 2015-16 and 2017-18 (2018, 2020) • Water (2018) • Minerals: 2005, 2010 and 2015 (2018) • Energy: 2015-16 to 2020-21(2022) • Solid Waste Accounts: 2020-21 (2022)

1.23 In order to conclude the project activities in India and to highlight the uses to which the natural capital accounts can be put, especially in the areas of decision making and policy analysis, the NSO, India conducted the NCAVES India Forum in January, 2021, where line Ministries, State Governments, Multilateral Organizations and Research Institutions had participated. During the Forum, MoSPI announced to release the 'Strategy for Environmental Economic Accounting in India' in order to provide a road-map for development for Environmental Accounting in India. In line with this, and to further expand the coverage of the Environmental Accounts in India, NSO, MoSPI released the 'Strategy for Environmental Economic Accounts in India: 2022-2026'[6] where some of the potential areas for work are identified, as given below has been identified:

(a) Energy Accounts
(b) Material Flow Accounts
(c) Ocean Accounts
(d) Thematic accounts for Biodiversity and Urban Area Accounts

1.24 The current publication which is seventh in series covers Energy Accounts, Ocean Accounts, Soil Nutrient Index and Biodiversity. A brief description about the chapters are provided in the subsequent paragraphs.

Chapter 2: Energy Accounts

1.25 Energy is an important input in the production of goods, including food, and is used by households for transportation, cooking, lighting, heating, cooling, etc. Given its importance to wellbeing, managing energy resources and energy supply and

[6] https://mospi.gov.in/sites/default/files/publication_reports/Environment%20Accounting%20Strategy%202022-261638528460762_0.pdf

use are areas of priority. In order to support the development and implementation of energy-related policies for improved wellbeing, it is helpful to have integrated information and data on energy.

1.26 The Energy Accounts are based on the System for Environmental Economic Accounting–Energy (SEEA-Energy) which is a multi-purpose conceptual framework for organising energy-related statistics. It supports analysis of the role of energy within the economy, the state of energy inputs and various energy-related transactions of environmental interest. NSO, India has been regularly compiling Energy Statistics following the International Recommendation for Energy Statistics (IRES) Framework. In 2022 publication the Energy Accounts were developed for the year 2015-16 onwards, following the SEEA-Energy Framework and utilizing latest Energy Statistics data as the base. This year the accounts have been updated in lines with the recent data releases. Chapter 2 of the current publication provides the Physical Asset Accounts for Energy and the Physical Supply and Use Tables utilizing the data provided by M/o Coal, M/o Petroleum & Natural Gas, Geological Survey of India and the Central Electricity Authority of M/o Power.

Chapter 3: Ocean Accounts

1.27 Oceans or the Blue ecosystems[7] spanning the water continuum are vital for communities, jobs, the global economy, food security and climate resilience. The oceans are a major carbon and heat sink and also contribute to the economy. Healthy blue ecosystems safeguard economic assets, enrich biodiversity and enhance planet and societal resilience. In order to ensure that the benefits from the oceans are sustainably harnessed, it is important that checks and balances are in place, for which ocean accounts are required. Ocean Accounts[8] organise social, economic and environmental information to enable coherent measurement of progress towards the sustainable development of the ocean, in line with the Sustainable Development Goals and other relevant national, regional and global commitments.

1.28 Chapter 3 of the publication provides the accounts for the ocean. The extent and the condition parameters of some of the ocean-related ecosystems have been covered in the chapter. The data have been largely sourced from National Centre for Coastal Research (NCCR), M/o Earth Sciences, the Ministry of Environment Forest, and Climate Change, etc.

[7] https://www.unep.org/topics/ocean-seas-and-coasts
[8] https://www.oceanaccounts.org/what-are-ocean-accounts/

Chapter 4: Soil Nutrient Index

1.29 Soil is the foundation of all terrestrial ecosystems and the agricultural and forestry provisioning services as well as being the structural medium for supporting the terrestrial biosphere and human infrastructure. Healthy soil increases the capacity of the crops to withstand weather variability, including short-term extreme precipitation events and intra-seasonal drought. Soil fertility, or the soil's reserve of crop nutrients, is broadly equated with soil quality and soil health.

1.30 Chapter 4 of the current publication provides the soil nutrient index for the period using the information collected for preparing Soil Health Card for the year 2023-24. Similar estimates were compiled in the year 2019 and 2021 issues of the publication.

Chapter 5: Biodiversity

1.31 Biodiversity[9] represents a key element of any country's natural capital stock. It underpins the provision of ecosystem services such as clean water, fertile soils and flood protection. It is the engine that drives the flow of benefits from natural capital to humanity. Therefore, it is important to keep a tap on the biodiversity of the area.

1.32 Chapter 5 of the publication presents the taxonomic faunal and floral diversity of India, the status of Leopard and Snow Leopard, and the Species Richness of Red List species by taxonomic groups as compiled using Spatial Datasets sourced from the International Union for Conservation of Nature (IUCN). This chapter also includes information on the conservation of animal, plant and fish genetic resources.

Conclusion

1.33 The subject matter of 'Environment' is not only vast and diverse, but is intermingled with multiple other disciplines. It is a significant challenge to understand the inter-relationships and also to assign 'numeric values' to its services. Nevertheless, NSO, India has been gradually expanding the scope and coverage of environmental accounts in terms of time, domains and geographic coverage since its inception. However, it is pertinent to note that understanding the intricacies of the data sources and methods used to compile accounts, will evolve over time as a result of engagement with the data sources agencies and the users, especially the policy makers. Lastly, as with all statistical products, with the availability of updated data,

[9] https://seea.un.org/sites/seea.un.org/files/enhanca_factsheet_biodiversity.pdf

the accounts presented so far do have a scope of further revision and refinement to better depict the connection between environment and economic & human activities.

1.34 EnviStats India: Environment Accounts is an attempt to acknowledge the value of 'nature' in the lives of humankind both in physical and monetary terms. This will help to provide the right push towards having a sustainable future emanating from a healthier environment in sync with "Better Environment, Better Tomorrow".

*****

Chapter 2

Energy Accounts

Chapter 2

Energy Accounts

Saving Energy today will make tomorrow bright.

-Anonymous

Introduction

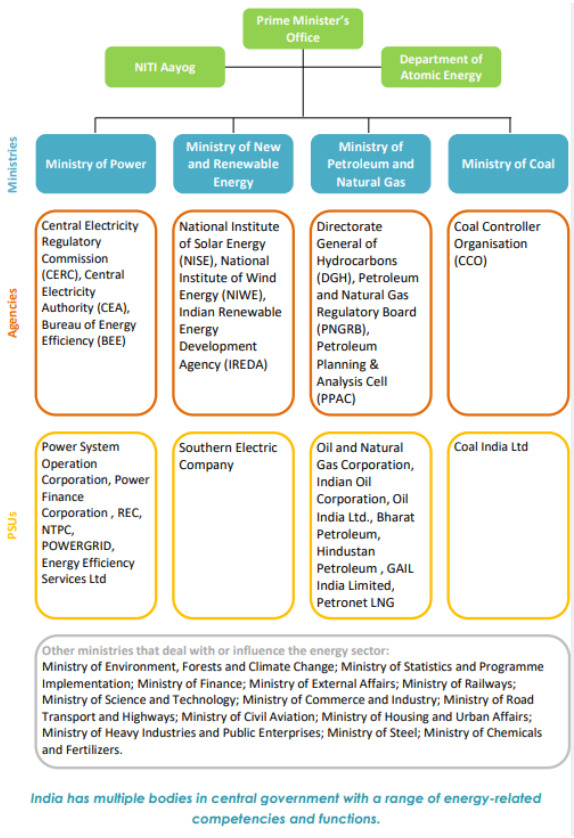
2.1 Energy plays a significant role in human life and is also one of the major inputs for the economic development of any country. In the case of developing countries, the energy sector assumes critical importance in view of ever-increasing energy needs, which require huge investments to meet them. Energy drives economies and enables development of the nation while addressing several societal issues related to well-being. However, there is also a need to understand the supply and demand of energy.

2.2 Various factors can be responsible for causing differences between primary energy supply and demand, including technological changes, economic growth and demographic changes. With the rise of low-cost automobiles and the spread of electricity, there has been a radical change in the energy requirement patterns of society. Energy has penetrated deep into the economies, facilitating services such as cooking, heating, cooling, lighting, operation of appliances, information and communication technology, and the functioning of machines. Thus, energy and power resources are considered as important national assets and organizations are set up for the conservation, development and proper working of these resources. It is, therefore, important to follow the path of sustainable energy which will open avenues for transforming lives and economies while safeguarding the planet.

2.3 There is a growing awareness about the need to switch to clean and green energy. The transition from fossil fuels to clean energy sources will depend on critical minerals such as copper, lithium, nickel and cobalt, the supply chain for which needs to be sustainably maintained.

India's Energy Scenario

2.4 India is a major force in the global energy economy. There has been a rapid increase in energy consumption due to a growing population and rapid economic growth. The growing demand is met through various energy sources, such as coal, oil and solid biomass. Coal[10] has underpinned the expansion of electricity generation and industry, and remains the largest single fuel in the energy mix. Oil consumption[11] and imports have grown rapidly on account of rising vehicle ownership and road transport use. Natural gas and modern renewable sources of energy have started to gain ground, and the rise of solar photovoltaic (PV), in particular, has been spectacular. India is currently the world's 3rd largest consumer of oil, 3rd largest LPG consumer, 4th largest LNG importer, 4th largest refiner and 4th largest automobile market[12]. As far as the governance of the energy sector by the central government is concerned, the following figure provides a snapshot.



India has multiple bodies in central government with a range of energy-related competencies and functions.

2.5 India's announcement[13] that it aims to reach net-zero emissions by 2070 and to meet fifty percent of its electricity requirements from renewable energy sources by 2030 is a significant moment for the global fight against climate change. India is pioneering a new model of economic development that could avoid the carbon-intensive approaches.

2.6 India is constantly endeavouring towards sustainable and clean energy. In line with the Prime Minister's announcement at COP-26[14], M/o New and Renewable Energy is working towards achieving 500 GW of Non-Fossil based electricity generation capacity by 2030. India stands 4th globally in Renewable Energy Installed capacity, 4th in Wind Power capacity and 5th in Solar Power capacity

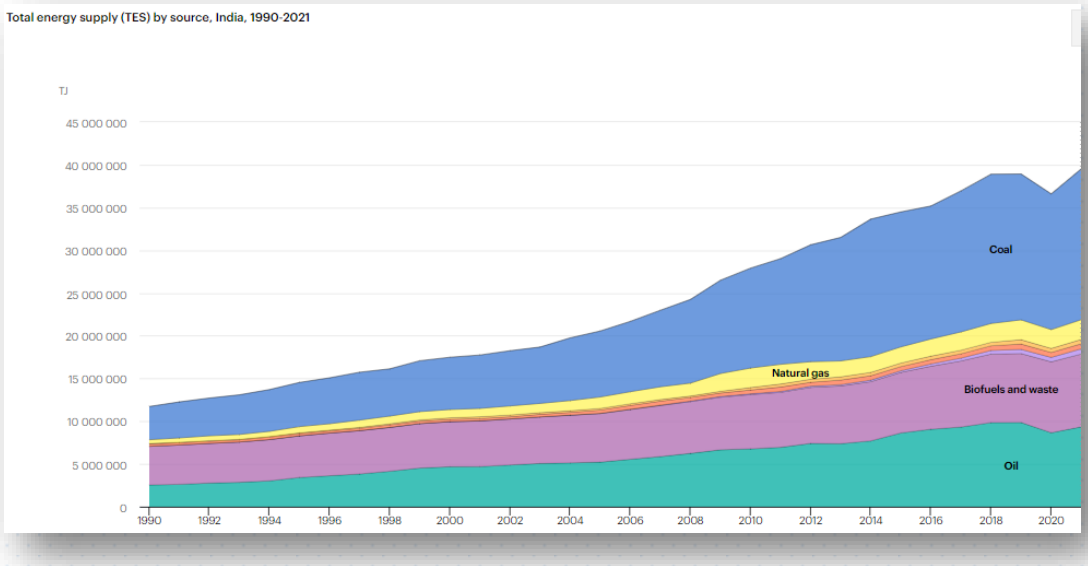
[10] https://www.iea.org/countries/india
[11] https://iea.blob.core.windows.net/assets/1de6d91e-e23f-4e02-b1fb-51fdd6283b22/India_Energy_Outlook_2021.pdf
[12] https://pib.gov.in/PressReleaseIframePage.aspx?PRID=1992767
[13] https://www.iea.org/commentaries/india-s-clean-energy-transition-is-rapidly-underway-benefiting-the-entire-world
[14] https://pib.gov.in/PressReleasePage.aspx?PRID=1992732

(as per the International Renewable Energy Agency — Renewable Capacity Statistics 2023). In addition, some of other program/schemes that are also being implemented are:

i. National Green Hydrogen Mission
ii. Green Energy Corridor-Inter State Transmission System for 13 GW RE Projects in Ladakh
iii. Production Linked Incentive (PLI) Scheme for High Efficiency Solar PV Modules
iv. Offshore Wind Energy, Bioenergy
v. Solar Parks, Pradhan Mantri Kisan Urja Suraksha evam Utthaan Mahabhiyan (PM KUSUM), Rooftop Solar etc.

2.7 Energy is the most important sector for adaptation as it is responsible for 75-80% of the emissions. India has emerged as a world leader in energy transition. Solar energy contributes to more than 50% in the total renewable energy segment, making it the largest contributor amongst all RE sources (excluding large hydro projects). Installed capacity of solar energy in India has increased by more than 25 times from 2.82 GW in March 2014 to 73.32 GW in December 2023[15].

Figure 2.1: Total Energy Supply by Source



Source: International Energy Agency

[15] https://pib.gov.in/PressReleaseIframePage.aspx?PRID=2003545

Energy and SDGs

2.8 The SDGs, unanimously adopted by the United Nations, provide an internationally recognised framework for key development objectives, including specific targets to measure progress. The scope of sustainable energy is primarily covered by SDG 7, but other SDGs, notably SDG 3 on health (including the severe impacts of air pollution), SDG 12 on sustainable consumption and production patterns as well as SDG 13 on climate, are closely linked to the Energy sector. The 3 targets that embody the SDG 7 objective to "ensure access to affordable, reliable, sustainable and modern energy for all" are central to India's current energy challenge of (i) universal access for all (ii) ambitious scale-up of renewable energy and (iii) enhanced energy efficiency.

2.9 As far as India[16] is concerned, India is making good progress in its national efforts to meet the various SDG 7 targets. These include measures to ensure universal access to modern energy, including electricity and clean cooking (SDG 7.1), to foster the deployment of renewables and to increase the share of renewable energy consumption in the global energy mix (SDG 7.2) and to double the rate of energy efficiency improvements (SDG 7.3).

SEEA-Energy

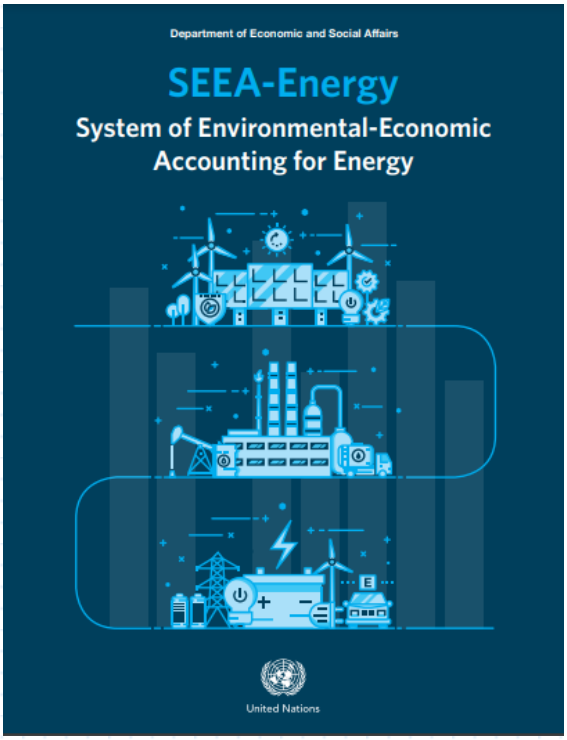
2.10 With the enormous potential of India's energy sector, comes a sense of responsibility towards the nation and the globe, at large. Tapping into energy resources while ignoring the environmental concerns will serve good to none. Therefore, the effect of energy supply and use on the environment has emerged as a critical policy issue. Hence, it becomes pertinent to know the proper supply and usage of energy especially in the context of sustainable development. The SEEA-Energy provides the framework for the compilation of the physical and monetary supply and use tables and also for having an idea about the stock of energy available in the country at a particular point of time.

2.11 For the purpose of compiling Energy Accounts for the country, the standard framework accepted internationally is the SEEA-Energy Framework. It is entirely consistent with the SEEA Central Framework and follows a similar accounting structure to the System of National Accounts (SNA). By doing so, the SEEA-Energy

[16] https://iea.blob.core.windows.net/assets/2571ae38-c895-430e-8b62-bc19019c6807/India_2020_Energy_Policy_Review.pdf

allows us to develop indicators and conduct analysis on the economy-environment nexus, with a focus on energy.

2.12 The System of Environmental Economic Accounting for Energy (SEEA-Energy[17]) is a multipurpose conceptual framework for organizing energy-related statistical information. It supports analysis of both the role of energy within the economy and the relationship between energy-related activities and the environment. At the core of SEEA-Energy is an accounting approach that records the stocks and flows of energy within the territory of reference. The value added of SEEA-Energy lies in its ability to bring a broader and more structured perspective to bear on the already available energy related information. Through their coherence with the SNA, the data in the Energy Accounts can be easily linked with other information collected for national accounts, which allows for a more detailed and policy-relevant analysis of energy information.



2.13 The capacity of SEEA-Energy to link energy accounts with economic and other environmental accounts underlines its power. Essential to the formulation of a policy response to an environmental issue such as climate change, which is affected by energy-related emissions of carbon into the air, is understanding both human impacts on the physical environment (through determining, for example, which industry is generating the carbon emissions and the energy products involved and energy needs and possible constraints and solutions (through determining, for example, ongoing energy requirements and what kind of low-carbon energy sources can be utilized). Indicators/statistics generated from SEEA-Energy Accounts can also enhance the understanding of issues related to the effects of using economic instruments (such as tradable carbon emission permits) on both the economy and the environment. Those effects may include impacts on energy prices, household spending and business profitability and, crucially, on emissions of carbon generated by domestic producers and as embodied in imports.

[17] https://seea.un.org/sites/seea.un.org/files/documents/seea-energy_final_web.pdf

2.14 SEEA-Energy has a close relationship with IRES (International Recommendation on Energy Statistics)[18], which contributes valuable inputs into the production of the tables and accounts of SEEA-Energy. In particular, IRES supports the use of the harmonized definitions of energy products in accordance with the Standard International Energy Product Classification (SIEC)[19] and offer guidance regarding data sources and data compilation.

2.15 The Energy Accounts, as described in SEEA, comprise three types of accounts, namely: Asset Accounts, Physical Supply and Use Tables (PSUT) and Monetary Supply and Use Tables (MSUT).

Asset Accounts for Energy

2.16 The purpose of an asset account is to record the opening and closing stock of the assets and the various types of changes in stock over an accounting period. The asset accounts in SEEA-Energy are compiled only for minerals and energy resources. These accounts provide valuable information to assess the fact whether the current patterns of economic activity are depleting and/or degrading the available mineral and energy resources. In addition, the information on the asset accounts can help in the management of mineral and energy resources.

2.17 Mineral and energy resources within SEEA-Energy include known deposits of oil resources, natural gas resources, coal and peat resources, and uranium and thorium resources, including those with no current economic value. These resources are defined more broadly than in the SNA 2008, which includes only those inputs that meet the definition of an economic asset. In the SEEA Central Framework, mineral and energy resources include known deposits of oil resources, natural gas resources, coal and peat resources, non-metallic minerals and metallic minerals. In SEEA-Energy, mineral and energy resources are restricted to those resources that can become energy products.

2.18 Known deposits of minerals and energy resources are categorized into three classes, based on criteria from the United Nations Framework Classification (UNFC) 2009[20]:

[18] https://unstats.un.org/unsd/energystats/methodology/documents/IRES-web.pdf
[19] https://unstats.un.org/unsd/classifications/Family/Detail/2007
[20] https://unece.org/fileadmin/DAM/energy/se/pdfs/UNFC/unfc2009/UNFC2009_ES39_e.pdf

(a) **Class A**: Commercially Recoverable Resources which includes on-production projects, projects approved for development and projects justified for development;

(b) **Class B:** Potentially Commercially Recoverable Resources which includes economic and marginal development projects pending and development projects on hold; and

(c) **Class C:** Non-Commercial and other known deposits which includes unclarified development projects, non-viable development projects, additional quantities in place.

2.19 The basic form of the Asset Account is shown in Figure 2.2. It begins with the opening stock of resources and ends with the closing stock of resources. In physical terms, the changes between the beginning and the end of the accounting period are recorded either as additions to or as reductions in the stock. Wherever possible, the nature of the addition or reduction is recorded.

Figure 2.2: Basic Form of an Asset Account

Basic Form of Asset Account
Opening stock of resources
Additions to the stock of resources
Growth in stock
Discoveries of new stock
Upward reappraisals
Reclassifications
Total additions to stock
Reductions in the stock of resources
Extractions
Normal loss of stock
Catastrophic losses
Downward reappraisals
Reclassifications
Total reductions in stock
Revaluation of the stock of resources*
Closing stock of resources

**Applicable only for Asset Accounts in monetary terms.*

Source: SEEA-Energy

2.20 According to SEEA-Energy, there are three types of additions to the stock of the Energy Assets:

- **Discoveries:** Discoveries should incorporate estimates of the quantity of new deposits found during an accounting period. To be regarded as a discovery, the new deposit must be a known deposit – i.e., in Class A, B or C. In situations, in which a quantity of potential deposits becomes known to a higher degree of confidence, this increase should be treated as discoveries. Discoveries should be recorded by type of resource and by category of resource.
- **Upward reappraisals:** Reappraisals should only pertain to known deposits. They will relate to additions in the estimated available stock of a specific deposit, or to changes in the categorization of specific deposits between Class A, B or C based on changes in geological information, technology, resource price or a combination of these factors.
- **Reclassifications:** Reclassifications may occur if certain deposits are opened or closed to mining operations due to a government decision concerning the access rights to a deposit. All other changes in the quantity of known deposits should be treated as reappraisals. Reclassifications may conceivably be recorded if asset accounts for energy resources are being compiled by institutional sector.

2.21 There are four types of reductions in the stock of energy assets:

- **Extraction:** Estimates of extraction should reflect the quantity of the resource physically removed from the deposit. It should exclude mining overburden, i.e., the quantity of soil and other material moved in order to extract the resource. The quantity should also be estimated before any refinement or processing of the resource is undertaken. Estimates of extraction should include estimates of illegal extraction, either by residents or non-residents, as these amounts reduce the availability of the resource.
- **Catastrophic losses:** Catastrophic losses are rare for most energy resources. While flooding and collapsing of mines do occur, the deposits continue to exist and can, in principle, be recovered. The issue in this case is one of economic viability of extraction rather than of actual loss of the resource itself. An exception to this general principle concerns oil wells that can be destroyed by fire or become unstable for other reasons, resulting in significant losses of oil resources. Losses of oil and related resources in this situation should be treated as catastrophic losses.

- **Downward reappraisals:** Reappraisals should only pertain to known deposits. They will relate to reductions in the estimated available stock of a specific deposit, or to changes in the categorization of specific deposits between Class A, B or C based on changes in geological information, technology, resource price or a combination of these factors; and
- **Reclassifications:** Reclassifications may occur if certain deposits are opened or closed to mining operations due to a government decision concerning the access rights to a deposit. All other changes in the quantity of known deposits should be treated as reappraisals. Reclassifications may conceivably be recorded if asset accounts for energy resources are being compiled by institutional sector.

2.22 Monetary asset accounts for mineral and energy resources provide a market-based valuation of the physical stock of mineral and energy resources and the changes in the value of these stocks over time. The same entries are made in monetary terms, although an additional entry recording revaluations of resource stocks is included. This entry accounts for changes in the value of assets over an accounting period due to movements in the price of the resources.

Physical Supply and Use Tables (PSUT)

2.23 SEEA-Energy records the physical flows, measured in physical units of energy content, through the compilation of Supply and Use tables. These tables are used to assess how an economy supplies and uses energy products, as well as to examine the changes in production and consumption patterns over time. These tables help in the presentation of how energy flows into the economy, how they are used within, and how they leave a country's national economy for a given period of time. The PSUT are expressed in a common energy unit such as joules and expresses the relationship between inputs to and outputs from energy transformation processes.

2.24 The general structure of the PSUT is shown in the Figure 2.3:

Figure 2.3: Basic Form of a Physical Supply and Use Table for Energy

Basic form of a physical supply and use table for energy (joules)						
Supply table						
	Industries	Households	Accumulation	Rest of the world	Environment	Total
Energy from natural inputs					A. Energy inputs from the environment	Total supply of energy from natural inputs
Energy products	C. Output			D. Imports		Total supply of energy products
Energy residuals	I. Energy residuals generated by industry	J. Energy residuals generated by household consumption	K. Energy residuals from accumulation	L. Energy residuals received from the rest of the world	M. Energy residuals recovered from the environment	Total supply of energy residuals
Use table						
	Industries	Households	Accumulation	Rest of the world	Environment	Total
Energy from natural inputs	B. Extraction of energy from natural inputs					Total use of energy from natural inputs
Energy products	E. Intermediate Consumption	F. Household Consumption	G. Change in inventories	H. Exports		Total use of energy products
Energy residuals	N. Collection and treatment of energy residuals		O. Accumulation of energy residuals	P. Energy residuals sent to the rest of the world	Q. Energy residual flows direct to environment	Total use of energy residuals

Note: Dark grey cells are null by definition.
Source: SEEA-Energy

Monetary Supply and Use Tables (MSUT)

2.25 MSUT fully articulates, in monetary terms, the flows of energy products in an economy between different economic units. MSUT for energy provides information on the energy sector and the level of activity in this sector. They also provide detailed information on the industries within the economy that are using these energy products. Monetary supply and use tables for energy can readily be linked with PSUT for energy to create a powerful analytical tool.

2.26 Monetary supply and use tables have their roots in economic accounting and utilize the same organizational principles and display the same characteristics as physical supply and use tables. Nevertheless, while the physical supply and use table for energy contains three main types of flows, namely, energy from natural inputs, energy products and energy residuals, the monetary supply and use table for energy records only those flows related to energy products.

2.27 The general structure of the MSUT is shown in the Figure 2.4 below:

Figure 2.4: Basic Form of a Monetary Supply and Use Table for Energy

	Industries	**Households**	**Government**	**Accumulation**	**Rest of the world**	**Total**
Supply Table						
Products	Output				Imports	Total Supply
Use table						
Products	Immediate consumption	Household final consumption expenditure	Government final consumption expenditure	Gross capital formation (including changes in inventories)	Exports	Total Use
	Value added					

Note: Dark Grey cells are null by definition
Source: SEEA-Energy

Data Sources for Energy Accounts in India

2.28 The major data-sources for the compilation of the Energy Accounts in India are given as follows:

(i) **Energy Statistics:** Energy Statistics is a regular annual publication, of the Economic Statistics Division (ESD) of National Statistical Office (NSO), Ministry of Statistics & Programme Implementation (MoSPI), using the IRES Framework. The data are primarily sourced from the Ministry of Coal, Ministry of Petroleum & Natural Gas, Ministry of Mines, Ministry of Power, Ministry of New and Renewable Energy and others. The data pertaining to the energy sector of the economy provided in the publication are in respect of the reserves and potential for generation, installed capacity and capacity utilization, production of energy, foreign trade, availability of energy resources, consumption of energy resources, energy balance and sustainability;

(ii) **Geological Survey of India, Ministry of Mines**: Its main functions relate to creation and updation of national geoscientific information and mineral resource assessment. These objectives are achieved through ground survey, air-borne and marine surveys, mineral prospecting and investigations, multi-disciplinary geoscientific, geo-technical, geo-environmental and natural hazards studies, glaciology, seismotectonic study, and by carrying out fundamental research;

(iii) **Ministry of Petroleum and Natural Gas**: It is concerned with the exploration and production of oil & natural gas, and refining, distribution, marketing, import, export and conservation of petroleum products. Oil and gas being the important imports for our economy, many initiatives have been taken by the Ministry for increasing production and exploitation of all domestic petroleum resources to address the priorities like Energy Access, Energy Efficiency, Energy Sustainability and Energy Security;

(iv) **Central Electricity Authority, Ministry of Power**: It has the mission to achieve the vision by performing its statutory function by providing a technical support base to all stakeholders in the power sector, supporting the Ministry of Power in forming policies in the power sector to make technical standards & regulations, to carry out project monitoring, to disseminate power sector information, to upgrade skills of human resources in the power sector of the country.

2.29 SEEA recommends compilation of the accounts for all three types of energy resources: Class A, B and C, both in physical and monetary terms. Even though Class A is included in the core accounts, countries are encouraged to compile information on Classes B and C.

Physical Asset Accounts for Energy for India

2.30 The Physical Asset Accounts for energy, considering the crude oil, natural gas, coal and lignite, have been compiled for India for the years 2015-16 to 2022-23 using data from M/o Coal, M/o Petroleum and Natural Gas and the Geological Survey of India. The accounts for the atomic energy resources could not be compiled due to the non-disclosure policy regarding confidential information. For the assets such as coal and lignite, the Geological Survey of India compiles estimates of these in three main categories of Proved, Indicated and Inferred.

2.31 Proved resources are the economically mineable part of Measured Mineral Resource. These resources are generally taken to be those quantities that geological and engineering information indicates with reasonable certainty and can be recovered in the future from known reservoirs under existing economic and operating conditions.[21] For Indicated mineral resources, tonnage, density, shape, physical characteristics grade and mineral content can be estimated with a reasonable level of confidence based on exploration, sampling and testing information, and location of borehole, pits, etc. For Inferred Mineral Resources, tonnage, grade and mineral content can be estimated with a low level of confidence inferred from geological evidence.[22] However, the majority of the extractions take place from the proved category of the resources with around 10% uncertainty. The other categories possess a higher degree of uncertainty. Thus, it would be more appropriate to subtract the 'extraction estimates' from the Proved category rather than from the Total ('proved + indicated + inferred') while compiling the Asset Accounts. Also, according to a report of the Expert Committee on Road Map for Coal Sector Reforms under the chairmanship of Shri T.L. Sankar, released in December 2005 by Ministry of Coal, GoI[23], a ratio of 1:4.7 is approximately suggested to know the proportion of the coal extracted and coal sterilized during the extraction process (1 unit of Coal extraction involves 3.7 units of sterilization loss). Similarly, a ratio of 1: 4.46 is approximately suggested to know the proportion of Lignite extracted and Lignite sterilized during the extraction process (1 unit of lignite extraction involves 3.46 units of sterilization loss) as provided by Neyveli Lignite Corporation India Limited.

2.32 So, for assets such as coal and lignite, only the 'proved' category of resources has been used for compilation of the Asset Account as it has the lowest level of uncertainty amongst the other classes of resources and also because of the fact that most of the coal is extracted from 'proved' resources. For the Crude Oil and Natural gas, 2P reserve has been considered, which is the sum of 'proved' and 'probable reserves'. The current publication is restricted to only the compilation of the Physical Asset Accounts and Physical Supply and Use Tables. Efforts will be made to compile the Monetary Supply and Use Table (MSUT) in consultation with the stakeholders.

2.33 The Asset Accounts for the year 2022-23 is provided in Table 2.1. For the other years i.e. 2015-16 to 2021-22, the year wise asset accounts for coal, lignite, crude oil and

[21] Coal Directory of India, 2020-21, Ministry of Coal

[22] National Mineral Inventory - An Overview
https://ibm.gov.in/writereaddata/files/07072014130440nmi%20overview%20142010_Chapter%2011.pdf

[23] http://www.indiaenvironmentportal.org.in/files/expertreport-1.pdf

natural gas are provided in the **Annexure 2.1**. The Opening Stock (Inventory) data as given in the Coal Directory differs from what has been computed in the Asset Accounts. The reason for this is the deduction of the extraction and sterilization loss in the Asset Accounts which is not considered in the geological resources by the GSI.

Table 2.1: Physical Asset Accounts for Energy: 2022-23

	Type of Energy Resource			
	Coal (Proved Category)	Lignite (Proved Category)	Crude Oil (2P Reserve)	Natural Gas (2P Reserve)
	Million tonnes	Million tonnes	Million BBL	MMSCM
Opening stock of mineral and energy resources (Closing for last FY)	**1,02,174**	**2,193**	**3,291**	**6,49,560**
Additions in stock:				
Discoveries	12,799	132	201	40,626
Upward appraisals			17	
Total Addition to The Stock	**12,799**	**132**	**218**	**40,626**
Reduction in Stock:				
Extraction	893	42	214	34,450
Sterilization Loss	3,304	145		
Downwards reappraisals			0	5,109
Total Reduction in Stock	**4,197**	**187**	**214**	**39,559**
Closing Stock of mineral and energy resources	**1,10,776**	**2,138**	**3,295**	**6,50,626**

Source: Geological Survey of India, Ministry of Petroleum and Natural Gas
*Sterilization Loss for Coal = Extraction*3.7*
*Sterilization Loss for Lignite = Extraction*3.46*
2P is the sum of proved and probable reserves.

Physical Supply and Use Table for Energy

2.34 'Physical Supply and Use Tables for Energy' aims at comprehensiveness that entails recording all energy flows both within the economy, between the economy and

the environment. These accounts along with the Asset accounts, provide necessary granular level information to help identifying the policy concern areas.

2.35 In the chapter, the PSUT for Energy has been compiled following the structure of SEEA-Energy. Following accounting identities have been adhered to while compiling the PSUT for Energy.

(i) Total Supply of Energy from Natural Inputs =Total Use of Energy from Natural Inputs

(ii) Total Supply of Energy Products=Total Use of Energy Products (Transformation + End Use)

(iii) Total Supply of Energy Residuals=Total Use of Energy Residuals

Procedure for Compiling Physical Supply and Use Table

2.36 The Methodology for compiling the Physical Supply and Use Tables is as given below:

(i) **Energy from Natural Inputs:** In the Supply Table, most of the data (for coal, lignite, crude oil and natural gas) have been sourced from the Energy Statistics India-2024 publication[24] and the values are shown in the column 'Flows form Environment'. On the Use side, industry-wise distribution of these 'Energy from Natural Inputs' have been made. The values in physical units are converted to Petajoules using the appropriate conversion factors [1 MTOE= 41.868 PJ];

(ii) **Energy Products:** Both for the Supply side and the Use side, the data have been primarily sourced from the Energy Statistics India 2024 publication. Entries in the Supply Table and Use Table have been matched energy component-wise. After converting all the entries into Petajoules, the tables are balanced by making appropriate adjustments in the column titled 'statistical difference';

(iii) **Energy Residuals:** The distribution loss for natural gas and electricity and the loss in petroleum (flare and other loss) has been taken from the Energy Statistics.

2.37 The Physical Supply and Use Tables for Energy for the years 2015-16 to 2022-23 have been compiled. The PSUT for energy for the year 2022-23 has been presented

[24] https://mospi.gov.in/publication/energy-statistics-india-2024-1

in **Tables 2.2 (a)** and **2.2 (b)**. For the years 2015-16 to 2021-22, PSUT for energy is given in **Annexures 2.2 to 2.8**. The Energy Accounts compiled in the current publication is at a preliminary stage and has scope for further improvement with the availability of granular information from the source agencies, especially NIC-wise disaggregated data, data on residuals and losses, data on the accumulations, etc.

Figure 2.5: Total supply of Energy in Petajoules for the year 2022-23

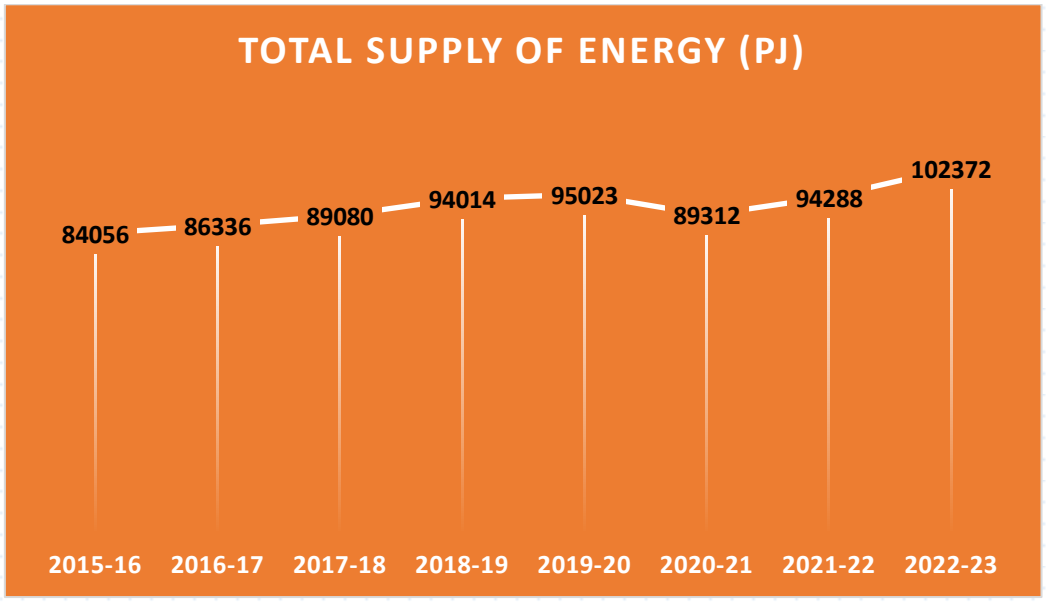
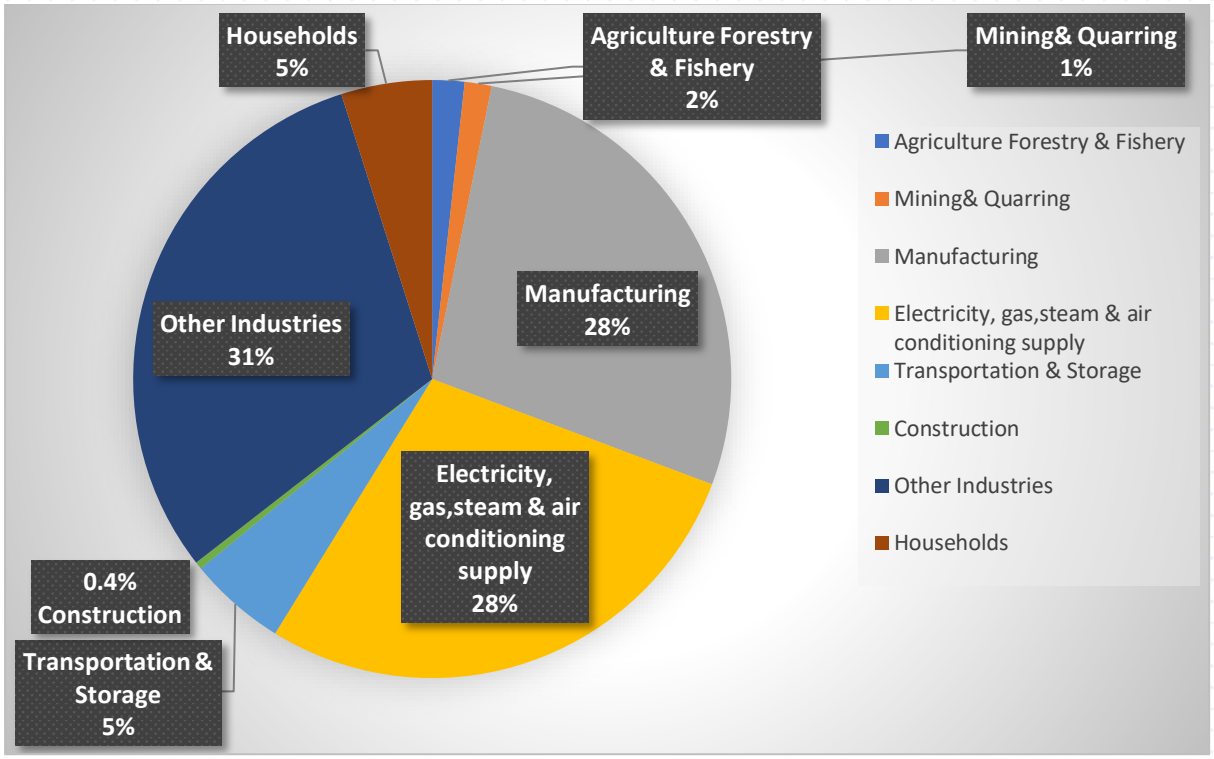


Figure 2.6: Industry-wise use (Transformation and End Use) of Energy for 2022-23



2.38 Based on the available data, Figure 2.5 shows the supply of Energy in Peta Joules over the years indicating generally an increasing trend. Figure 2.6 shows the industry-wise use of energy for the year 2022-23. The highest share of use can be seen in the Other industries, Manufacturing and the Electricity sector for the year 2022-23.

Table 2.2 (a): Physical Supply Table for Energy: 2022-23

PHYSICAL SUPPLY TABLE (Unit: PJ)	Production (Incl. household own account) & generation of residuals										
	Industries (by ISIC)						Households	Accumulation	Flows from the rest of the world	Flows from the Environment	Total
	Agriculture Forestry & Fishery	Mining& Quarrying	Manufacturing	Electricity, gas, steam & air conditioning supply	Transportation & Storage	Other Industries					
	(ISIC A)	(ISIC B)	(ISIC C)	(ISIC D)	(ISIC M)						
Energy from natural inputs:											
Natural resource inputs											
Coal										15055	15055
Lignite										429	429
Crude Oil										1249	1249
Natural Gas										1334	1334
Nuclear										500	500
Inputs from RES										765	765
Hydro										585	585
Total										19918	19918
Energy Products:											
Production of energy products by SIEC class:											
Coal		15055							5290		20345
Lignite		429							0		430
Crude Oil		1249							9958		11207
Oil Products			11387						1869		13256

PHYSICAL SUPPLY TABLE (Unit: PJ)	Production (Incl. household own account) & generation of residuals										
	Industries (by ISIC)										
	Agriculture Forestry & Fishery	Mining& Quarrying	Manufacturing	Electricity, gas, steam & air conditioning supply	Transportation & Storage	Other Industries	Households	Accumulation	Flows from the rest of the world	Flows from the Environment	Total
	(ISIC A)	(ISIC B)	(ISIC C)	(ISIC D)	(ISIC M)						
Natural Gas		1334							1019		2353
Electricity				6639					28		6667
Total	**0**	**18067**	**11387**	**6639**	**0**	**0**			**18164**		**54258**
Energy Residuals:											
Distribution		1114		1007							2121
Extraction											
Other Losses											
Other Energy Residuals	890	745	3179	371	2702	15671	2517				26076
Total energy residuals	**890**	**1860**	**3179**	**1377**	**2702**	**15671**	**2517**				**28196**
Other Residual Flows:											
Residuals from end-use for non-energy purposes											
Energy from solid waste											
TOTAL SUPPLY	**890**	**19927**	**14566**	**8016**	**2702**	**15671**	**2517**		**18164**	**19918**	**102372**

Note: Grey cells are Nil by definition. *PJ: Petajoules* *Total may not match due to rounding off.*

Table 2.2(b): Physical Use Table for Energy: 2022-23

PHYSICAL USE TABLE (Unit: PJ)	Intermediate consumption, Use of energy resources, receipt of energy losses							Final Consumption	Accumulation	Export	Statistical Difference	Flows to the Environment	Total
	Industries (by ISIC)												
	Agriculture Forestry & Fishery	Mining& Quarrying	Manufacturing	Electricity, gas, steam & air conditioning	Transportation & Storage	Construction	Other Industries	Households					
	(ISIC A)	(ISIC B)	(ISIC C)	(ISIC D)	(ISIC M)								
Energy from natural inputs:													
Natural resource inputs													
Coal		15055											15055
Lignite		429											429
Crude Oil		1249											1249
Natural Gas		1334											1334
Nuclear				500									500
Inputs from RES				765									765
Hydro				585									585
Total		**18067**		**1850**									**19918**
Energy Products:													
Transformation of energy products by SIEC class													
Coal				13277									13277
Lignite				372									372
Crude Oil			10921										10921

PHYSICAL USE TABLE (Unit: PJ)	Intermediate consumption, Use of energy resources, receipt of energy losses							Final Consumption	Accumulation	Export	Statistical Difference	Flows to the Environment	Total
	Industries (by ISIC)												
	Agriculture Forestry & Fishery	Mining& Quarrying	Manufacturing	Electricity, gas, steam & air conditioning	Transportation & Storage	Construction	Other Industries	Households					
	(ISIC A)	(ISIC B)	(ISIC C)	(ISIC D)	(ISIC M)								
Oil Products				37									37
Natural Gas				316									316
Electricity													0
Total Transformed Energy	**0**	**0**	**10921**	**14002**	**0**		**0**						**24924**
End-use of energy products by SIEC class:													
Coal	0	0	1716		0	174	5090	0	-274	33	329		7068
Lignite	0	0	35		0	14	26	0	17	0	-35		58
Crude Oil							1110				-824		286
Oil Products	17	50	564		2078	16	5569	1214		2666	1044		13219
Natural Gas	**6**	695	864		534	0	75	0		**0**	**-138**		2037
Electricity	867	0	0	371	90	0	3799	1303		37	200		6667
Total End Use for Energy purposes	**890**	**745**	**3179**	**371**	**2702**	**204**	**15671**	**2517**	**-256**	**2736**	**576**		**29335**
End-use of energy products for non-energy purposes													
Energy Residuals:													
Distribution												2121	2121
Extraction												0	0

PHYSICAL USE TABLE (Unit: PJ)	Intermediate consumption, Use of energy resources, receipt of energy losses							Final Consumption	Accumulation	Export	Statistical Difference	Flows to the Environment	Total
	Industries (by ISIC)												
	Agriculture Forestry & Fishery	Mining& Quarrying	Manufacturing	Electricity, gas, steam & air conditioning	Transportation & Storage	Construction	Other Industries	Households					
	(ISIC A)	(ISIC B)	(ISIC C)	(ISIC D)	(ISIC M)								
Other Losses												0	0
Other Energy Residuals												26076	26076
Total energy residuals												**28196**	**28196**
Other Residual Flows:													
Residuals from end-use for non-energy purposes									0				**0**
Energy from solid waste													**0**
TOTAL USE	**890**	**18813**	**14101**	**16223**	**2702**	**204**	**15671**	**2517**	**-256**	**2736**	**576**	**28196**	**102373**

Note: Grey cells are Nil by definition. *PJ: Petajoules* *Total may not match due to rounding off.*

Energy Indicators

2.39 Energy indicators describe the link between energy use and human activity in a disaggregated framework. They are essential measures of energy consumption and in identifying the underlying factors driving that consumption. They are commonly constructed in order to calculate changes in energy efficiency. Indicators help to show how energy use is shaped by economic and technical factors, such as energy prices, economic growth and new technologies. Disaggregated measures of energy intensities are necessary to determine the impact of prices, policies and other factors on reducing energy consumption and hence, transcending the system from efficient to sustainable.

2.40 Several Energy indicators can be derived from the SEEA-Energy Accounts such as:

i. Energy Intensity for an industry [Total Energy supply/ use of energy/GDP at constant prices]
ii. Energy supply/ use per capita [total annual supply/use of energy/mid-year population]
iii. Electricity conversion and distribution efficiency [Losses in transmission of electricity/ Gross generation of electricity]
iv. Sectoral Electricity Intensities [Amount of electricity consumed against a sector/ GVA of that sector]
v. Fuel share in Total Energy Supply/ Use [Energy supplied/ consumed by a particular energy commodity/ Total Primary Energy Supply/Use].
vi. Fuel share in the Total electricity generation
vii. Net Energy Import dependency [Net imports of the energy commodity/ Total supply of all energy commodity]

2.41 These indicators provide a fair amount of idea about the efficiency and structural change in industry contribution. Some of the Energy indicators are available in the annual publication of the Ministry of Statistics & PI titled "Energy Statistics India 2024[25]". In addition, compilation of the Monetary Supply and Use Tables will help in providing additional information which might aid in building linkages with the National Accounts.

[25] https://mospi.gov.in/publication/energy-statistics-india-2024-1

Conclusion

2.42 SEEA-Energy also bears direct linkages with the targets under Sustainable Development Goal 7 ("Ensure access to affordable, reliable, sustainable and modern energy for all"). Besides this, the targets under SDG 12 (specially Target 12.2 which pertains to the material footprint and domestic material consumption and Target 12.c which focuses on rationalizing inefficient fossil-fuel subsidies that encourage wasteful consumption of fossil fuels) can also be compiled with the use of the Energy Accounts. Energy Accounts provides a myriad of information linked to the social, economic and environmental dimensions.

2.43 Addressing the energy security is also one of the major objectives in the sustainable development criteria of many countries. Interruptions in energy supply can cause serious financial and economic losses. To support the goals of sustainable development, energy must be available at all times, in sufficient quantities and at affordable prices. Secure energy supplies are essential to provide reliable energy services to the society for maintaining economic activity. The monitoring of trends of net imports and the availability of appropriate stocks of critical fuels are important for assessing energy security.

2.44 As the energy sector plays an integral role in the life of humans, how we use it becomes an essential consideration within the context of sustainable development. There are growing concerns about the impact of rising energy use and of related emissions on the local and global environment. At the same time, it is recognized that continuing human welfare and development are dependent upon the benefits to be derived from energy use. Hence, the need is to work towards fulfilment of the energy requirements of not only the current generations but to save enough for the future as well. As far as India[26] is concerned, rapid economic growth, marked by an expanding middle class and swift urbanization, has propelled it to become one of the largest energy consumers worldwide. This surge in demand for energy underscores the critical need for a sustainable approach to energy consumption, aligning with India's ambitious goals for a low-carbon future. The Energy Accounts compiled in this chapter would help policy makers to have a better understanding of each energy component as also the major suppliers and users.

[26] https://static.pib.gov.in/WriteReadData/specificdocs/documents/2024/mar/doc202431317201.pdf

2.45 In this chapter, the NSO, India has attempted compilation of the Energy Accounts with the best available information at hand. The Accounts do have a scope of further refinement based on the data availability and further understanding of the concepts and methodology.

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Chapter 3

Ocean Ecosystem Accounts

Chapter 3

Ocean Accounts

The sea, once it casts its spell, holds one in its net of wonder forever.

-Jacques Cousteau

Introduction

3.1 The ocean occupies more than 70% of the Earth's surface, holds 97% of its water and supports 80% of its life forms. Oceans are a life source for our planet and are a strong driver of the Earth's climate and ecology. Human well-being and economic prosperity are dependent on a healthy ocean.

3.2 The benefits in the form of ocean resources (i.e. natural capital) provide ecosystem services such as food and raw materials, as well as the maintenance of an environment that caters to both market and non-market needs of humanity. The ocean produces[27] half the Earth's oxygen and absorbs more than 90% of heat from greenhouse gas emissions. It regulates the climate, and also marine and coastal ecosystems offers flood control and protection from natural disasters, natural hazards, pollution.

3.3 On the edges of the ocean, coastal wetlands–such as mangroves, salt marshes and seagrass meadows–protect the shores as well. These unique areas also draw in carbon as they grow, and store it in their leaves, stems and the rich soils held by their roots. This 'blue carbon'[28] can remain in the soil for thousands of years. Coastal wetlands store five times more carbon per hectare than rainforests, helping to mitigate climate change. The ocean is one of the largest carbon reservoirs on Earth, holding about 50 times more carbon than the atmosphere.

3.4 The ocean also plays a crucial role in the global economy as it is an essential source of food, energy and other ocean resources. These include traditionally exploited marine resources – either living resources (fish) or non-living resources (oil and gas) – and the use of the ocean for tourism, research and shipping. Ocean is also

[27] OECD- Sustainable Ocean Economy Country Diagnostics of Indonesia
[28] https://www.undp.org/nature/our-work-areas/ocean-governance

critical for the livelihoods of billions of people, as many economic sectors are directly or indirectly dependent on ocean resources.

3.5 There will be much agreement to the fact that the oceans are both critical and threatened. Unless a coherent measure exists, the degree of importance and the extent of being threatened cannot be assessed. From fisheries to marine-based tourism, oceans are a vital source of livelihood, employment, nutrition and economic growth and are essential in balancing the climate. Marine and coastal ecosystems serve as the first line of defence against ocean storms, coastal erosion and saltwater inundation, and they are among the richest sources of biodiversity.

Ocean in the context of India

3.6 India has a unique maritime position and a coastline extending 7,516.6 km across 9 Coastal States (Gujarat, Maharashtra, Goa, Karnataka, Kerala, Tamil Nadu, Andhra Pradesh, Odisha, West Bengal) and 4 Union Territories (Andaman and Nicobar Islands, Dadra and Nagar Haveli and Daman and Diu, Lakshadweep and Puducherry) including 2 groups of islands. It has over 4 million fishermen and other coastal communities. The coastal belt comprises a wide range of habitats such as sandy beaches, rocky shores, mudflats, saltpans, creeks, lagoons, and valuable coastal ecosystems like mangroves, seagrass, seaweeds and coral reefs. These coastal states play an important economic role and contribute significantly to several industries, such as fishing, mining, tourism, transport and tidal energy.

3.7 Coastal regions are complex environments characterised by diverse hydrodynamic conditions, bio-geomorphological features, socio-economic and ecological challenges. These systems are among the most affected by both natural and anthropogenic activities. The sustainable future of coastal zones depends on systematic mapping, monitoring, modelling for effective management at different spatio-temporal scales. The challenge for the policymakers and coastal resource managers is to figure out ways to reap the economic benefits of coastal resources sustainably.

3.8 In current scenario, oceans and marine ecosystems are being impacted by climate change in five significant ways: ocean warming, ocean acidification, ocean deoxygenation, sea level rise, and heat stress. Coastal seas face the broadest array of human pressures and uses, as the rate of pollution and land-use change is most significant near the coast. Through agriculture, aquaculture, settlements, port

development and tourism, the ability of coastal ecosystems to accumulate carbon is diminished, potentially leading to the release of CO_2 from coastal sediments.

3.9 In order to ensure that the potential of these ecosystems is sustainably harnessed, checks and balances need to be put in place so as to counter the negative side-effects of an increase in these industries. This can be done effectively with the help of Ocean Accounts.

Ocean Accounts and Global Practices

3.10 Ocean Accounts is a structured compilation of consistent and comparable information: maps, data, statistics and indicators concerning marine and coastal environment, including related social circumstances and economic activity. Major advantages for compiling Ocean Accounts include:

i. To inform and enable public policy decision-making about oceans, and related analysis and research,
ii. To provide coherent structures for standardizing fragmented data to produce reliable integrated indicators of interest to policy, and
iii. To achieve the UN Sustainable Development Goals (SDGs) - 14 towards conserving and sustainably using the oceans, seas and marine resources for sustainable development.

3.11 Ocean Accounts are integrated records of regularly compiled and comparable data concerning ocean environment conditions (e.g., extent/condition of mangroves), economic activity (e.g., sale of fish) and social conditions (e.g., coastal employment). Using the accounting principles and structures described in the System of National Accounts (SNA) and SEEA, Ocean accounts describe:

- Interactions between the economy and the environment,
- The stocks and changes in stocks of environmental assets (natural capital) that provide benefits to people,
- The flows of services and benefits to society (including businesses and people) and the distribution of those benefits, and
- Social and governance factors affecting the status and condition of environmental assets and associated benefits.

3.12 Although the global relevance of the oceans cannot be undermined, till date there is no internationally agreed standard framework available for ocean accounting. The UNSC is working towards developing the SEEA—Oceans as the agreed methodology for ocean accounting based on the progress made on the development

of the Technical Guidance on Ocean Accounting for Sustainable Development including testing and experimentation at the country level.

3.13 Many of the international organisers and partnerships are working in the direction of making the value of the ocean ecosystem visible and enabling countries and other stakeholders for sustainable management of ocean resources. One of them is the Global Ocean Accounts Partnership (GOAP) which is a global, multi-institutional partnership established to enable countries and other stakeholders to go beyond GDP, of which India has been a member since 2020.

3.14 Based on the literature review, Table 3.1 below provides a glimpse of the various country practices as well as global efforts related to the work done by the countries on Ocean Accounts:

Table 3.1: Countries by their level of work towards Ocean Ecosystem Accounts

Type of Accounts			
Ecosystem Accounts (I)	**Satellite Accounts/ Sector wise accounts (II)**	**Preliminary Stage (III)**	**MSP/Blue/Marine Economy (IV)**
Australia Canada China (Pilot Accounts) Fiji Islands France Indonesia Malaysia (Pilot) South Africa Maldives Netherlands United Kingdom Columbia Greneda	Norway Portugal Republic of Korea United States of America Japan	Costa Rica Japan Mexico Samoa Thailand Philippines Viet Nam Chile Myanmar Guatemala (supported by WAVES) Madagascar (supported by WAVES)	Republic of Korea Samoa Thailand China The Maldives Philippines Canada Costa Rica United States of America Seychelles
Remarks: *I: These countries have developed some of the ecosystem accounts for selected ocean ecosystems. Extent and condition parameters have been provided by many of the countries. However, the estimation of ocean ecosystem*			

services is at preliminary stage. The monetary valuation of some services which have market prices have been attempted.

II: These countries have compiled ocean economy or ocean tourism satellite accounts. Separate Ocean Ecosystem Accounts have not been compiled.

III: These countries have identified certain roadmap and they are yet to develop frameworks. Some of the countries have begun the pilot work and constituted technical committees. Some of the countries may not have defined Ocean ecosystem related roadmap, but a few components are covered as part of some other environment accounting policies or sustainable development plans.

IV: These countries have identified MSP and Blue Economy as a priority policy area and are either working towards it or planning to initiate work in this direction.

Oceans Accounts and SDGs

3.15 The SDGs regime has an independent goal relating to the Ocean, i.e. SDG 14: Conserve and sustainably use the oceans, seas and marine resources for sustainable development. A dedicated SDG on the ocean recognises the growing importance of ocean development; however, it leans more towards environmental aspects. SDG 14 seeks to address some of the challenges faced by life under threats of marine and nutrient pollution, resource depletion and climate change, degradation and loss of biodiversity, and ocean acidification, all caused primarily by human actions. The ten targets of SDG 14 aim to sustainably manage and protect marine and costal ecosystems.

India's Efforts Towards Ocean Accounts

3.16 Recognizing the significant contribution of ocean and coastal resources to India's economic output, the Government of India's Vision of New India by 2030, enunciated in February 2019, highlighted the Blue Economy as one of the ten core dimensions for growth. Further, the Draft Policy Framework on India's Blue Economy, released in September 2020, identified seven priority areas for strengthening India's Blue Economy, where the development of a robust mechanism for a National Accounting Framework for Blue Economy and Ocean Governance is outlined as its first priority. There has also been significant thrust given in the very recent past to the development of Coastal and Marine Spatial Plans for various regions in India (such as Puducherry, West Bengal, Lakshadweep, etc.) and the preparation of framework and action plan for the National Coastal and Marine Spatial Plan.

3.17 The Government of India's Sagarmala Project, also known as the Blue Revolution, is working to improve the state of India's ports and coastlines. In addition to conserving marine ecosystems, the Ministry of Environment, Forest and Climate Change (MoEFCC) is implementing a National Plan for the Conservation of Aquatic Ecosystems[29] since 2013 for conservation and management of wetlands (including lakes) in the country on a cost-sharing basis between the Central Government and respective State/UT Governments. The Government of India has also implemented the Integrated Coastal Zone Management Project (ICZMP)[30], a World Bank Assisted Project, in identified stretches of Gujarat, Odisha and West Bengal from 2010 to 2020 with the purpose of protecting and conserving the coastal and marine environment of the country. This includes developing an Integrated Coastal Zone Management Plan, prevention of soil erosion, shelterbelt plantation, mangrove plantation, strengthening requirements for ecosystem monitoring, biodiversity conservation and sustainable livelihood of coastal communities.

3.18 MoEFCC has notified Coastal Regulation Zone Notification, 2019[31] to conserve and protect coastal stretches, marine areas and to ensure livelihood security for the fishermen and other local communities. As per CRZ notification, 2019, certain coastal areas were declared as coastal regulation zones, wherein setting up of industries and expansion of industries are prohibited activities and other developmental activities/projects are regulated/ permitted as per provisions of the said notification. The notification also provides for 'No Development Zones' (NDZ) along various coastal areas to protect India's coastline from encroachment, erosion and accretion. Additionally, MoEFCC has framed a national strategy for coastal protection, along with guidelines, for all coastal states and union territories.

3.19 Further, the Ocean Accounts have a synergetic association with India's ongoing environmental-economic accounting work. NSO, India, has joined the Global Ocean Accounts Partnership (GOAP)[32] in 2020 to gear up the compilation of Ocean Accounts. In addition, NSO, India, and the Ministry of Earth Science have also been included as members of the Working Group on Ocean Accounts, which is constituted by the United Nations Statistics Division (UNSD) for the development of the Global Ocean Accounts Framework.

[29] https://indianwetlands.in/our-work/national-plan-for-conservation-of-aquatic-ecosystems/
[30] https://pib.gov.in/PressReleasePage.aspx?PRID=1812037
[31] https://pib.gov.in/PressReleasePage.aspx?PRID=1842623
[32] https://www.oceanaccounts.org/about-the-global-ocean-accounts-partnership/

3.20 As an important step towards operationalizing the Ocean Accounts in India, the NSO, MoSPI organized a brainstorming session in collaboration with the Ministry of Earth Sciences on 4th November, 2022 at the National Centre for Coastal Research, Chennai. As a way forward, MoSPI constituted an "Expert Group on Ocean Ecosystem Accounts in India" on 11th July 2023 involving members from various Central Ministries/Departments, Research Institutions/Organization and eminent Experts under the chairpersonship of the Additional Director General, Social Statistics Division, MoSPI.

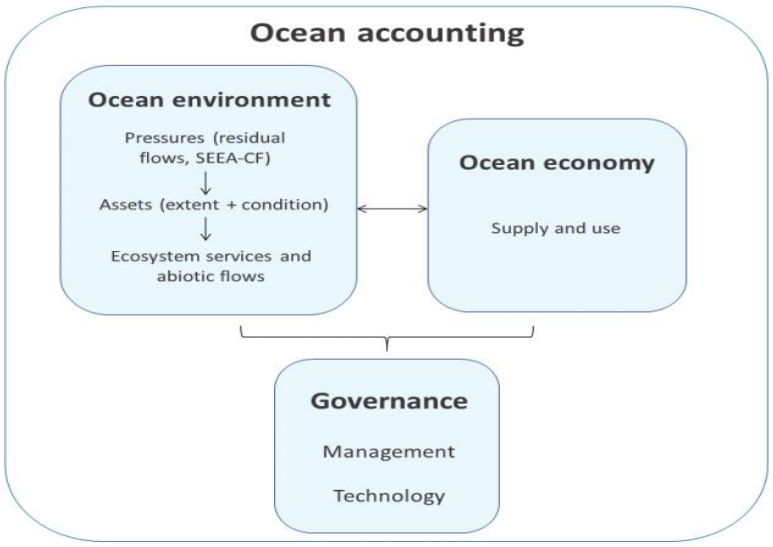
Framework for the Ocean Accounts

3.21 In accordance with the SEEA Framework, the Ocean Accounts would include:

1. Ecosystem Extent Accounts to track the size of an ecosystem asset in terms of spatial area.
2. Ecosystem Condition Accounts to measure the quality of an ecosystem by tracking indicators of ecosystem health through the ecosystem's abiotic and biotic components.
3. Physical Ecosystem Service Flow Accounts record the supply of ecosystem services by ecosystem assets and the use of those services by economic units such as households.
4. Monetary Ecosystem Service Flow Accounts record the value of ecosystem services in monetary terms based on the prices for individual ecosystem services.
5. Monetary Ecosystem Asset Accounts record the value of stocks of assets given the expected flow of ecosystem services over a specified time horizon, and changes in asset degradation and enhancement projected over that time horizon.

3.22 According to the SEEA-EA guidelines, the Ocean Accounts Framework can be described as shown in the figure below:

Figure 3.1. Coverage of Ocean Accounts Framework



Source: System of Environmental-Economic Accounting—Ecosystem Accounting, 2021

3.23 Ocean accounts integrate four key components:

i. Macroeconomic Accounts from which economic measures such as GDP are derived, and from which legal, illegal, unreported, and unregulated activities can be accounted for;
ii. Environmental-Economic Accounts that explain assets and flows, wastes, expenditures, taxes, and subsidies and the distribution of those flows across economic units;
iii. Ecosystem Accounts which agree on a spatial framework or the extent, condition, biodiversity, services, and value of ecosystems;
iv. Structured data on ocean beneficiaries (in particular concerning identification of the characteristics of different beneficiaries), technology, governance, and management.

3.24 Although the current chapter focuses on the Ocean framework, some of the prime data source agencies for the compilation of the ocean accounts parameters are as follows:

(i) National Centre for Coastal Research, M/o Earth Sciences: The NCCR is responsible for providing long-term organisational framework to continue research activities related to oceans. NCCR is envisaged to develop and improve the country's capabilities in addressing the

challenging problems prevailing in the coastal zone, which have societal, economic and environmental implications.

(ii) National Centre for Sustainable Coastal Management (NCSCM), M/o Environment Forest and Climate Change: The NCSCM under MoEFCC is an autonomous institution to support the protection, conservation, rehabilitation, management and policy advice of the coast.

(iii) Forest Survey of India, M/o Environment Forest and Climate Change: FSI is an organisation under the Ministry of Environment & Forests, Government of India. Its principal mandate is to conduct survey and assessment of forest resources in the country.

Ocean Extent

3.25 As per the Law of the Sea Convention (LOSC) the ocean is divided into six different zones: (i) Internal Water (ii) Territorial Sea (iii) Contiguous Zone (iv) Exclusive Economic Zone (EEZ) (v) Continental Shelf (vi) High Seas and Deep Ocean Floor (vii) Coastal Regulation Zone. As per the CRZ, the coastal areas have been classified into four different zones, viz. CRZ-1, CRZ-2, CRZ-3 and CRZ-4. In the current chapter, the extent boundary is considered the EEZ. Again, for the sake of simplicity the entire ocean ecosystems have been categorised into eight major sub-ecosystems, such as Mangroves, Coral Reefs, Seagrass, Estuaries, Lagoon, Sandy Coast, Coastal Ocean Water and Mudflats. These are defined as given below:

(i) **Mangroves**: Mangroves create structurally complex and productive ecosystems in the intertidal zone of depositional coasts, around tropical and warm temperate regions. The biota includes aquatic and terrestrial species, and intertidal specialists. Large volumes of mangrove leaves and twigs are decomposed by fungi and bacteria, mobilizing carbon and nutrients for invertebrates such as crabs, worms and snails. Shellfish and juvenile fish are protected from desiccation and predators amongst mangrove roots. Mangrove canopies support many terrestrial species, particularly birds. These forests are important carbon sinks, retaining organic matter in sediments and living biomass;

(ii) **Coral Reefs**: These slow growing biogenic structures are formed by the calcium carbonate skeletons of certain coral species that depend on symbiotic relationships with algae. They occur in warm, shallow, low-nutrient waters and provide complex three-dimensional habitat for a highly diverse community across all trophic levels, from algae to sharks, along

with other characteristic sessile organisms like coralline algae and sponges. Niche habitats produce specialist behaviours and diets, like the symbiotic relationship between clown fish and anemones. Storms and marine heat waves drive cycles of reef destruction and renewal;

(iii) **Seagrass**: These shallow, subtidal systems are the only marine ecosystems with abundant flowering plants. They are typically found mostly on soft, sandy or muddy substrates around relatively sheltered coastlines. Extent is limited in the shallows by wave action, tidal exposure and at depth by light availability. Productive ecosystems' three-dimensional structure provides shelter for juvenile fish, invertebrates and epiphytic algae. Diverse organisms live in and around seagrass beds, including many grazers, from tiny invertebrates to megafauna such as dugongs;

(iv) **Estuaries**: These coastal ecosystems are shifting mosaics of different habitats, depending on the shape of the local coast and the proportional inflow of freshwater and seawater. Combined nutrients from marine, freshwater and land-based sources support very high productivity. Large animals like dugongs, dolphins, turtles and shorebirds feed on abundant fish, invertebrates and plant life, and they commonly serve as sheltered nursery areas for fish. Many organisms are adapted to significant variations in salinity;

(v) **Lagoon**: These coastal water bodies have high spatial and temporal variability in structure and function, which depends largely on the status of the lagoonal entrance (open or closed). Communities have low species richness compared to those of permanently open estuaries. Lagoonal entrance closure prevents the entry of marine organisms, and resident biota must tolerate significant variations in salinity, inundation, dissolved oxygen, and nutrient concentrations. Opportunists with short lifecycles dominate resident communities;

(vi) **Sandy Coast**: Sandy shorelines include beaches, sand bars, and spits. Beaches, sand bars and spits are exposed to waves and tides on moderate-high energy coasts and rely on drift seaweed and surf-zone phytoplankton for nutrients. Polychaete worms, bivalve shellfish and a range of smaller invertebrates burrow in the shifting sediments, while larger vertebrate animals like seabirds, egg-laying turtles and scavenging foxes can also be found at various times. Storm tides and waves periodically restructure the sediments and profoundly influence the traits of the organisms living in these highly dynamic systems;

(vii) **Coastal Ocean Water**: The epipelagic or euphotic zone of the open ocean is the uppermost layer that is penetrated by enough light to support photosynthesis. This uppermost ocean layer (0-200m depth) is the most influenced by the atmosphere and is defined and structured by light availability. Photosynthesis in these ecosystems accounts for half of all global carbon fixation. That productivity supports diverse marine life, including many visual predators, like tuna, that rely on the highlight environment. Migration is a typical life history trait across all groups: either vertical – rising from the depths to feed at the surface at night to evade daytime predators; or horizontal – between breeding and feeding grounds. Detritus from this zone is an essential nutrient source for lower oceanic layers;

(viii) **Mudflats**: Mudflats occur on low-energy coastlines. Mud and silt, often from nearby rivers, protect the burrowing organisms in these ecosystems from typical shoreline stressors (e.g. high temperatures and desiccation) and predatory shorebirds, crabs and fish. These shorelines are critical stopovers and foraging grounds for migratory shorebirds. Primary productivity is mostly from diatoms (single-celled algae) that rely on tides. Oxygen can be low where sediments are very fine or burrowing, or another disturbance is limited.

3.26 Table 3.2 provides a framework for recording statistics on Ocean Ecosystem Extent Accounts. A fundamental objective of compilation of ecosystem extent accounting is to record differences between the current composition of ecosystem types and a reference or baseline composition. It may be noted here that there may be other ecosystems & extent parameters, but the ones considered in the table below are the simplest one to begin with.

Table 3.2: Framework for the Extent Accounts for the Ocean Ecosystem-Tier I

Sl. No.	Ecosystem Extent Parameters	Opening Extent at time (t1)	Additions	Reductions	Closing Extent at time (t2)	Changes over time (t2-t1)
	(i) Mangroves					
1	Coverage					
1.1	Tree Cover					
1.2	Percent Tree Cover					
	(ii) Coral reefs					

Sl. No.	Ecosystem Extent Parameters	Opening Extent at time (t1)	Additions	Reductions	Closing Extent at time (t2)	Changes over time (t2-t1)
2	Coverage					
2.1	Coral reef Cover					
2.2	Percent Coral Cover					
	(iii) Seagrass					
3	Coverage Area					
3.1	Seagrass Cover					
3.2	Percent Seagrass Cover					
	(iv) Estuaries					
4	Coverage					
	(v) Lagoons					
5	Coverage					
	(vi) Sandy coast					
6	Coverage					
	(vii) Coastal Ocean Water					
7	Coverage					
	(viii) Mudflats					
8	Coverage					

3.27 Regular monitoring of the ecosystem extent is necessary for the formulation of conservation strategies and for an up-to-date account of its climate change mitigation potential.

3.28 The coast is subjected to multiple coastal processes and anthropogenic pressures, making it vulnerable to erosion. The loss (erosion) and gain (accretion) of coastal land are visible because shorelines are reshaped in the face of these dynamic conditions. MoEFCC has also delineated the hazard line for the country's entire coast. The hazard line indicates the shoreline changes, including sea level rise due to climate change. Drawing up a site-specific shoreline management plan and an Integrated Coastal Zone Management plan is essential for adequate shoreline protection.

3.29 The length of coastline across the states sourced from Ministry of Home Affairs are provided in Table 3.3. As far as the changes in the length of the coastline[33] is concerned, the following Table 3.4 sourced from NCCR, MoES provides the status of state-wise shoreline changes along the Indian coast (1990-2018). The data reveals that

[33] https://www.nccr.gov.in/?q=activities/coastal-process

about 33.6%, 26.9% and 39.6% of the coast is eroding, accreting and stable in nature, respectively.

Table 3.3: Length of Coastline across States

S.No.	State/UT	Length of Coastline (Kms.)
1	Andhra Pradesh	973.7
2	Goa, Daman and Diu	160.5
3	Gujarat	1,214.7
4	Karnataka	280.0
5	Kerala	569.7
6	Maharashtra	652.6
7	Odisha	476.4
8	Tamil Nadu	906.9
9	West Bengal	157.5
10	Andaman & Nicobar	1,962.0
11	Puducherry	30.6
12	Lakshadweep	132.0
	Total	**7,516.6**

Source: Ministry of Home Affairs

Table 3.4: Status of State-wise Shoreline Changes along Indian Coast (1990-2018)

S. No	Coast	State/UT	Coast Length (km) 1990	Coast Length (km) 2018					
				Erosion		Stable		Accretion	
				Km	%	Km	%	Km	%
1	West Coast	Gujarat	1,945.60	537.50	27.6	1030.90	53.0	377.20	19.4
2		Daman & Diu	31.83	11.02	34.6	17.09	53.7	3.72	11.7
3		Maharashtra	739.57	188.26	25.5	477.69	64.6	73.62	10.0
4		Goa	139.64	26.82	19.2	93.72	67.1	19.10	13.7
5		Karnataka	313.02	74.34	23.7	156.78	50.1	81.90	26.2
6		Kerala	592.96	275.33	46.4	182.64	30.8	134.99	22.8
7	East Coast	Tamil Nadu	991.47	422.94	42.7	332.69	33.6	235.85	23.8
8		Puducherry	41.66	23.42	56.2	13.82	33.2	4.42	10.6
9		Andhra Pradesh	1,027.58	294.89	28.7	223.36	21.7	509.33	49.6
10		Odisha	549.50	140.72	25.6	128.77	23.4	280.02	51.0
11		West Bengal	534.35	323.07	60.5	76.40	14.3	134.88	25.2
Total			**6907.18**	**2318.31**		**2733.86**		**1855.03**	
%				**33.6**		**39.6**		**26.9**	

Source: Ministry of Earth Sciences

3.30 According to Forest Survey of India (FSI), a nodal agency for assessing the Forest Cover in the country, mangroves are salt tolerant evergreen forest ecosystem found mainly in Tropical and Sub-Tropical coastal and/or inter-tidal regions. The area covered under mangrove vegetation is interpreted from Remote Sensing data. The mangroves show conspicuous tone and texture on satellite images. The categories of the mangroves include:

i. Very Dense Mangroves (Canopy Density of 70% and above)
ii. Moderately Dense Mangroves (Canopy Density of 40% and more but less than 70%)
iii. Open Mangroves (Canopy Density of 10% and more but less than 40%)

3.31 As per ISFR 2021 the mangrove cover are as follows:

Area Covered	4,992 sq km (0.15% of total geographical area)
Very Dense Mangrove	1,475 sq km (29.55% of total Mangrove Cover)
Moderately Dense Mangrove	1,481 sq km (29.67% of total Mangrove Cover)
Open Mangroves	2,036 sq km (40.78% of total Mangrove Cover)
Net Increase	17 sq km (Compared to ISFR 2019)

The area and the percentage change in area under mangroves for the different States/UTs are provided in Table 3.5 below:

Table 3.5: Area and Percentage Change of Mangrove Cover in India

States/UTs	2013	2015	2017	2019	2021	2013-15	2015-17	2017-19	2019-21
	Area (in sq. km.)					Percentage Change			
Andaman & Nicobar	604	617	617	616	616	2.15	0.00	-0.16	0
Andhra Pradesh	352	367	404	404	405	4.26	10.08	0.00	0.25
Daman and Diu	1.63	3	3	3	3	84.05	0.00	0.00	0
Goa	22	26	26	26	27	18.18	0.00	0.00	3.85
Gujarat	1,103	1,107	1,140	1,177	1,175	0.36	2.98	3.25	-0.17
Karnataka	3	3	10	10	13	0.00	233.33	0.00	30
Kerala	6	9	9	9	9	50.00	0.00	0.00	0
Maharashtra	186	222	304	320	324	19.35	36.94	5.26	1.25
Odisha	213	231	243	251	259	8.45	5.19	3.29	3.19
Puducherry	1	2	2	2	2	100.00	0.00	0.00	0
Tamil Nadu	39	47	49	45	45	20.51	4.26	-8.16	0
West Bengal	2,097	2,106	2,114	2,112	2114	0.43	0.38	-0.09	0.09
India	**4,627.63**	**4,740**	**4,921**	**4,975**	**4,992**	**2.43**	**3.82**	**1.10**	**0.34**

Source: India State of Forest Report 2021

Ocean Conditions

3.32 The coastal regions are unique because of their position at the interface of atmosphere, lithosphere and hydrosphere. This interaction creates various complex habitats that host rich biodiversity, energy and mineral resources. Ocean ecosystems provide essential ecological and economic services in the form of coastal protection, fisheries, and other living and non-living resources. This has made the coastal areas the centre of human activity for millennia. However, the services provided by the ocean are very dependent on the health of the oceans. The Condition Accounts help to assess the health of the ocean over a period of time.

3.33 Ecosystem Condition Accounts provide a structured approach to recording and aggregating data describing the characteristics of ecosystem assets and how they have changed. The framework for the condition accounts for different ocean ecosystem types is as given in Table 3.6 below. There are several other condition parameters and condition indices but the following table provides a simplest framework with limited indices.

Table 3.6: Framework for the Condition Accounts for Different Ocean Ecosystem Types (Tier 1)

Sl. No	Ecosystem Condition Parameters	Condition at time (t1)	Condition at time (t2)	Changes over time (t2-t1)
(i)	**Mangroves**			
1	Water Quality Index			
2	Fish diversity Index			
3	Plankton diversity Index			
(ii)	**Coral Reefs**			
1	Water Quality Index			
2	Fish diversity Index			
3	Plankton diversity Index			
(iii)	**Seagrass**			
1	Water Quality Index			
2	Fish diversity Index			
3	Plankton diversity Index			
(iv)	**Estuaries**			
1	Water Quality Index			
2	Fish diversity Index			
3	Plankton diversity Index			
(v)	**Lagoon**			

Sl. No	Ecosystem Condition Parameters	Condition at time (t1)	Condition at time (t2)	Changes over time (t2-t1)
1	Water Quality Index			
2	Fish diversity Index			
3	Plankton diversity Index			
(vi)	**Sandy Coast**			
1	Water Quality Index			
2	Fish diversity Index			
3	Plankton diversity Index			
(vii)	**Coastal Ocean Water**			
1	Water Quality Index			
2	Fish diversity Index			
3	Plankton diversity Index			
(viii)	**Mudflats**			
1	Water Quality Index			
2	Fish diversity Index			
3	Plankton diversity Index			

3.34 The different indices mentioned above are defined as follows:

i. **Water Quality Index**: An indicator to identify and assess periodical changes in seawater quality. The assessment[34] is done through a collection of physical, chemical and biological samples. Based on the Coastal Water Quality Index developed by NCCR, the monitoring locations can be categorized as Poor, Fair, Good etc. Ranges for coastal water quality is as follows:

1) 0-20: Very Poor
2) 21-40: Poor
3) 41-60: Moderate
4) 61-80: Good
5) 81-100: Very Good

ii. **Fish Diversity Index:** Fish assemblages[35] often experience temporal variations in species diversity in terms of richness (the number of species), abundance (the biomass of species) and evenness (the homogeneity of species across spatial and temporal scales). The fish diversity index is an indicator of how diverse/spread the fish are. Thus,

[34] https://www.nccr.gov.in/?q=activities/monitoring
[35] https://eprints.cmfri.org.in/10933/1/2.%2045862.pdf

the higher richness and evenness show the rich diversity of the coastal ecosystem's aquatic species.

iii. **Plankton Diversity Index**: Index measuring the plankton species' differences, abundance and diversity.

3.35 The Coastal Water Quality Index for 2023-24 for the coastal states can be visualized through the following Figures 3.2 using the indices provided by NCCR. The tables showing the values of the index from 2020-21 to 2023-24 can be seen in **Annexure 3.1**.

Figure 3.2: Coastal Water Quality Index- 2023-24

Marine Protected Animals

3.36 The marine protected animals of India include Sponges, Mammals, Reptiles, Holothurians (sea-cucumber), Molluscs, Marine Arthropods (Horseshoe and robber crab), Gorgonians (Sea fan), Antipatharians (Black coral) and Corals. The marine faunal diversity in India and in the world is provided in Table 3.7 below. The details of marine ecosystem wise faunal diversity of India are given in **Annexure 3.2**.

Table 3.7: Marine Faunal diversity in India and the World

S. No.	Phylum	Total number of marine faunal species		Number of species in India under other groups		Total number of faunal species	
		World	India	Indian Mangrove System	Estuarine Ecosystem	World	India
1	Protista			349	58		
2	Protozoa	31,250	2,577			50,012	3,588
3	Mesozoa					122	10
4	Foraminifera				130		
5	Porifera	8,339	512	5	4	8,550	575
6	Cnidaria	11,935	1,385	73	92	11,935	1,472
7	Ctenophora	199	19	4	5	199	20
8	Platyheminthes	12,821	832	1		29,495	1,813
9	Polyclad	1,005	46				
10	Dicyemida	122	6				
11	Nemertea	1,368	6	1		1,368	6
12	Gastrotricha	497	61	1		790	164
13	Rotifera	172	47	53	38	2,200	467
14	Chephalorhyncha						
15	Kinorhyncha	315	10	1		315	10
16	Acanthocephala	6,000	229	1	1	1,308	312
17	Nematoda	6,833	356	125	30	30,027	3,065
18	Gnathostomulida	101	4				
19	Mollusca	42,579	3,400	173	426	85,015	5,273
20	Opisthobrachia	3,736	389				
21	Annelida	11,800	590	269	269	20,006	1,064
22	Arthropoda	50,588	3,956	2,393	1003	12,04,316	78,258
23	Sipuncula	162	41	1	1	162	41
24	Echiura					198	47
25	Onycophora					183	1
26	Tardigrada	202	8			1381	34
27	Phoronida	12	3			12	3

S. No.	Phylum	Total number of marine faunal species		Number of species in India under other groups		Total number of faunal species	
		World	India	Indian Mangrove System	Estuarine Ecosystem	World	India
28	Bryozoa	6,148	272	2	4	5,434	355
29	Entoprocta	181	4	1		150	10
30	Brachiopoda	392	8	2	3	392	8
31	Echinodermata	7,551	777	8	28	7,551	788
32	Chaetognatha	170	44	15	14	170	44
33	Hemichordata	139	14	1	1	139	14
34	Chordata			1,544	1276	1,10,321	7,119
35	Cephalochordata	33	6			33	6
36	Tunicata/Urocgordata	2,804	516			2,804	534
37	Pisces	18,196	3,267			70,449	3,579
38	Reptilia	74	32			11,733	738
39	Aves		33			10,357	1,347
40	Mammalia	130	33			6500	438
41	Meiofauna	21,606	961				
42	**Total (Protista+Animalia)**	2,47,605	20,444	5,023	3383	15,71,751	1,04,561

Source: Zoological Survey of India, Ministry of Environment, Forest & Climate Change. (As on September 2024)

Ocean Services

3.37 SEEA-EA defines ecosystem services as ***the contributions of ecosystems to the benefits that are used in economic and other human activity***[36]**.** Ecosystem Services can be broadly categorized into three categories[36]:

a. Provisioning Services are those ecosystem services representing the contributions to benefits that are extracted or harvested from ecosystems. These are related to the supply of food, fibre, fuel and water.

b. Regulating Services are those ecosystem services resulting from the ability of ecosystems to regulate biological processes and to influence climate, hydrological and biochemical cycles, and thereby maintain environmental conditions beneficial to individuals and society. These

[36] System of Environmental-Economic Accounting— Ecosystem Accounting, 2021

services are related to activities of filtration, purification, regulation and maintenance of air, water, soil, habitat and climate, etc.

c. Cultural Services are the experiential and intangible services related to the perceived or actual qualities of ecosystems whose existence and functioning contributes to a range of cultural benefits. Cultural[37] ecosystem services and benefits can include health, learning, social connections, sensory experiences, cultural and symbolic importance and identity.

3.38 Collectively, the benefits provided by ocean ecosystems are referred to as ocean ecosystem services. The ocean ecosystems have been providing many benefits to humankind since ages. Some of these are listed below:

a. Provide seafood, habitats, fuel wood, energy sources, wetland protection and genetic resources [Provisioning Services];
b. Regulate weather and climate, protect coasts and sediment deposition, mitigates storm damage [Regulating Services];
c. Provide cultural services, including recreational, educational, aesthetic and spiritual. [Cultural Services].
d. Supports economic activity, including jobs, fisheries, food, marine transportation, trade, fuel, and energy.

3.39 A list of selected ecosystem services against each of the ecosystem types is provided in Table 3.8 below:

Table 3.8: List of Selected Ecosystem Services against each of the ecosystem type

Category	Ecosystem Services	Ecosystem Type							
		Mangrove	Lagoon	Coral reef	Seagrass	Estuary	Sandy Coast	Coastal Ocean	Mudflats
Provisioning	Fishery • Captured fishery • Aquaculture								

[37] https://www.forestresearch.gov.uk/research/cultural-ecosystem-services-values-and-benefits/#:~:text=Cultural%20ecosystem%20services%20and%20benefits,and%20symbolic%20importance%20and%20identity

Category	Ecosystem Services	Ecosystem Type							
		Mangrove	Lagoon	Coral reef	Seagrass	Estuary	Sandy Coast	Coastal Ocean	Mudflats
	Food other than fishery • Seaweed • salt	■	■	■	■	■	■	■	
	Fuel/Firewood	■	■	■		■	■	■	
	Desalination								
Regulating	Carbon sequestration (by biomass)	■	■		■	■	■	■	■
	Carbon storage in soil	■	■	■	■	■	■	■	■
	Water purification	■	■	■	■	■	■	■	
	Storm surge/protection	■	■	■	■	■	■		
	Flood control	■	■	■	■	■			
Cultural	Tourism & recreation	■	■	■	■	■	■	■	
	Ecotourism	■		■			■		
Other	Minerals		■	■	■	■	■	■	
	Energy (Solar energy, Wind, Tidal)	■	■	■		■	■	■	
	Shipping								

**Grey cells denote relevant ecosystem type for an ecosystem service.*

3.40 A brief description of each of the services is given in Table 3.9. As an initial step, it is suggested to estimate these services in physical terms and subsequently based on the data availability, monetary estimates may be attempted. The list of services is not exhaustive; however, these services are found to be some of the most relevant and estimable ones in light of data availability.

Table 3.9: Brief description of selected Ecosystem Services

Type of Services	Ecosystem Service	Description
Provisioning Service	Fish Provisioning	Fish provisioning services are the ocean ecosystem contributions to the growth of fish that are captured in uncultivated production contexts by economic units for various uses, primarily food production.
	Food (other than fish) Provisioning (Seaweed, salt)	These are the contributions of ocean ecosystems in production of biomass primarily used for food such as seaweed and salt.
	Fuel/Firewood	Fuel and Firewood provisioning services are the ocean ecosystem contributions to the growth of trees and other woody biomass in both cultivated (plantation) and uncultivated production contexts that are harvested by economic units for fuel and energy.
	Desalination	These may be defined as the ecosystem's contribution in desalination of seawater.
Regulating Services	Carbon sequestration (by biomass)	The carbon sequestration component of the service reflects the ability of ecosystems to remove carbon from the atmosphere. This may involve storage within an ecosystem asset, e.g., a mangrove or wetland. Here, carbon storage in Biomass is considered.
	Carbon storage in soil	This service indicates the carbon sequestration in soil relating to ocean ecosystems. Carbon sequestration in soil is the long-term storage of carbon in soils of ocean related ecosystems.
	Water purification	Water purification is one among the regulating services which are the benefit provided by ecosystem processes that moderate natural phenomena. Water purification services are the ecosystem contributions to the restoration and maintenance of the chemical condition of water through the breakdown or removal of nutrients and other pollutants by ecosystem components that mitigate the harmful effects of the pollutants on human use or health.
	Storm surge protection (Storm Mitigation)	Storm mitigation services are the ecosystem contributions of vegetation including linear elements, in mitigating the impacts of wind, sand and other storms (other than water related events) on local communities.
	Flood control	Coastal flood control (protection) services are the ecosystem contributions of linear elements in the

		seascape, for instance coral reefs, sand banks, dunes or mangrove ecosystems along the shore, in protecting the shore and thus mitigating the impacts of tidal surges or storms on local communities.
Cultural Services	Tourism & recreation	Recreation-related services are the ecosystem contributions, in particular through the biophysical characteristics and qualities of ecosystems, that enable people to use and enjoy the environment through direct, *in-situ*, physical and experiential interactions with the environment.
Other Flows/Supporting Services	Minerals Provisioning	These services are the contributions of ecosystems in production of Minerals.
	Energy (Solar energy, Wind, Tidal)	These services include energy outputs of ocean ecosystems. The ecosystem services are contribution of ecosystems to the benefits derived in form of energy outputs.
	Shipping	The ocean water and coastal ecosystems are vital for shipping industry. They provide a transportation medium for shipping.

Ocean Assets

3.41 SEEA EA defines ecosystem assets as contiguous spaces of a specific ecosystem type characterized by a distinct set of biotic and abiotic components and their interactions. Ocean Ecosystem Asset Accounts record the stocks and flows of biotic and abiotic natural assets related to oceans. Ocean ecosystem assets are recorded in a combination of accounts for individual environmental assets (minerals, energy and aquatic resources, e.g., fish stocks) from the SEEA CF and for ecosystem assets (such as wetlands, coral reefs) from the SEEA EA. The ocean ecosystem assets such as mangrove, corals etc. may be characterized by their extent and their condition. For the individual natural assets such as sand, minerals quantity and quality may be specified based on their characteristics. Ecosystem accounting incorporates recording entries for ecosystem assets based on their exchange values, together with associated changes in the value of ecosystem assets over an accounting period. Most of the assets may be recorded in both physical and monetary units. The broad framework for the Ocean Asset (quantity and quality) Accounts in physical units are given in Table 3.10 and Table 3.11.

Table 3.10: Framework for Ocean Asset Accounts

Unit: Physical

Ocean Asset	Opening Stock at time (T1)	Addition to Stock	Reduction in Stock	Closing Stock at time (T2)
Environmental Assets				
Asset 1				
Asset 2				
Asset 3				
…				
Ecosystem Assets				
Asset 1				
Asset 2				
Asset 3				
…				

Table 3.11: Framework for Ocean Asset Accounts (Quality)

Unit: Physical

Ocean Asset	Condition of Stock at time (T1)	Condition of Stock at time (T2)	Reference Value (quantitative/qualitative)	Changes w.r.t Reference (quantitative/qualitative)
Environmental Assets				
Asset 1				
Asset 2				
…				
Asset n				

Conclusion

3.42 The Government of India has taken several initiatives to harness the potential of ocean resources in sustainable manner. Some of them are– O-SMART (Ocean-Services, Modelling, Application, Resources and Technology), Deep Ocean Mission (DOM), Marine Spatial Planning, Blue Economy, Coastal Regulation Zone Management, and Marine Protected Area.

3.43 The Ocean Ecosystem Account is relevant while addressing several dimensions of ocean policy challenges like measuring blue economy, sustainability of ocean economic activities, synergy with area-based planning/ management, designing policy/ institutional reforms to manage the transition to a Blue Economy, etc. Therefore, the area of ocean accounting has a huge ambit. With the limited data availability, some parameters of ocean extent and conditions have been covered and compiled in the current publication; however, the scope ahead is enormous.

3.44 The services provided by the oceans and the valuation of these services is a crucial part of the Ocean Accounts and may be taken up in consultations with the stakeholder Ministries/agencies. Also, valuation of the ocean assets which includes minerals, fish stock, other aquatic resources, timber, dolphins, sea turtles etc. is another area which requires further exploration.

3.45 The Ocean Accounts when viewed in the light of the ocean pressures such as water emissions, solid wastes, waste water flows and air emissions flows, provides useful insights into the various threats to the ocean conditions and their services. These then form the basis for policy formulation for sustainable coast management.

3.46 The Framework for Ocean Ecosystem Accounts developed in the Chapter has enormous scope for modification/ updation. With more discussions with the stakeholders, the framework is likely to evolve to a further improved version. Also, addressing the data gaps will help in providing true glimpse of the state of oceans in India.

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Chapter 4

Soil Nutrient Index

Chapter 4

Soil Nutrient Indices

To forget how to dig the earth and tend the soil is to forget ourselves

- Mahatma Gandhi

Introduction

4.1 Soil may be defined as a thin layer of earth's crust which serves as a natural medium for the growth of plants[38]. It is the unconsolidated mineral matter that has been subjected to, and influenced by genetic and environmental factors – parent material, climate, organisms, and topography, all acting over a period of time. Soil differs from the parent material in the morphological, physical, chemical and biological properties. Also, soils differ among themselves in some or all the properties, depending on the differences in the genetic and environmental factors. Thus, some soils are red, some are black; some are deep and some are shallow; some are coarse-textured and some are fine-textured. They serve in varying degree as a reservoir of nutrients and water for crops, provide mechanical anchorage and favourable tilth. The components of soils are mineral material, organic matter, water, and air–the proportions of which vary and which together form a system for plant growth.

4.2 The term 'Soil', derived from the Latin word 'solum' is commonly defined as the top layer of the earth's crust, formed by mineral particles, organic matter, water, air and living organisms. Rocks are the chief sources for the parent materials over which soils are developed. Soil is a unique and complex ecosystem[39]. Soil, and the organisms living within it, provides an array of ecosystem goods and services that are vital for life on the planet. The soil ecosystem is at the core of other terrestrial ecosystems, such as croplands, forests, etc. and it plays a crucial role in agricultural, socioeconomic, and climatic change related issues structural medium for supporting the terrestrial biosphere and human infrastructure.

4.3 Soil is at the same time a habitat and a unique ecosystem, a blend of living (organic) and non-living matter (essentially minerals and rock fragments). Soil plays a vital role in all terrestrial ecosystems and particularly so in natural ecological cycles

[38] https://agriculture.uk.gov.in/files/Soil_Testing_Method_by_Govt_of_India.pdf
[39] https://publications.jrc.ec.europa.eu/repository/bitstream/JRC120383/eu_ecosystem_assessement_final.pdf

(carbon, nitrogen, oxygen, water and nutrients). They also provide a range of ecosystem services including the provision of nutrients from decomposition of organic residues, water filtration, buffering of contaminants, providing building material, controlling the discharge of excess rain water, serving as a buffer to protect the delicate plant roots from drastic fluctuations in temperature, storing organic carbon etc. In fact, soils are a source of many current medicines, probiotics and antibiotics.

4.4 Four basic elements found in most soils are: air, water, mineral particles, and organic matter or carbon. With more carbon in them than in the atmosphere and terrestrial vegetation put together, soils constitute a significant carbon sink. Because it holds nitrogen, phosphorus, and a variety of other nutrients, soil organic carbon is the foundation of any soil and is essential to preserving fertility. It facilitates gaseous exchange, root development, and the enhancement of soil qualities such as its ability to hold water.

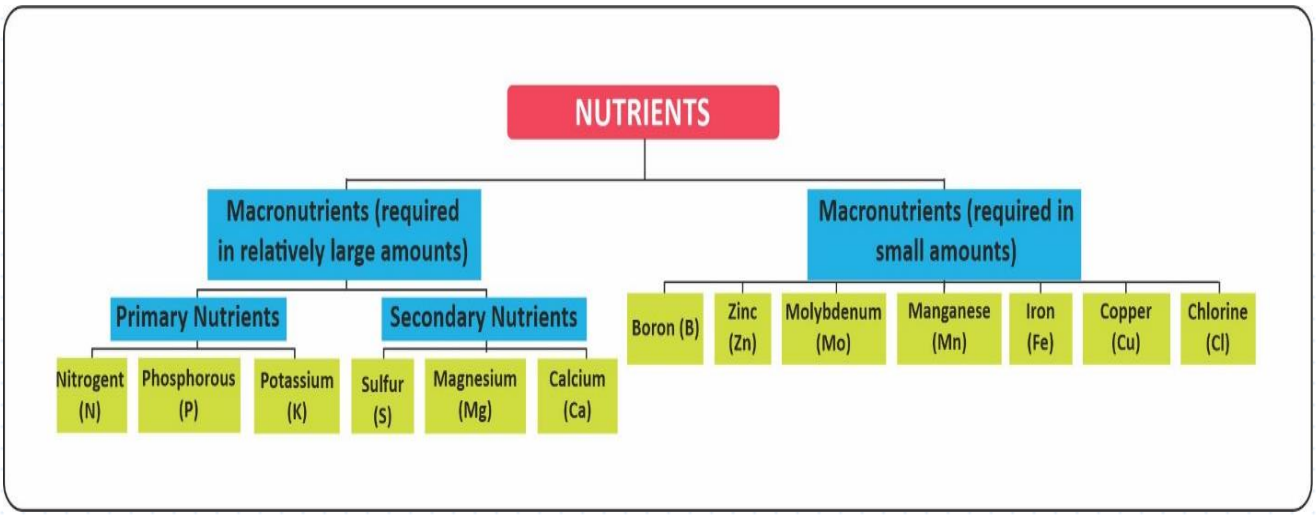
4.5 Soils are under pressure from a range of drivers, reflecting diverse competition for land. These include urban expansion, population growth, intensive agriculture and industrial pollution. The ability of soil to maintain or improve the quality of water and air, support plant and animal health and sustain plant and animal productivity is known as soil health. As per the Food and Agriculture Organization (FAO), it is estimated that 95% of our food is directly or indirectly produced on our soils[40] and it can take up to 1000 years to form just 2-3 cm of soil[41]. Healthy soils supply the essential nutrients, water, oxygen and root support that our food-producing plants need to grow and flourish. Nutrient loss severely affects humankind , impacting its well-being. Therefore, in order to maximize the effectiveness of nutrients applied to raise agricultural output, it is important to regularly monitor changes in the soil and study the dynamics of the soil.

4.6 Soil is a major source of nutrients required for plants' growth. The complex balance of physical, biological and chemical qualities determines the fertility of the soil. There are two types of nutrients found in soil: *Macronutrients* and *Micronutrients*. Macronutrients are elements which plants require in relatively large amounts whereas micronutrients are those which plants require in much smaller amounts. Macronutrients are further classified as primary or secondary. Phosphorus, Potassium,

[40] https://openknowledge.fao.org/server/api/core/bitstreams/4fb89216-b131-4809-bbed-b91850738fa1/content
[41] https://www.fao.org/about/meetings/soil-erosion-symposium/key-messages/en/

and Nitrogen are the three main macronutrients. Plant nutrition content, plant enzymes and biochemical processes, and plant cell integrity are all influenced by these nutrients. In comparison to primary macronutrients, secondary nutrients are often required in moderate amounts. Sulphur is classified as a secondary macronutrient. Zinc, Manganese, Iron, Copper, Manganese, Molybdenum, and Chlorine are examples of micronutrients. The Figure 4.1 below shows the different nutrients available in the soil.

Figure 4.1 Nutrients Available in Soil



growing plant. Toxicity occurs when a nutrient is in excess of plant needs and decreases plant growth or quality.

4.8 Physical parameters of soil like pH and Electrical Conductivity also play a significant role in soil fertility. For instance, most plant nutrients are optimally available to plants within the 6.5 to 7.5 soil pH range, and this range of pH is generally very compatible with plant root growth. On the other hand, soil Electrical Conductivity (EC) is an indicator of nutrient availability and loss, soil texture and available water capacity.

Soil Types in India

4.9 The soils of India can be classified into different groups, such as black, red, laterite, alluvial saline, desert, alkaline, forest, hilly, and peaty and marshy. Table 4.1 provides a brief description of major types of soil found in India. Figure 4.2 shows the distribution of different types of soil in India.

Table 4.1: Different Types of Soil in India

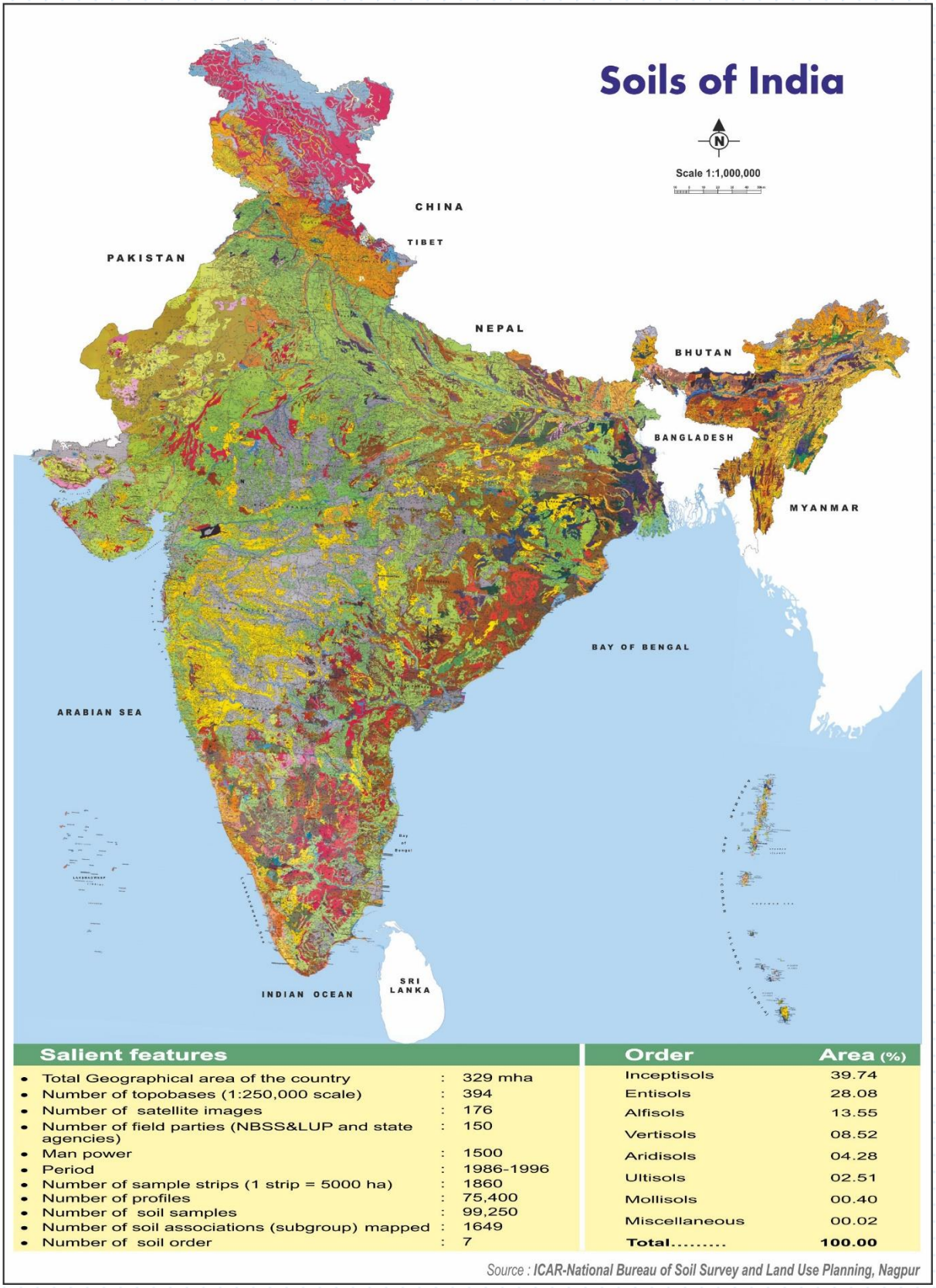
Soil Type	Characteristics
Alluvial Soil	Alluvial soil develops on alluvium of river basin and river valleys. The soils are extensively distributed in the Indo-Gangetic plains and Brahmaputra valley. They also occur in the coastal and deltaic regions. These soils are ideal to grow all the crops dominantly grown in the region (wheat, maize, sugarcane, pulses, oilseed etc.) and cultivation of horticultural crops. They are fertile and most productive soils. The soil greatly differs in colour, texture, drainage, presence or absence of sodium salts, etc.
Black Soil	Black Soil is dark black to grey in colour. The black soils are generally clayey, in texture, deep and impermeable. They swell greatly and become sticky when wet in the rainy season. In the dry season, the moisture evaporates, the soil shrinks and develops wide cracks. The soil is rich in bases, lime and calcium. The pH of black soil is ranges between 7.2 and 8.5. It has neutral to slightly alkaline reactions. The soil is deficient in nitrogen, phosphate and organic matter but rich in potash, calcium and magnesium. Black soil ranges from heavy clay (ill-drained) to loams (well- drained). Black soil is also known as "Regur Soil" or the "Black Cotton Soil" as cotton crop are dominantly grown in the black soil region.
Red Soil	Red soils formed from weathered material of metamorphic rocks. Soils can vary from reddish brown to reddish yellow due to their high iron content. It is porous and friable, neutral to acidic in reaction. Nitrogen, phosphate, lime and humus content are very low in this soil. In general, red soils possess some characteristics of good growing soil.
Lateritic Soil	Laterite soil is formed in areas receiving high rainfall with alternating wet and dry spells. The name "Lateritic" has been derived from the Latin word "later" which means brick. This soil is red to reddish-yellow in colour. Heavy rains cause leaching of bases and silica from the surface of the soil. The soil shows acidic character with pH of 5–6 and is poor in nitrogen, phosphorus, potash, magnesium and lime. Such soil is porous and well- drained with poor water-holding capacity.

Soil Type	Characteristics
Desert (Arid) Soil	Desert soils are sandy to gravelly in texture, and is found in low rainfall areas, aridic climatic condition. These soils are alkaline in nature with pH value nearly 7.8 to 8.7 and is less productive. It is rich in soluble salts, and poor in nitrogen and organic matter content. The physical conditions of the soil are unfavourable as it has low water-holding capacity due to high sand content.
Forest and Hill Soil	These soils are found in forest and hilly regions. These soils are coarser texture in upper slopes and finer in lower/valley sides. The texture of the soil depends on the mountain environment where they are found. The Generally, these soils are stony, low in bases and slightly acidic in reaction and infertile for the production of crops. The soils found in the lower valleys are fertile.
Saline and Alkali soil	Saline soil shows white incrustation of salts (chlorides and sulphates of sodium, calcium and magnesium) on the surface due to high evaporation during summers. It is also called 'white alkali soil'. Such soil is, generally, infertile and poor in drainage. Such soil is formed as a result of saline irrigation water and over-irrigation for a long time, which raises the water table of the soil. Alkaline soil is rich in carbonates and bicarbonates of sodium and is non-porous. It is also called 'black alkali' or 'Usar' soil.
Peaty and Marshy soil	This soil is highly acidic in nature and black in colour. Excessive wetness of the soil causes decay and degradation of dead vegetation, forming a layer of partially decomposed organic matter, resulting into peaty and marshy soil.

Source: Importance of Soil: Testing & Treatment, Ministry of Education[42]

[42] https://soilhealth.dac.gov.in/files/Manual/Updated_140723FinalDraftManualClasses6_8.pdf

Figure 4.2: Soil Distribution in India



Salient features		
• Total Geographical area of the country	:	329 mha
• Number of topobases (1:250,000 scale)	:	394
• Number of satellite images	:	176
• Number of field parties (NBSS&LUP and state agencies)	:	150
• Man power	:	1500
• Period	:	1986-1996
• Number of sample strips (1 strip = 5000 ha)	:	1860
• Number of profiles	:	75,400
• Number of soil samples	:	99,250
• Number of soil associations (subgroup) mapped	:	1649
• Number of soil order	:	7

Order	Area (%)
Inceptisols	39.74
Entisols	28.08
Alfisols	13.55
Vertisols	08.52
Aridisols	04.28
Ultisols	02.51
Mollisols	00.40
Miscellaneous	00.02
Total.....	**100.00**

Source : ICAR-National Bureau of Soil Survey and Land Use Planning, Nagpur

Linkages of Soil with the SDGs

4.10 Soil, being critical to achieving Sustainable Development Goals (SDGs) of the UN, strengthening understanding of its properties and processes at the national and regional scales is imperative. The necessity to realize SDGs by 2030 also inspires a greater sense of responsibility and care for soils. Sustainable management of soil health is important to achieving several SDGs.

4.11 Zero Hunger (Goal 2: End hunger, achieve food security and improved nutrition and promote sustainable agriculture) is the most straightforward link that connects soils, food production, and healthy living. Moreover, improving soil quality is an integral step towards achieving the other SDGs such as No Poverty (Goal 1: End poverty in all its forms everywhere), Good Health and Well-being (Goal 3: Ensure healthy lives and promote well-being for all at all ages), Clean Water and Sanitation (Goal 6: Ensure availability and sustainable management of water and sanitation for all), Climate action (Goal 13: Take urgent action to combat climate change and its impacts), and Life on land (Goal 15: Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss).

4.12 These SDGs rely considerably on plant production which depend on soil processes. Pertinent among soil processes are water movement, heat transfer, sorption and physical filtration, ion exchange, and biochemical and biophysical transformations.

Soil Health Card Scheme

4.13 Soil testing schemes are the first step towards determining nutrient status of soil and to make efficient soil management decisions. Soil testing helps ascertain the status of various nutrients, soil fertility level, pH, etc. It is important to know the fertility status and physical properties of soil for maximum production and rational soil management. By knowing the nutrient status of the soil, farmers can apply fertilisers and soil amendments more precisely, matching the specific needs of the crops or plants being grown.

4.14 Soil health and quality remain a matter of great concern for the Government of India. The Soil Health Card (SHC) scheme is a flagship programme of the Ministry of Agriculture and Farmers Welfare launched in February 2015, under which uniform norms are followed across different States for soil analysis to diagnose fertility-related constraints and make site-specific fertilizer recommendations. Two Cycles of this

flagship programme were conducted – Cycle I during 2015-17 and Cycle II during 2017-19. During the financial year 2019-20, the Model Villages Programme has been taken up under Soil Health Card (SHC) Scheme on a pilot basis. This programme includes adopting one village per block for landholding-based soil sampling, testing & distribution of Soil Health Cards and subsequently conducting SHC based demonstrations in each model village to scale awareness amongst the farmers across India. In the Model Village Programme, soil samples collection has been taken up at individual farm holdings with farmers' participation instead of sample collection at grids. The scheme is managed by the Integrated Nutrient Management (INM) Division in the Ministry of Agriculture and Farmers Welfare, Government of India. This scheme has been merged as Soil Health & Fertility of Rashtriya Krishi Vikas Yojana (RKVY)[43] from the year 2022-23.

4.15 Under the Soil Health Card Scheme, soil health condition is assessed with respect to twelve important soil parameters, namely:

a. Nitrogen (N), Phosphorus (P), Potassium (K) – *primary macronutrients*;
b. Sulphur (S) – *secondary macronutrients*;
c. Zinc (Zn), Iron (Fe), Copper (Cu), Manganese (Mn), Boron (B) – *micronutrients*;
d. pH, Electrical Conductivity (EC), Organic Carbon (OC) – *physical parameters*.

The main objective of the scheme is to assist states in promoting 'Integrated Nutrient Management' through judicious use of chemical fertilizers including secondary and micronutrients in conjunction with organic manures and bio-fertilizers for improving soil health and its productivity.

4.16 Under the guidelines set forth in the scheme's operational rules, soil samples taken from various places undergo analysis in the Soil Testing Labs. In order to register soil samples, record soil test findings, create Soil Health Cards (SHCs) and track advancement, the results are uploaded on the national Soil Health Card website: www.soilhealth.dac.gov.in. The SHC contains advisory based on the soil nutrient status of a farmer's holding. It shows recommendations on the dosage of different nutrients needed. Further, it provides advice to the farmers on the fertilizers[44] and their quantities to be applied and also the soil amendments to be undertaken in order

[43] https://soilhealth.dac.gov.in/files/Implementation.pdf
[44] https://soilhealth.dac.gov.in/files/FAQ_Final_English.pdf

to realize optimal yields. The Government of India scheme "Soil Health and Fertility", revamped in 2023, has made some technological interventions in the New Soil Health Card Scheme. The Soil Health Card portal has been revamped and integrated with a Geographic Information System (GIS) system so that all the test results are captured and seen on a map[45]. Following frequent soil observations, the authorities give the farmers a report every three years. Farmers have the provision to choose the kinds of crops to grow for generating more revenue and other corrective actions by having their soil examined.

Soil Nutrient Index

4.17 Indices are used for spatiotemporal comparison. Soil Nutrient Index (N.I) is one such measure of nutrient supplying capacity of soil to plants (Singh et al., 2016)[46]. Soil nutrients refer to nutrients that can be directly or indirectly absorbed and utilized by the plants. It is the material basis of soil fertility and one of the important indicators for evaluating soil quality.

4.18 The Nutrient Index approach introduced by Parker et al. (1951)[47] has been adopted and modified by several researchers. The Parker Nutrient Index is widely used method to assess soil fertility. The method for "Nutrient Indexing" has been discussed in detail in the Manual on "Soil Testing in India" published by the Ministry of Agriculture, Government of India in 2011[48]. The Nutrient Index, as described in the said manual, is compiled using the assessment of soil fertility classified in three classes, i.e., low, medium and high. The nutrient index can then be calculated based on the information collected on the level of each nutrient using the following formula:

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

where,

N_L: Indicates the number of samples falling in the 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 the high class of nutrient status

N_T: Indicates the total number of samples analysed in a given area ($N_L + N_M + N_H$).

[45] https://pib.gov.in/PressReleaseIframePage.aspx?PRID=1947891#:~:text=Soil%20Health%20Card%20scheme%20has,2023.

[46] 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), 1-9.*

[47] 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), 105-112

[48] Manual on "Soil Testing in India", 2011, Ministry of Agriculture & Farmers Welfare, Government of India. https://agriculture.uk.gov.in/files/Soil_Testing_Method_by_Govt_of_India.pdf

The interpretation of N.I. based on the value is given in Table 4.2 below:

Table 4.2: Interpretation of the Nutrient Index

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

4.19 However, it is crucial to understand that these values are index numbers and may not be the direct measures of actual plant-available nutrients in the soil. The intensity and distribution of sampling location may also affect the indices and are also essential for interpreting index value for a region.

Soil Nutrient Index: State-wise Analysis

4.20 The current assessment of Soil Nutrient Index for States/UTs have been made on the basis of information on the soil samples collected under Soil Health Card Scheme for the year 2023-24 and received from MoAFW. The trend of Soil Fertility status of Indian Soil has been analysed in the 2019 and 2021 issues of this publication and information collected under Soil Health Card Scheme for Cycle I (2015-17) & Cycle II (2017-19) and Model Village Programme (2019-20) were utilized for the purpose.

4.21 The status of macronutrients has been categorized into three categories in the Soil Health Card database, i.e., low, medium, high, while the status of micronutrients has been categorized into two categories, i.e., sufficient and deficient. For the sake of calculation of the aggregate nutrient index, in case of micronutrients and sulphur, "deficient" category samples are taken under "low class of nutrient status", and "sufficient" category samples are taken under "medium class of nutrient status".

4.22 The state-wise Soil Nutrient Index for 2023-24 is given in the Table 4.3. Figure 4.3 gives the state-wise distribution of some of the main soil nutrients during 2023-24. It may be noted that since the design for collection of soil samples is different for the various round of data collection under Soil Health Card Scheme, the State-wise Index is not strictly comparable across years. The state wise number of soil samples as on 01/07/2024 based on which the Soil Nutrient Index have been calculated are given in

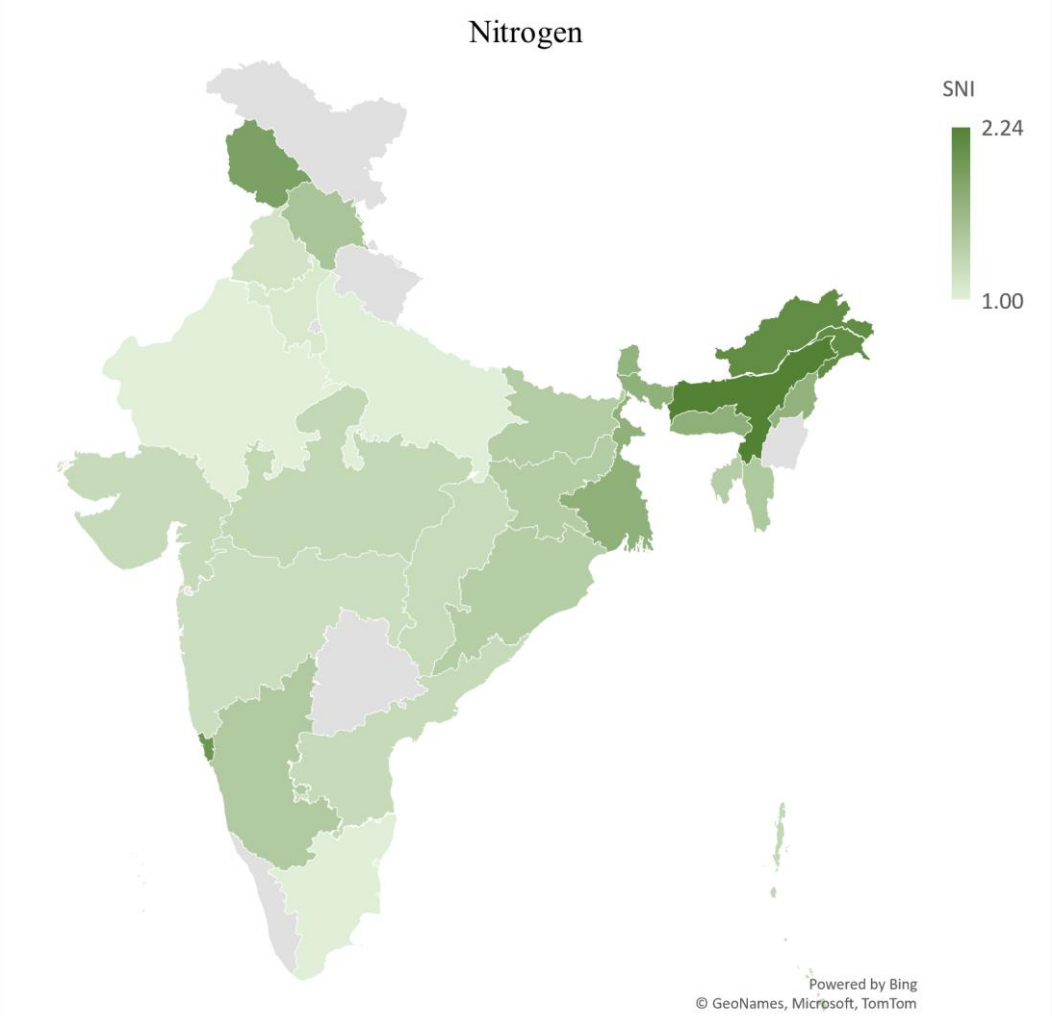
Annexure 4.1. The state-wise distribution of the Soil Nutrient Index for 2023-24 is presented in Table 4.4.

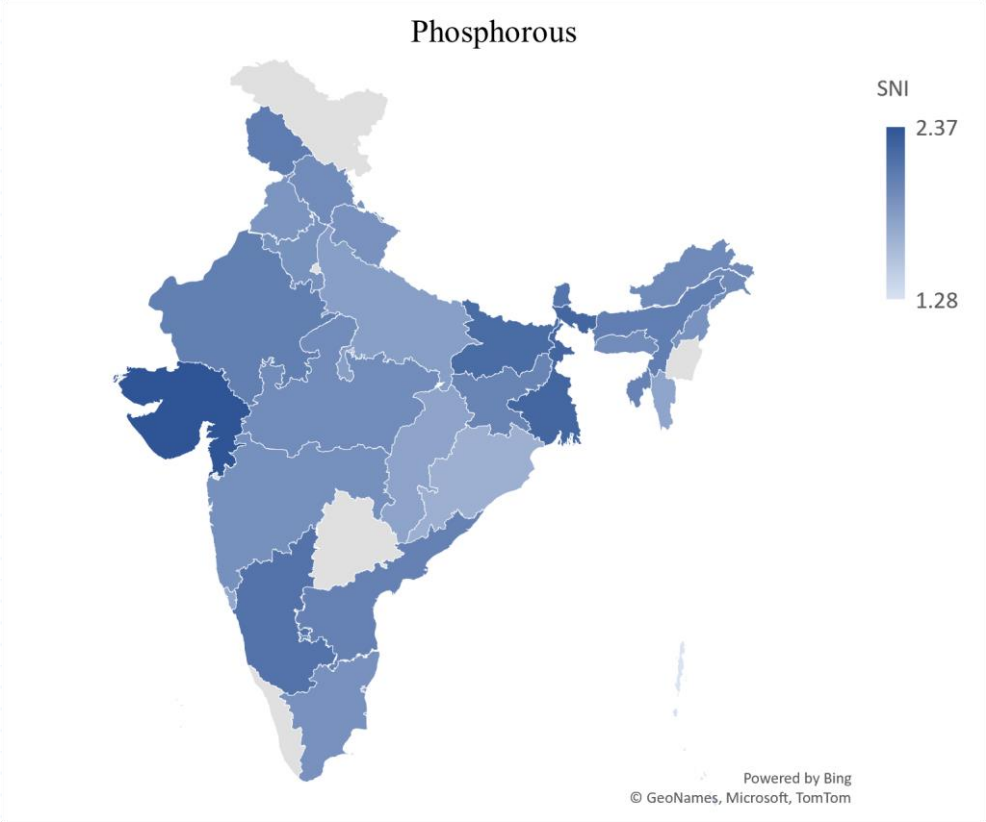
Table 4.3: State-wise Nutrient-wise Soil Nutrient Indices-2023-24

Sl. No.	State/UT	Soil Nutrient Index									
		Macronutrients			Micronutrients						OC
		Nitrogen	Phosphorous	Potassium	Copper	Boron	Sulphur	Iron	Zinc	Manganese	
1	Andhra Pradesh	1.24	2.02	2.71	1.97	1.92	1.85	1.71	1.66	1.90	1.41
2	Arunachal Pradesh	2.12	1.95	2.41	1.96	1.88	1.70	1.92	1.80	1.69	1.85
3	Assam	2.24	2.05	2.20	2.00	1.00	2.00	2.00	1.93	1.78	1.85
4	Bihar	1.40	2.19	2.64	1.98	1.97	1.79	1.93	1.75	1.93	1.68
5	Chhattisgarh	1.23	1.76	2.69	1.96	1.97	1.62	1.89	1.49	1.97	1.49
6	Goa	2.01	1.73	2.44	1.98	1.80	1.67	1.98	1.74	1.96	1.85
7	Gujarat	1.24	2.37	2.82	1.94	1.83	1.79	1.71	1.64	1.91	1.67
8	Haryana	1.08	1.89	2.28	1.93	1.62	1.90	1.72	1.79	1.74	1.23
9	Himachal Pradesh	1.49	1.94	2.49	1.99	2.00	1.93	1.95	1.94	1.86	1.92
10	Jharkhand	1.40	1.99	2.22	1.97	1.95	1.86	1.95	1.80	1.91	1.63
11	Karnataka	1.43	2.14	2.52	1.96	1.86	1.70	1.49	1.44	1.85	1.52
12	Madhya Pradesh	1.27	1.94	2.65	1.91	1.95	1.81	1.74	1.51	1.92	1.73
13	Maharashtra	1.20	1.91	2.80	1.96	1.81	1.48	1.41	1.48	1.87	1.46
14	Meghalaya	1.72	1.94	2.15	1.50	1.74	1.64	1.53	1.41	1.56	1.99
15	Mizoram	1.44	1.75	1.87	2.00	2.00	1.01	1.01	2.00	1.00	1.72
16	Nagaland	1.70	1.90	2.34	1.93	1.93	1.52	1.83	1.83	1.75	1.86
17	Odisha	1.39	1.67	2.39	1.97	1.79	1.86	1.96	1.59	1.98	1.57
18	Punjab	1.14	1.87	1.66	1.99	2.00	1.84	1.83	1.88	1.43	1.63
19	Rajasthan	1.00	2.03	2.79	1.96	1.98	1.92	1.49	1.42	1.92	1.18
20	Sikkim	1.68	2.12	2.48	1.93	1.71	1.84	1.89	1.96	1.81	1.83
21	Tamil Nadu	1.01	1.90	2.61	1.97	1.89	1.66	1.61	1.55	1.73	1.12
22	Tripura	1.39	2.01	2.11	1.96	2.00	1.95	2.00	1.48	1.99	1.68
23	Uttarakhand		1.90	2.32	1.97	1.97	1.79	1.91	1.90	1.89	1.79
24	Uttar Pradesh	1.02	1.80	2.37	1.96	1.97	1.65	1.73	1.65	1.87	1.13
25	West Bengal	1.71	2.23	2.44	1.97	1.87	1.62	1.99	1.76	1.87	1.73
26	Andaman & Nicobar	1.27	1.28	1.38	1.93	2.00	1.01	2.00	1.79	2.00	1.03
27	Jammu And Kashmir	1.89	2.06	2.52	1.90	1.94	1.79	1.62	1.69	1.71	1.81
28	Puducherry	1.01	1.82	1.90	1.99			1.92	1.95	1.97	

Remark: Blank Cells denote either the soil health card samples have not been collected entirely or for the selected nutrient in the States/UTs.
Data as on 01/07/2024.

Figure 4.3: Soil Nutrient Index for Nitrogen, Phosphorous & Potassium for 2023-24




Phosphorous
SNI
2.37
1.28
Powered by Bing
© GeoNames, Microsoft, TomTom

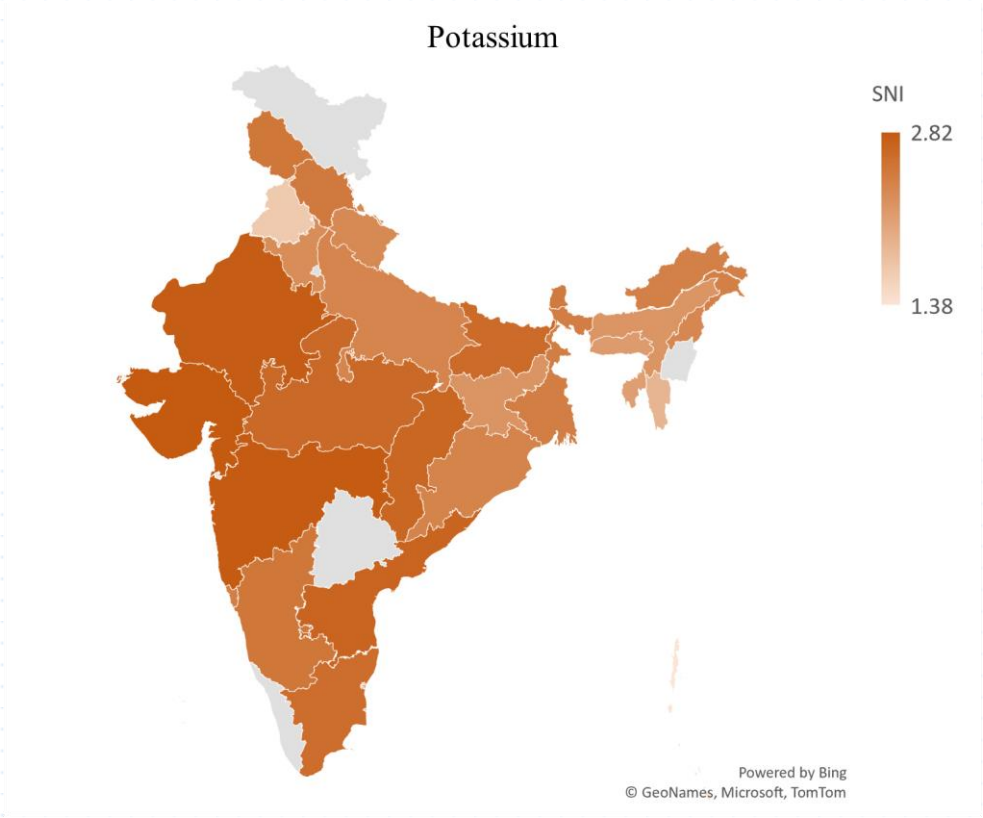

Potassium
SNI
2.82
1.38
Powered by Bing
© GeoNames, Microsoft, TomTom

Table 4.4: State-wise Distribution of Soil Nutrient Indices 2023-24

S.No.	State	Low	Medium	High
1	Andhra Pradesh	N, Zn, OC	P, B, S, Fe, Mn, Cu	K
2	Arunachal Pradesh		N, P, B, S, Fe, Zn, Mn, OC, Cu	K
3	Assam	B	N, P, K, S, Fe, Zn, Mn, OC, Cu	
4	Bihar	N	P, B, S, Fe, Zn, Mn, OC, Cu	K
5	Chhattisgarh	N, S, Zn, OC	P, B, Fe, Mn, Cu	K
6	Goa		N, P, B, S, Fe, Zn, Mn, OC, Cu	K
7	Gujarat	N, Zn	B, S, Fe, Mn, OC, Cu	P, K
8	Haryana	N, B, OC	P, K, S, Fe, Zn, Mn, Cu	
9	Himachal Pradesh	N	P, B, S, Fe, Zn, Mn, OC, Cu	K
10	Jharkhand	N, OC	P, K, B, S, Fe, Zn, Mn, Cu	
11	Karnataka	N, Fe, Zn, OC	P, B, S, Mn, Cu	K
12	Madhya Pradesh	N, Zn	P, B, S, Fe, Mn, OC, Cu	K
13	Maharashtra	N, S, Fe, Zn, OC	P, B, Mn, Cu	K
14	Meghalaya	Cu, S, Fe, Zn, Mn	N, P, K, B, OC	
15	Mizoram	N, S, Fe, Mn	P, K, B, Zn, OC, Cu	
16	Nagaland	S	N, P, B, Fe, Zn, Mn, OC, Cu	K
17	Odisha	N, Zn, OC	P, B, S, Fe, Mn, Cu	K
18	Punjab	N, K, Mn, OC	P, B, S, Fe, Zn, Cu	
19	Rajasthan	N, Fe, Zn, OC	P, B, S, Mn, Cu	K
20	Sikkim		N, P, B, S, Fe, Zn, Mn, OC, Cu	K
21	Tamil Nadu	N, S, Fe, Zn, OC	P, B, Mn, Cu	K
22	Tripura	N, Zn	P, K, B, S, Fe, Mn, OC, Cu	
23	Uttar Pradesh	N, S, Zn, OC	P, B, Fe, Mn, Cu	K
24	Uttarakhand		P, K, B, S, Fe, Zn, Mn, OC, Cu	
25	West Bengal	S	N, P, B, Fe, Zn, Mn, OC, Cu	K
26	Andaman & Nicobar	N, P, K, S, OC	B, Fe, Zn, Mn, Cu	
27	Jammu & Kashmir	Fe	N, P, B, S, Zn, Mn, OC, Cu	K
28	Puducherry	N	P, K, Fe, Zn, Mn, Cu	

Nutrients - N: Nitrogen; P: Phosphorus; K: Potassium; S: Sulphur; Zn: Zinc; Fe: Iron; Cu: Copper; Mn: Manganese, B: Boron; OC: Organic Carbon.
Level of Nutrients: Low: <1.67; Medium: 1.67-2.33; High: >2.33
Source: Calculated using data received from Ministry of Agriculture & Farmers Welfare as on 01/07/2024

Soil Nutrient: pH

4.23 The soil pH[49] is the negative logarithm of the active hydrogen ion (H+) concentration and it is an indicator of the level of acidity or alkalinity of soil. It is an important characteristic of soil as it significantly influences the availability of nutrients

[49] https://agriculture.uk.gov.in/files/Soil_Testing_Method_by_Govt_of_India.pdf

to crops. Change in pH may affect nutritional balance[50] in the soil as well as microbial activities in it. The following Table 4.5 provides the type of soil on the basis of pH:

Table 4.5: Types of Soil on the basis of pH values

pH Range	Soil Type
<4.6	Extremely Acidic
4.6-5.5	Strongly Acidic
5.6-6.5	Moderately Acidic
6.6-6.9	Slightly Acidic
7.0	Neutral
7.1-8.5	Moderately alkaline
>8.5	Strongly alkaline

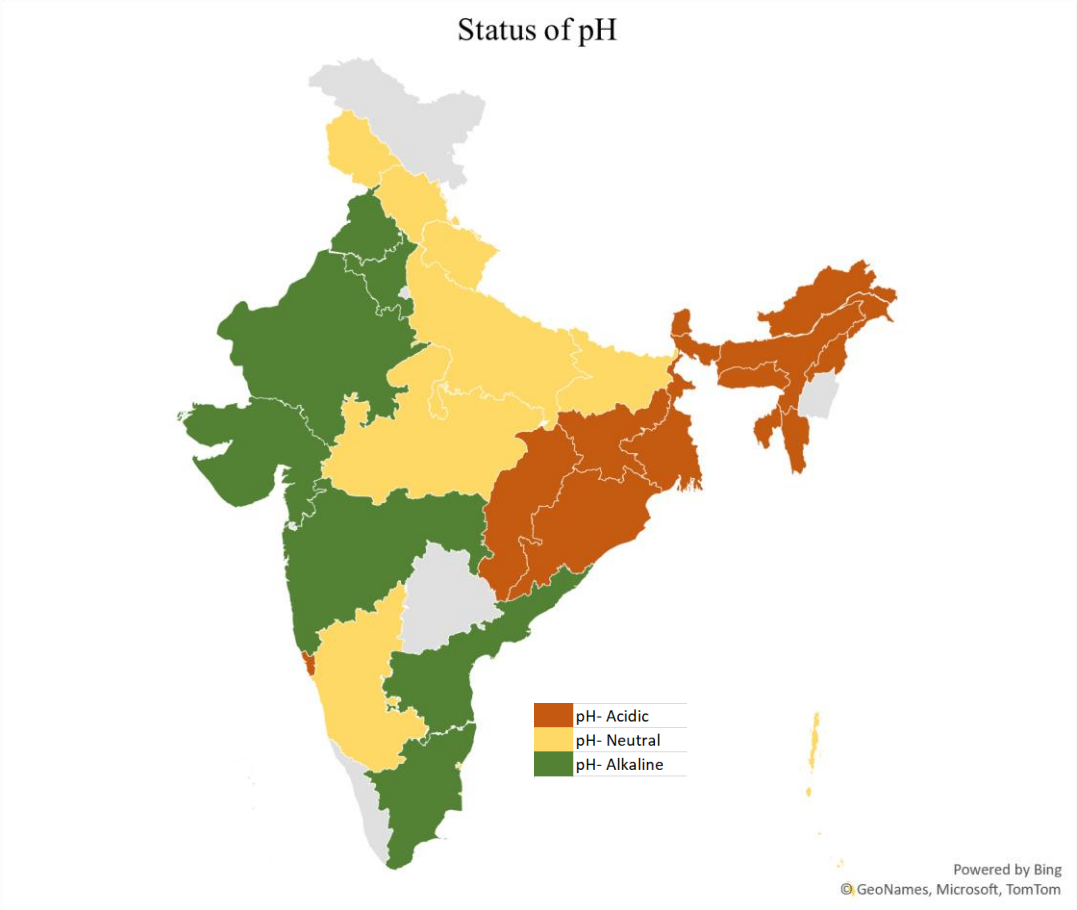
4.24 Most nutrient elements are available in the pH range of 5.5 to 6.5. The acidic soils need to be limed before they can be put to normal agriculture production. The alkali soils need to be treated with gypsum to remove the excessive content of sodium. The pH of alkaline soils[51] can be decreased by using acidifying fertilizers or organic materials. Some of the effects of soil pH on plant growth are:

- In general, soil pH 6.5 to 7.5 is considered optimum for maximum availability of plant nutrients;
- The development of strongly acidic soils (less than 5.5 pH) can result in poor plant growth as a result of one or more of the factors namely, aluminium toxicity, manganese toxicity, calcium deficiency, magnesium deficiency, and low levels of essential plant nutrients such as phosphorous and molybdenum. Also, acidic levels are unwelcoming to beneficial soil bacteria;
- Alkaline soils impede the availability of nutrients like iron, manganese, copper, zinc, and also phosphorous. Plants dependent on high levels of iron evergreens in particular perform poorly in alkaline soils.

4.25 Generally agricultural crops are varied in terms of suitability for soil pH range. The following figure shows the status of pH across the country based on the number of samples collected in the Soil Health Card Scheme under each category.

[50] https://soilhealth.dac.gov.in/files/Manual/Updated_140723FinalDraftManualClasses6_8.pdf
[51] https://www.researchgate.net/publication/330729435_Introductory_Chapter_Relevance_of_Soil_pH_to_Agriculture#fullTextFileContent

Figure 4.4: Status of pH in the Soil



Soil Nutrient: Electrical Conductivity

4.26 The Electrical Conductivity (EC) is a measure of the ionic transport in a solution between the anode and cathode. EC is normally considered to be a measurement of the dissolved salts in a solution. In agriculture, EC has been used principally as a measure of soil salinity[52]; however, in non-saline soils, EC can be an estimate of other soil properties such as soil moisture and soil depth.

4.27 Soil EC does not directly affect plant growth but has been used as an indicator of the amount of nutrients available for plant uptake and salinity levels. EC has been used as a surrogate measure of salt concentration, organic matter, cation exchange capacity, soil texture, soil thickness, nutrients (e.g., nitrate), water holding capacity, and drainage conditions. Table 4.6 provides the classes of salinity and EC (1 dS/m = 1 mmhos/cm)

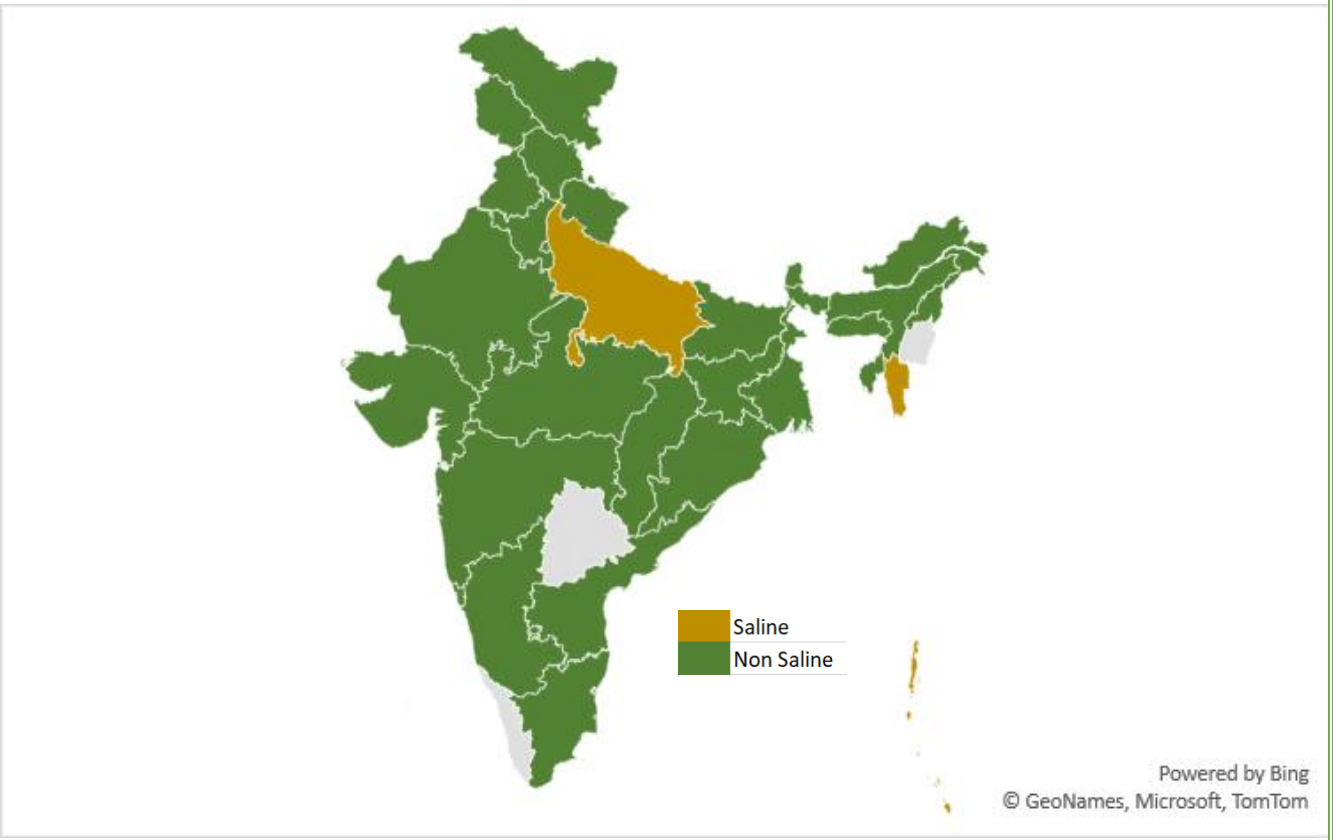
[52] https://www.nrcs.usda.gov/sites/default/files/2022-10/Soil%20Electrical%20Conductivity.pdf

Table 4.6: Salinity Classes of Soil on the Basis of Electrical Conductivity

EC (dS/m)	Salinity Class
0<2	Non-saline
2<4	Very slightly saline
4<8	Slightly saline
8<16	Moderately saline
>=16	Strongly saline

4.28 High EC may impede crop growth and microbial activity. Soils with high EC resulting from a high concentration of sodium generally have poor structure and drainage and sodium becomes toxic to plants. Figure 4.5 shows the state-wise status of salinity based on the number of Soil Health Card Samples in each category.

Figure: 4.5 Status of Soil Salinity



Conclusion and Way Forward

4.29 The Soil and Land Use Survey of India (SLUSI) under M/o Agriculture and Farmers' Welfare has initiated the task for the development of a digitalized detailed

soil database. The work of the Detailed Soil Survey[53] will provide complete diagnosis of soils for evaluating the potential of soils and integrating it with soil health card fertility status map of villages to develop integrating soil maps for sustainable crop production. In addition, a MoU has been signed between SLUSI and NRSC for the preparation of the Soil Resource Atlas of India on 1:50000 scale. Several government initiatives such as National Project on Management of Soil Health and Fertility, Soil Health Management (SHM), Soil Health Card aim towards having improved soil conditions for better crop production.

4.30 A study of the soil nutrient index is important from a crop husbandry point of view, since it reveals the soil characteristics that directly impacts the plant growth. A study of soil nutrient index supplemented by physical, chemical and biological properties of the soil will provide a full picture of the soil fertility and productivity. The impact of soil fertility is reflected in most of the Sustainable Development Goals, as they contain economic, social and environmental aspects. Fertile soil can easily be cultivated, it absorbs rainwater well and withstands siltation and erosion. Therefore, proper management of soil resources is essential to ensure that productive arable land, an essential pillar of sustainable agriculture, is kept intact. This will also aid in reducing water and air pollution and also help in regulating water availability. Healthy soils act as a carbon sink; thereby, mitigating the impact of climate change.

4.31 The Soil Nutrient Index is one of the condition accounts for the Soil Ecosystem. Given the myriad contributions of this ecosystem, it is essential to account for the other services of soil as well as regularly monitor the soil condition. With the availability of data on other parameters related to soil, additional accounts may be developed for soil to truly reflect its contribution.

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[53] Annual Report: Ministry of Agriculture and Farmers' Welfare

Chapter 5

Biodiversity

Chapter 5

Biodiversity

Biodiversity starts in the distant past and it points toward the future.

-Frans Lanting

Introduction

5.1 Biodiversity means the 'diversity' of life on Earth at all levels, from genes, species to ecosystems. It includes diversity within species, between species and of ecosystems. Biodiversity encompasses all ecosystems–manmade (plantations, farms, croplands, aquaculture sites, urban parks) and natural (forests, nature preserves or national parks) and represents the wealth of biological resources available to human beings. The diversity of life on earth is essential for the healthy functioning of ecosystems and it is the biodiversity that boosts ecosystem productivity. It is high time that humankind realizes the fact that economies are embedded in nature and are not external to it.

5.2 Today, there are between 8-20 million species[54] of organisms, may be more, with cells containing a distinct nucleus that houses genetic material in the form of chromosomes (such organisms are called eukaryotes). Only about 2 million eukaryotes have been recognized and named so far. In addition, there are unknown and much larger numbers of archaea and bacteria, which do not have a cell nucleus (called prokaryotes). Biodiversity does not only pinpoint the number of species of organisms that inhabit the Earth, but also has further deeper dimensions, including the genes these organisms contain and, the functional characteristics of the ecosystems in which they live. The chemical reactions occurring in the Earth's plants, algae and many bacteria sustain life by converting sunlight and nutrients into food and usable energy as well as recycling waste. Their activities are often both silent and hidden from view, but they enable ecosystems to function and provide a multitude of services on which we rely. The biosphere, which is the part of Earth occupied by living organisms, is a regenerative entity. As the ability to regenerate is a characteristic of

[54] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/957292/Dasgupta_Review_-_Abridged_Version.pdf

living systems, regeneration of the biosphere is key to the sustainability of human beings. Ecosystems are actually constituents of the biosphere.

Global Biodiversity Framework

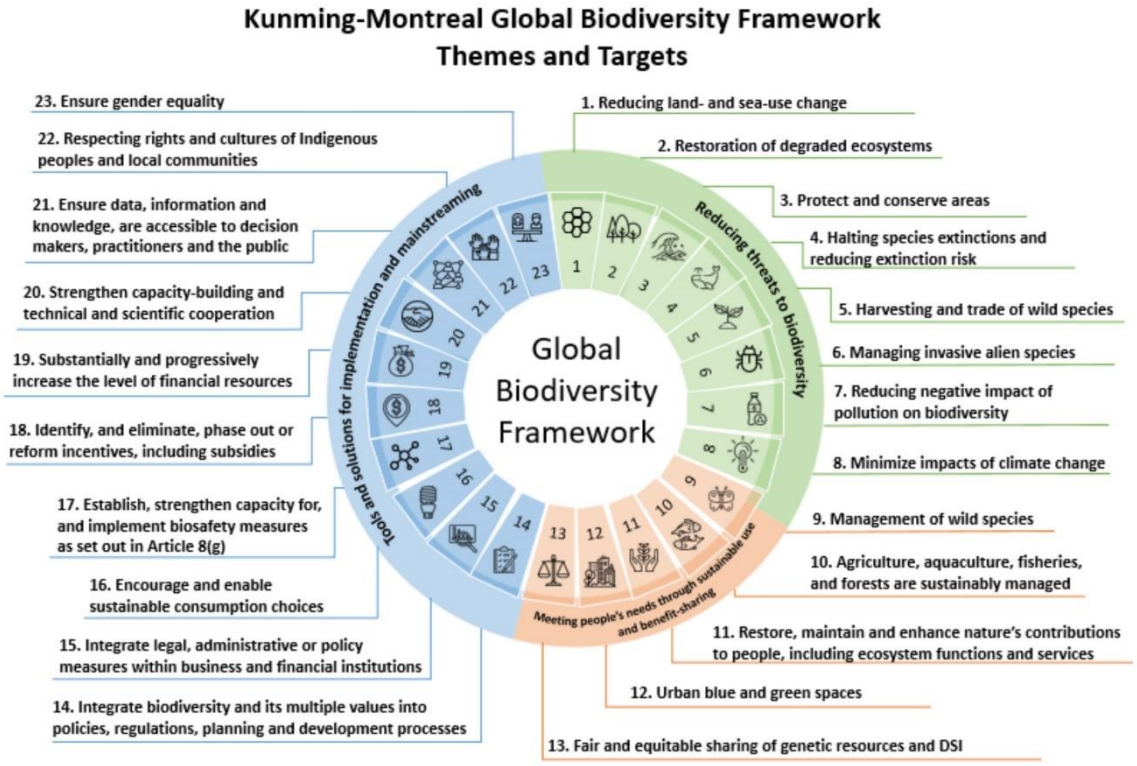
5.3 Biodiversity, and the benefits it provides, are fundamental to human well-being and a healthy planet. The Kunming-Montreal Global Biodiversity Framework, building on the Strategic Plan for Biodiversity 2011–2020, its achievements, gaps, and lessons learned as well as the experience and achievements of other relevant multilateral environmental agreements, sets out an ambitious plan to implement broad-based action to bring about a transformation in our societies' relationship with biodiversity by 2030, in line with the 2030 of the Sustainable Development Goals, and ensures that, by 2050, the shared vision of living in harmony with nature is fulfilled. Among the Framework's key elements are 4 goals for 2050 and 23 targets for 2030[55]. The Kunming-Montreal Global Biodiversity Framework contributes to the achievement of the 2030 Agenda for Sustainable Development Goals. At the same time, progress towards the Sustainable Development Goals and the achievement of sustainable development in all its three dimensions (environmental, social and economic) is necessary to create the conditions necessary to fulfil the goals and targets of the Framework. It will place biodiversity, its conservation, the sustainable use of its components and the fair and equitable sharing of the benefits arising out of the utilization of genetic resources, at the heart of the sustainable development agenda, recognizing the important linkages between biological and cultural diversity. The compilation of accounts using SEEA can inform several headline indicators of the monitoring framework, including[56]:

a. A.2: Extent of natural ecosystems
b. B.1: Services provided by ecosystems

The Figure 5.1 shows the various Kunming-Montreal Global Biodiversity Framework Themes and Targets.

[55] https://www.cbd.int/gbf/introduction
[56] https://seea.un.org/content/biodiversity

Figure 5.1: Kunming- Montreal Global Biodiversity Framework Themes and Targets

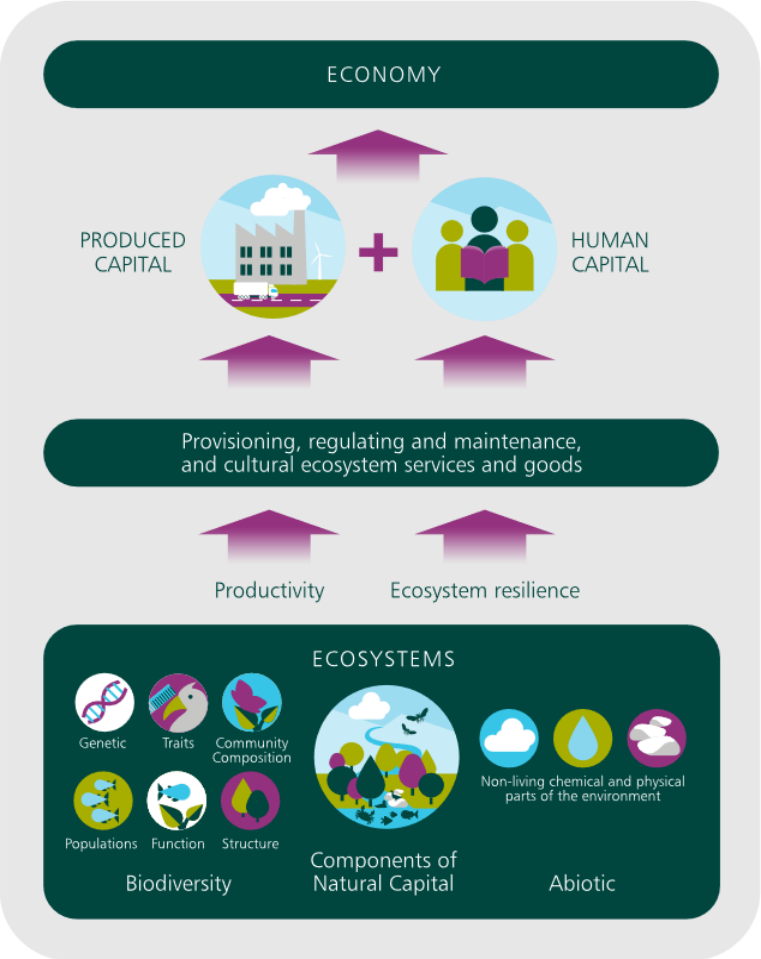


Source: Environment and Climate Change, Canada

Linkages of Biodiversity to Economy

5.4 Biodiversity is characteristic of ecosystems. It enables ecosystems to flourish and supply a wide variety of services on which humankind is dependent upon. The various factors that influence the biodiversity of a region include temperature, altitude, precipitation, soils and pressures from the human activities. Nature's goods and services are the foundations of our economies. They include the provisioning services that supply the goods we harvest and extract (food, water, fibres, timber, medicines), regulatory services (pollination, biological pest control and disease control, waste decomposition and detoxification etc.) and cultural services, such as the gardens, parks and coastlines we visit for pleasure, as well as emotional sustenance and recuperation. In addition to these Nature's processes, biodiversity also maintains a genetic library, preserve and regenerate soil, control floods, filter pollutants, assimilate waste, pollinate crops, maintain the hydrological cycle, regulate climate and fulfil many other functions. Without these ecosystem services, life would not be possible.

Figure 5.2: Links from Biodiversity to the Economy



Source: The Economics of Biodiversity: the Dasgupta Review (Abridged Version)

India - A Mega Diverse Country

5.5 India is one of the world's 17 mega diverse nations with around 8% of the world's documented species and 4 of the 36 globally recognised biodiversity hotspots[57]. Different aspects of India's biodiversity have been discussed in the 2022 issue of this publication[58].

5.6 India is tremendously rich in species and ecosystem diversity. Around 1,04,561 species of fauna and 55,726 species of flora have been documented in the 10 biogeographic zones of the country. Considering floral diversity, out of the 55,726 known plant species in India, 14,770 are endemic (Table 5.1). Endemism describes taxa that are distributed in particular areas. Endemic species are those that live in a

[57] Animal Discoveries, 2023
[58] EnviStats India 2022, Vol. II: Environment Accounts

particular area, such as a mountain range, lake or island, among others. Table 5.2 shows the known faunal species, their endemism and threat status.

Table 5.1: India's Floral Species Diversity and Endemism – 2022, 2023

Year	2022			2023		
Major Groups	**Number of Species**	**No. of Endemic Species**	**No. of Threatened Species**	**Number of Species**	**No. of Endemic Species**	**No. of Threatened Species**
Flowering Plants						
Gymnosperms	83	16	7	83	16	13
Angiosperms	22,108	5,180	1,700	22,214	5,286	1,782
Non-flowering Plants						
Bryophytes	2,819	925	80	2,835	941	80
Pteridophytes	1,319	98	414	1,321	100	414
Others						
Virus & Bacteria	1,278			1,288	-	-
Algae	9,035	2,141	580	9,085	2,191	580
Fungi	15,701	4,918		15,812	5,029	-
Lichens	3,044	1,163		3,088	1,207	-
Total	**55,387**	**14,441**	**2,781**	**55,726**	**14,770**	**2,869**

Source: Botanical Survey of India

Table 5.2: India's Faunal Species Diversity and Endemism – 2022, 2023

Major Groups	2022			2023		
	Number of Species	**No. of Endemic Species**	**No. of Threatened Species**	**Number of Species**	**No. of Endemic Species**	**No. of Threatened Species**
Protozoans	3,570	-	-	3,588	-	-
Invertebrates	93,308	-	272	93,854	-	272
Chordates	7,042	1,572	831	7,119	1,582	1,024
Of which						
Fishes	3,532	655	350	3,579	664	391
Amphibia	450	370	37	457	359	176
Reptilia	738	415	143	758	427	144
Birds	1,346	80	172	1,347	79	183
Mammals	436	52	129	438	53	130
Total	**103,920**			**1,04,561**		

Source: Zoological Survey of India

Invasive Alien Species

5.7 Invasive Alien Species Management, preventing the entry and periodical monitoring of the alien species in a new habitat, is one of the important steps to be followed to get rid of the invasive alien species menace. Target 6 of Kunming-Montreal Global Biodiversity Framework aims at preventing the introduction and establishment of priority invasive alien species, reducing the rates of introduction and establishment of other known or potential invasive alien species by at least 50 per cent by 2030 and eradicate or control invasive alien species, especially in priority sites, such as islands[59]. Table 5.3 below provides the number of invasive alien species in India.

Table 5.3: Invasive Alien Species in India

Category	Number of Invasive Alien Species
Terrestrial Plants	60
Aquatic Ecosystem	57
Agriculture Ecosystem	47
Island Ecosystem	14
Total	**178**

Source: Invasive Alien Species of India (2019) published by National Biodiversity Authority, Botanical Survey of India, Zoological Survey of India

Taxonomic diversity of India

5.8 The Botanical Survey of India (BSI) and the Zoological Survey of India (ZSI) (largest faunal specimen repositories in the world[60]) are the two apex organisations of India that have been actively engaged in 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 5.4** gives the phylum-wise details of the taxonomic diversity of India compiled using information from the BSI and ZSI.

[59] https://www.cbd.int/gbf/targets

[60] https://zsi.gov.in/WriteReadData/userfiles/file/Annual%20Report/Annual%20Report%202020-21.pdf

Table 5.4: Number of Fauna and Flora Species in India – 2022, 2023

Category		Taxonomic group	Number of Species in India	
			2022	2023
FAUNA	Protista		**3,570**	**3,588**
		Phylum Protozoa	3,570	3,588
	Animalia		**1,00,350**	**1,00,973**
	INVERTEBRATA	Phylum Mesozoa (Dicyemida)	10	10
		Phylum Porifera	574	575
		Phylum Cnidaria	1,468	1,472
		Phylum Ctenophora	20	20
		Phylum Platyhelminthes	1,806	1,813
		Phylum Rotifera	467	467
		Phylum Gastrotricha	163	164
		Phylum Kinorhyncha	10	10
		Phylum Nematoda	3,031	3,065
		Phylum Acanthocephala	308	312
		Phylum Sipuncula	41	41
		Phylum Mollusca	5,266	5,273
		Phylum Echiura	47	47
		Phylum Annelida	1,060	1,064
		Phylum Onychophora	1	1
		Phylum Arthropoda	77,776	78,258
		Phylum Phoronida	3	3
		Phylum Bryozoa (Ectoprocta)	355	355
		Phylum Entoprocta	10	10
		Phylum Brachiopoda	8	8
		Phylum Chaetognatha	44	44
		Phylum Tardigrada	32	34
		Phylum Nemertea	6	6
		Phylum Echinodermata	788	788
		Phylum Hemichordata	14	14
		Phylum Protochordata		
		Phylum Chordata	7,042	7,119
		Of Which		
	VERTEBRATA	Class Pisces: Fresh water Fishes	3,532	3,579
		Class Pisces: Marine and Estuarine Fishes		
		Class Amphibia	450	457
		Class Reptilia	738	758
		Class Aves	1,346	1,347

Category		Taxonomic group	Number of Species in India	
			2022	2023
		Class Mammalia	436	438
TOTAL FAUNAL SPECIES			**1,03,920**	**1,04,561**
FLORA		Virus/Bacteria	1,278	1,288
		Algae	9,035	9,085
		Fungi	15,701	15,812
		Lichens	3,044	3,088
		Bryophytes	2,819	2,835
		Pteridophytes	1,319	1,321
		Gymnosperms	83	83
		Angiosperms	22,108	22,214
TOTAL FLORAL SPECIES			**55,387**	**55,726**
GRAND TOTAL (FLORA + FAUNA)			**1,59,307**	**1,60,287**

Source: Botanical Survey of India, Zoological Survey of India

Status of Leopard in India

5.9 Large animals need large areas. When these areas are protected, thousands of other plants and animals also benefit from this protection. Failing to protect them can lead not only to the extinction of these species, but the loss of many other associated plant and animal species that make up the ecological community of their respective habitat. This loss of species and genetic level biodiversity also impacts ecosystem functions and makes ecosystems less resilient to environmental shocks and changes (including climate change). In addition, this threatens the supply of future ecosystem services. These considerations are reflected in India's long-standing and successful track record of protecting its tigers and elephants.

5.10 Leopards serve as apex predators in most of the forested landscapes in India, beyond the realm of tiger and lion. Leopard is vitally important in culling its prey-base in a sustainable manner. In the absence of these, the prey base would breed exponentially with no natural control and the forest would not be capable of providing sufficient fodder to the prey base. The Indian leopard (*Panthera pardus fusca*) is distributed across a variety of forested habitats in India, Nepal, Bhutan, and parts of Pakistan, excluding mangrove forests and desert habitats (Prater 1980, Daniel 1996)[61,62]. Despite being listed in Schedule I of the Indian Wildlife (Protection) Act, 1972

[61] Prater, S.H. 1980. The book of Indian animals (3rd edition). Bombay Natural History Society, Bombay
[62] Daniel, J.C. 1996. The leopard in India- a natural history. Natraj Publishers. Dehradun

and classified as "Vulnerable" by the IUCN Red List Category and Criteria[63], leopard populations face significant threats including habitat loss, fragmentation, human-wildlife conflict, poaching, and illegal trade.

5.11 Leopards occupy a prominent position in the trophic pyramid alongside tigers, lions and dholes exhibiting adaptability in habitat and dietary preferences, and playing a vital role as top predators in a wide array of landscapes across India. However, their adaptability often leads to conflicts with humans, posing a significant conservation challenge within their range. Global distribution and population trends indicate significant declines due to various anthropogenic pressures, including habitat loss, prey depletion and poaching.

5.12 In India, the population estimates of Leopard are obtained along with the assessment for the tigers, which acts as an umbrella species for the majority of eco-regions in the Indian subcontinent. The National Tiger Conservation Authority (NTCA) in collaboration with the State Forest Departments, Conservation NGOs and coordinated by the Wildlife Institute of India (WII), conducts a National assessment for the "Status of Tigers, Co-predators, Prey and their Habitat" every four years since 2006. This exercise not only comes up with tiger numbers for the country but also evaluates the status of co-predators, prey, habitat and human disturbance parameters. Third

Source: Status of Leopards in India, 2022

[63] https://www.iucnredlist.org/species/15954/254576956

cycle of this assessment yielded the first country-wide minimal population estimation of leopards at 7,910 (SE 6,566-9,181) in forested habitats of 18 tiger-bearing states of the country[64].

Table 5.5: Estimated Leopard Population under Different Cycles of Tiger Status Assessment

Year	Report Title	Estimated Population
2014	Status of Tigers, Co-predators and Prey in India-2014 (3rd cycle of National Tiger Status Assessment)	7,910
2018	Status of Leopards in India, 2018 (4th cycle of National Tiger Status Assessment)	12,852
2022	Status of Leopard in India, 2022 (5th cycle of National Tiger Status Assessment)	13,874

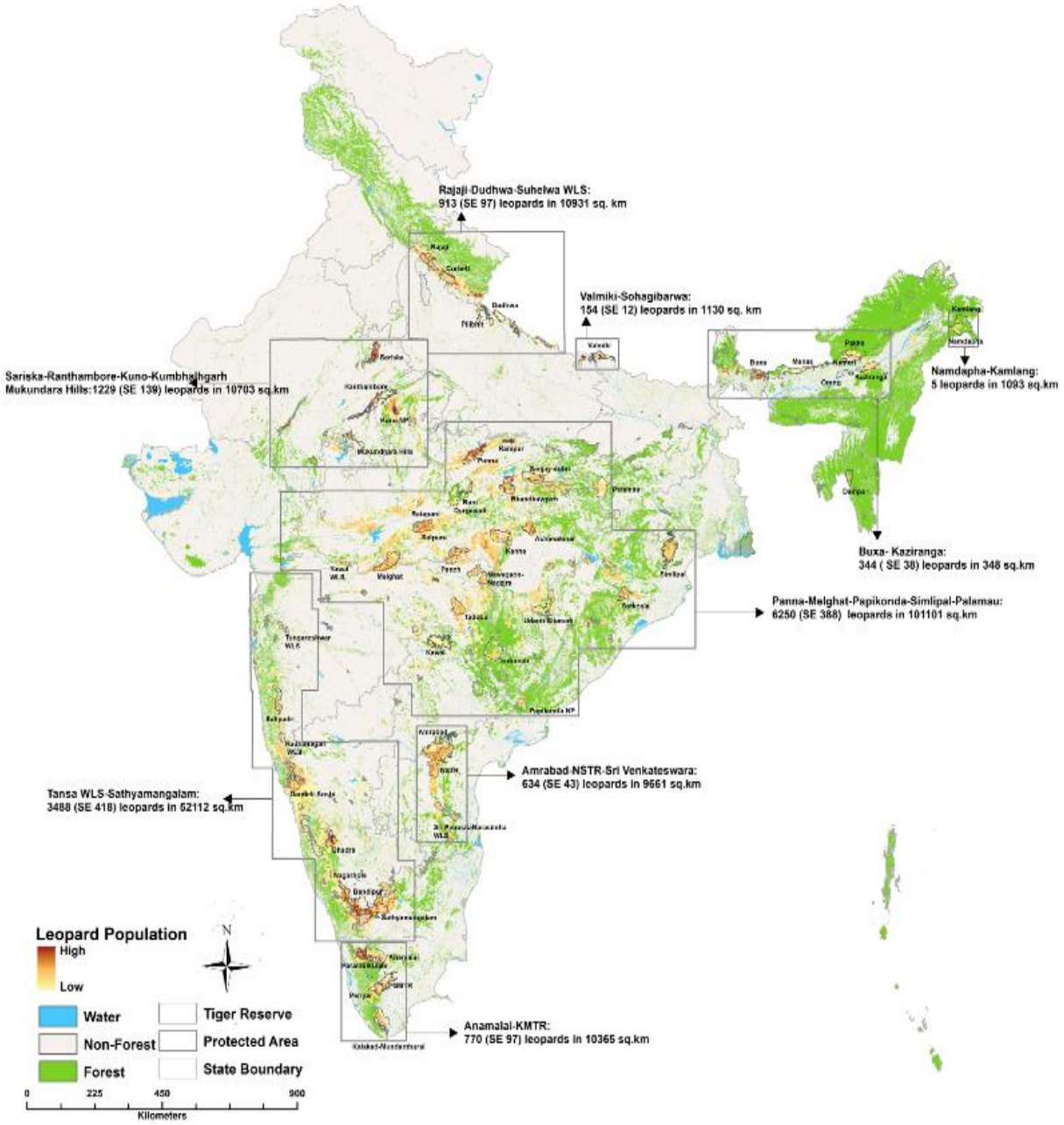
5.13 The fourth cycle of the tiger assessment, undertaken in 2018, estimated the leopard population in India as 12,852 with a standard error limit of 12,172-13,535. The fifth India's leopard population is estimated at 13,874 (Range: 12,616 – 15,132), representing a stable population in comparison to the similar area being sampled in 2018. This estimate represents a population of 70% of leopard habitat; the Himalayas and semi-arid parts of the country which are not tiger habitat were not sampled. Unlike tiger populations, leopard populations show weak structuring across landscapes, with shared genetic affinity between different regions.

5.14 Figure 5.3 shows the leopard abundance, extent and population block in India[65] for 2022. The status of leopard population estimates in the forested areas of tiger states in 2018 and 2022 is given in Table 5.6. Figure 5.4 shows the estimated leopard numbers in landscapes and states of India in 2022.

[64] Status of Leopards in India, 2022

[65] http://www.indiaenvironmentportal.org.in/files/file/Status%20of%20Leopard%20in%20India%202022%20summary%20report.pdf

Figure 5.3: Leopard Abundance, Extent and Population Blocks in India, 2022



Source: Status of Leopards in India 2022

Table 5.6: Leopard population estimates in 2018 and 2022

State	Population estimates (SE), 2018	Population estimates (SE), 2022
Shivalik Hills & Gangetic Plains		
Bihar	98 (8)	86 (3)
Uttarakhand	839 (48)	652 (77)
Uttar Pradesh	316 (39)	371(54)
Shivalik-Gangetic	**1,253 (95)**	**1109 (134)**
Central India & Eastern Ghats		
Andhra Pradesh	492 (31)	569 (41)
Telangana	334 (16)	297 (20)
Chhattisgarh	852 (39)	722 (45)
Jharkhand	46 (10)	51 (10)
Madhya Pradesh	3,421 (150)	3907 (215)
Maharashtra	1,690 (99)	1985 (122)
Odisha	760 (33)	568 (35)
Rajasthan	476 (39)	721 (112)
Central India & Eastern Ghats	**8,071 (417)**	**8820 (600)**
Western Ghats		
Goa	86 (3)	77 (13)
Karnataka	1,783 (71)	1879 (261)
Kerala	650 (28)	570 (76)
Tamil Nadu	868 (40)	1070 (132)
Western Ghats	**3,387 (142)**	**3596 (482)**
North East Hills, and Brahmaputra Flood Plains*		
Arunachal Pradesh (Pakke)	11 (3)	42 (10)
Assam (Manas, Nameri and Kaziranga)	47 (9)	74 (11)
West Bengal (Gorumara, Jaldapara and Buxa)	83 (17)	233 (21)
North East Hills, and Brahmaputra Flood Plains*	**141 (26)**	**349 (42)**
TOTAL	**12,852 (680)**	**13,874 (1,258)**

Source: Status of Leopards in India, 2018, 2022

** Estimates are only from camera trap sites*

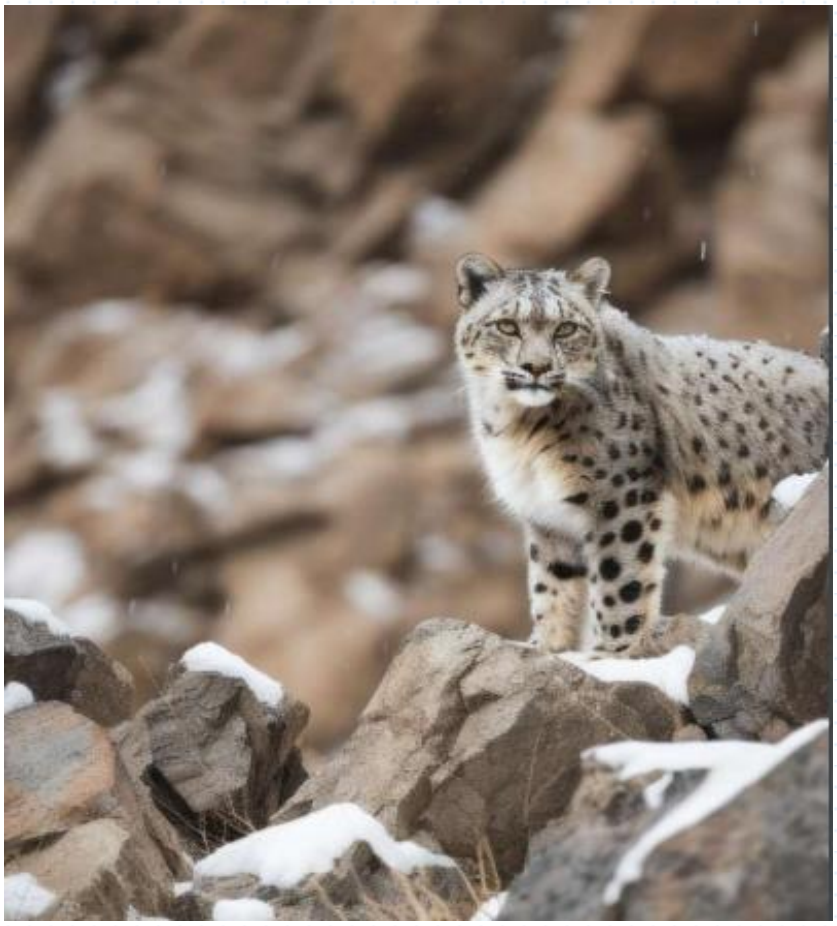
Figure 5.4: Estimated Leopard numbers in landscapes and states of India, 2022

Source: Ministry of Environment, Forest and Climate Change[66]

[66] https://pib.gov.in/PressReleaseIframePage.aspx?PRID=2010001

Snow Leopards

5.15 The Snow Leopard (Panthera uncia) plays a crucial role as an apex predator in the Himalayan ecosystem (Jackson *et.al.*, 2008)[67]. Hence, the snow leopard exerts top-down regulation on prey populations, thereby influencing the ecological equilibrium of its habitat (McCarthy *et. al.*, 2017)[68]. The Snow Leopard, besides its ecological significance, holds a cultural and economic importance, embodying a symbolic representation of local communities.



Source: Status of Snow Leopard in India, 2023

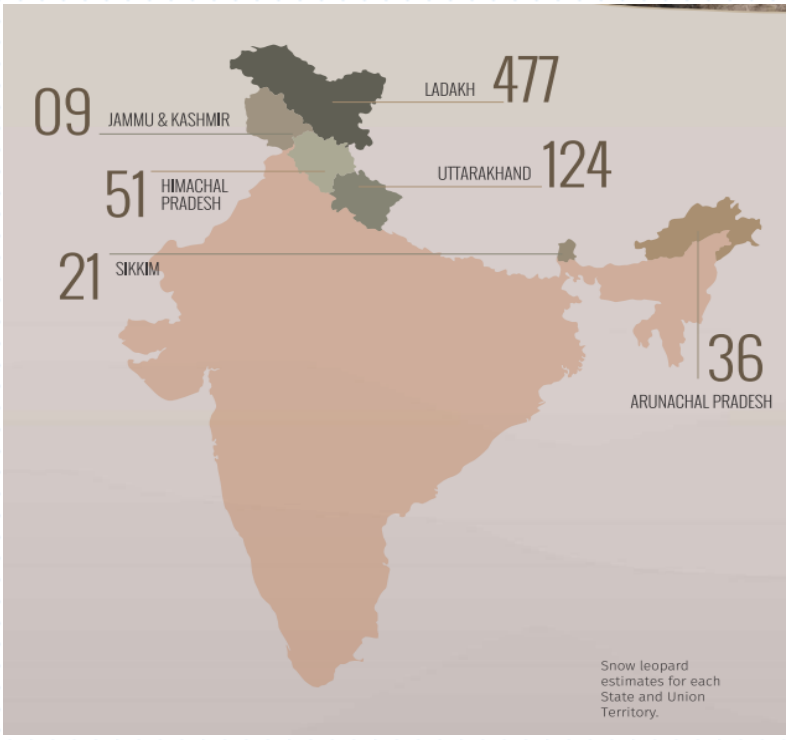
5.16 The Snow Leopard Population Assessment in India (SPAI) is in sync with the global effort initiated by the Global Snow Leopard and Ecosystem Protection Program (GSLEP) called the Population Assessment of the World's Snow Leopards (PAWS). SPAI exercise has led to the first ever rigorous examination of snow leopard populations in India, employing advanced methods such as occupancy modelling and camera trapping. The findings not only contribute towards the understanding of snow leopard ecology but also emphasize the ecological importance of high-altitude environments they inhabit. The snow leopard, designated as vulnerable by the International Union for Conservation of Nature (IUCN), confronts multifaceted threats, including overgrazing, human-wildlife conflicts, poaching, free-ranging dogs,

[67] Jackson, R., Mallon, D., McCarthy, T., Chundaway, R. A., Habib, B., & Asadov, A. 2008. Panthera uncia. The IUCN Red List of Threatened Species 2008.

[68] McCarthy T, Mallon D, Jackson R, Zahler P, McCarthy KP. 2017. Panthera uncia. The IUCN Red List of Threatened Species. Available at 10.2305/IUCN.UK.2017-2.RLTS.T22732A50664030.e.

and habitat degradation due to tourism and infrastructural development. The distribution of the Snow Leopards in India is shown in Figure 5.5 below.

Figure 5.5: Distribution of Snow Leopards in India



5.16 The estimates of snow leopards along with the density estimates are provided in Table 5.7 below:

Table 5.7: Estimates of Snow Leopards

States / UTs	Estimated Number of Snow Leopards
Ladakh	477
Jammu & Kashmir	9
Himachal Pradesh	51
Uttarakhand	124
Sikkim	21
Arunachal Pradesh	36
Total	**718**

Source: Status of Snow Leopard in India, 2023[69]

69 https://files.worldwildlife.org/wwfcmsprod/files/Publication/file/2i0lv8c7wq_SPAI_Flyer_29Jan_2024_compressed_Corrected_1_.pdf

Conservation Measures in India

5.17 Biological resources, nationally and globally, are depleting at an alarming rate in the last few decades due to increased destructive anthropogenic factors causing distress to all biological forms and disrupting ecosystems. There are two broad approaches in conservation that are adopted to protect and maintain biodiversity – *in-situ* and *ex-situ*. *In-situ* conservation refers to the conservation of species in their natural habitats, while ex-situ conservation is the preservation of components of biological diversity outside their natural habitats, e.g., zoos. *In-situ* conservation is considered the most appropriate way of conserving biodiversity. Conserving the areas where populations of species exist naturally is an underlying condition for the conservation of biodiversity and hence, protected areas form a central element of any national strategy to conserve biodiversity.

5.18 In India, the Protected Areas are declared under Wildlife (Protection) Act, 1972. India has 18 biosphere reserves and 123 conservation reserves. Amongst the protected areas, India has 106 national parks and 573 sanctuaries covering an area of 1.7 lakh sq. km. Table 5.8 provides the status of different categories of Protected Areas in India and Table 5.9 provides the status of Protected Areas in India since 2000. In addition, the flora species protected under Indian Botanical Garden are given in **Annexure 5.1**.

Table 5.8: Status of Different Categories of Protected Areas in India

Categories of Protected Area		Number	Area (in Km2)
Protected Area*	National Parks	106	44,403
	Wild Life Sanctuaries	573	127,198
	Community Reserves	220	1,455
	Conservation Reserves	123	5,585
	Total	**1022**	**178,641**
Of Which **Marine Protected Areas#**	**Total**	132	9,615

*Source: National Wildlife Database, Wildlife Institute of India[70] *: As on July 2023; #: As on July 2024*

[70] https://wiienvis.nic.in/Database/Protected_Area_854.aspx

Table 5.9: Protected Areas in India from 2000-2023

Year	National Parks		Wild Life Sanctuaries		Community Reserves		Conservation Reserves		Total Protected Area	
	Number	Area (km2)	Number	Area (km2)	Number	Area (km2)	Number	Area (km2)	Number	Area (km2)
2000	87	40,215	478	1,13,285	-	-	29	656	594	1,54,156
2002	87	40,215	483	1,13,931	-	-	29	656	599	1,54,802
2004	93	40,701	492	1,15,041	-	-	29	656	614	1,56,398
2006	95	40,904	494	1,15,079	-	-	33	699	622	1,56,682
2008	98	41,954	502	1,17,375	4	21	48	1,455	652	1,60,804
2010	101	42,781	510	1,18,124	7	51	49	1,459	667	1,62,415
2012	102	42,782	523	1,19,360	11	105	60	1,791	696	1,64,037
2014	103	42,998	539	1,23,512	48	141	67	2,188	757	1,68,838
2016	103	42,998	551	1,24,458	74	329	75	2,436	803	1,70,221
2018	104	43,747	552	1,24,617	147	863	89	4,121	892	1,73,348
2020	104	43,747	562	1,25,760	216	1370	94	4,276	976	1,75,152
2022	106	44,403	570	1,26,904	220	1455	107	5,291	1,003	1,78,053
2023*	106	44,403	573	1,27,198	220	1455	123	5,585	1,022	1,78,641

Source: National Wildlife Database, Wildlife Institute of India[71] (as on 24/09/2024)
Note: 1. These data are based on the availability of data from the Forest Department and Gazette Notification notified by the Ministries.
2. Community Reserves and Conservation Reserves have been established in India from 2006 onwards. Hence these values are zero for the year 2000.
** Till July 2023*

Conservation of flora and fauna genetic resources

5.19 Conservation is not an end in itself, but a means of ensuring that plant and animal genetic resources are available for use by present and future generations. The Gene Banks are vital for the future of humankind on this planet. A gene is the basic physical and functional unit of heredity. Gene banks are storehouses of various genetic material related to flora and fauna, seeds or vegetative tissue, kept in low humidity and temperature, to help maintain genetic diversity, primarily to preserve genetic biodiversity. Gene banks ensure that these genetic materials are safely conserved and available for utilization.

[71] https://wiienvis.nic.in/Database/Protected_Area_854.aspx

Conserving plant genetic resources

5.20 Gene banks provide the principal means of storing plant genetic material. This *ex-situ* system relies on following methods of storing[72] the material:

- Seed banks provide a controlled environment where seeds can be dried to low moisture content and stored at low temperature without losing their viability;
- Field gene banks such as arboreta, plantations and botanical gardens, are useful for species that are difficult or impossible to store as seed, including many perennials, vegetatively propagated crops and tree species;
- *In vitro* methods which conserve plant parts, tissue or cells in a nutrient medium can be used to conserve species that do not readily produce seeds, or where the seeds cannot be dried without damaging them;
- *Cryopreservation*[73] is the process of preserving living systems by freezing them and storing them at ultra-low temperatures, usually in liquid nitrogen (-196°C) or its vapor phase (-150-195°C). The method is increasingly used to conserve crops that do not produce seeds (such as banana), do not breed true from seeds (e.g. potato, onion) or have seeds that are desiccation- or chilling-sensitive and therefore cannot be safely conserved in a dried state in genebank cold rooms (e.g. most tropical fruit trees).

5.21 Plants are the basis of life on planet Earth. Plant genetic diversity is vulnerable to "genetic erosion", the loss of individual alleles/genes and of combinations of alleles/genes, such as those found in locally adapted landraces. According to the FAO, replacement of local varieties by modern varieties resulting in reduction of the sheer number of cultivars is the main cause of genetic erosion. This is intensified by the emergence of new pests, weeds and diseases, environmental degradation, urbanization and land clearing. Plant Genetic Resources (PGR), the only source of plant genetic diversity, provides valuable traits needed for meeting the challenges of adapting crop varieties. An individual genotype though not very useful today, may become essential tomorrow due to changing climatic conditions or outbreaks of disease. Therefore, it has been long realized that we "conserve" all the diversity we have.

5.22 ICAR- National Bureau of Plant Genetic Resources (NBPGR) collects and acquires germplasm from various sources, conserves it in the Gene bank, characterizes

[72] https://www.fao.org/4/v1430e/V1430E06.htm#:~:text=Conservation%20is%20not%20an%20end,situ%20and%20ex%20situ%20methods.

[73] https://www.genebanks.org/the-platform/conservation-module/cryopreservation/

and evaluates it for different traits and provides ready material for breeders to develop varieties for farmers. The following Table 5.10 shows the number of indigenous plant species conserved in various Gene banks.

Table 5.10: Status of Germ Plasm Conserved at National Genebank, NBPGR

Category Year	Number of accessions conserved in the base collection at National Gene bank (Seeds)	Number of accessions conserved in vitro genebank (Tissue Cultures)	Number of accessions status at Cryogen bank (-196 Degree Celsius)	Total
2014-15	4,19,275	1,665	11,624	**4,32,564**
2015-16	4,30,573	1,882	12,152	**4,44,607**
2016-17	4,34,946	1,821	12,935	**4,49,702**
2017-18	4,39,717	1,861	13,263	**4,54,841**
2018-19	4,43,921	1,886	16,025	**4,61,832**
2019-20	4,48,581	1,916	14,020	**4,64,517**
2020-21	4,58,873	1,936	14,245	**4,75,054**
2021-22	4,63,130	1,964	14,729	**4,79,823**
2022-23	4,65,718	1,987	14,928	**4,82,633**
2023-24	4,69,250	2,020	15,182	**4,86,452**

Source: National Bureau of Plant Genetic Resources, (ICAR-NBPGR), Ministry of Agriculture and Farmers' Welfare

Conserving animal genetic resources

5.23 *Ex-situ* conservation of animal genetic resources includes "cryogenic preservation techniques" — the collection and freezing in liquid nitrogen of semen, ova or embryos, or the preservation of DNA segments in frozen blood or other tissues. It also encompasses the captive breeding of wild or domesticated species in zoos or other locations away from their natural environment. *Ex-situ* gene banks have similar advantages and disadvantages to those used to hold plant germplasm[74].

5.24 *In-situ* conservation enables animal populations to continue to evolve and be selected for use in their natural environments. It is particularly important for species

[74] Harvesting Nature's Diversity, FAO https://www.fao.org/4/v1430e/V1430E06.htm#:~:text=Conserving%20animal%20genetic%20resources&text=It%20also%20encompasses%20the%20captive,used%20to%20hold%20plant%20germplasm.

or within geographical regions where cryogenic preservation is not well developed or available[74].

5.25 The ICAR- National Bureau of Animal Genetic Resources (ICAR-NBAGR)[75] is a premier institute that is dedicated to working with its mandate of identification, evaluation, characterization, conservation and utilization of livestock and poultry genetic resources of the country. The diverse animal genetic resources of the country are the backbone of the Indian economy and represent a reliable cushion against adversities such as climate change, diminishing pastures and emerging diseases. The National Gene Bank at NBAGR functions with the objective of cryopreservation of germplasm with maintaining the indigenous livestock biodiversity of the country. The conservation of DNA for posterity underscores its potential as a reservoir of genetic information. A genomic DNA repository provides a valuable resource for molecular studies of biodiversity and facilitates long-term conservation and archival of samples. The Bureau has preserved genomic DNA samples from 170 breeds/populations of indigenous livestock. Following table shows the number of animal genetic resources preserved under different conservation mechanism at NBAGR.

Table 5.11: Number of animal genetic resources for food and agriculture secured in either medium- or long-term conservation facilities

Year	Category		
	Semen doses	Somatic cells	**Total**
2014-15	1,40,364	0	**1,40,364**
2015-16	1,46,364	0	**1,46,364**
2016-17	1,55,864	412	**1,56,276**
2017-18	1,79,839	1,289	**1,81,128**
2018-19	1,97,739	2,810	**2,00,549**
2019-20	2,17,189	3,460	**2,20,649**
2020-21	2,36,134	3,820	**2,39,954**
2021-22	2,57,314	4,790	**2,62,104**
2022-23	2,87,974	6,530	**2,94,504**
2023-24	3,06,024	10,190	**3,16,214**

Source: National Bureau of Animal Genetic Resources, (ICAR-NBAGR), Ministry of Agriculture and Farmers' Welfare

[75] https://nbagr.icar.gov.in/en/home/

Table: 5.12: Preserved DNA samples of indigenous livestock at NBAGR

S.No	Species	Defined breeds	Lesser known populations
1.	Cattle	46	2
2.	Buffalo	16	8
3.	Sheep	24	10
4.	Goat	21	6
5.	Pig	3	3
6.	Dog	3	1
7.	Chicken	16	–
8.	Duck	–	6
9.	Yak	1	2
10.	Camel		1
11.	Horse	1	
	Total	131	39

Source: ICAR- National Bureau of Animal Genetic Resources[76]

5.26 ICAR-National Bureau of Fish Genetic Resources (NBFGR) was established in 1983, under the aegis of the Indian Council of Agricultural Research, to undertake research related to the conservation of fish germplasm resources of the country. The institute works towards the exploration, characterization, cataloguing, maintenance and preservation of fish genetic resources for the conservation and utilization of prioritized species.

Table 5.13: Conservation of fish genetic resource, (in number)

Category	Gametes and Cell lines preserved	Conservation Aquaculture	Total Species Conserved
2014-15	46	1	**47**
2015-16	48	2	**50**
2016-17	50	3	**53**
2017-18	54	4	**58**
2018-19	58	5	**63**
2019-20	60	7	**67**
2020-21	72	9	**81**
2021-22	79	12	**91**
2022-23	85	15	**100**
2023-24	85	16	**101**

Source: National Bureau of Fish Genetic Resources (ICAR-NBFGR), Ministry of Agriculture and Farmers' Welfare

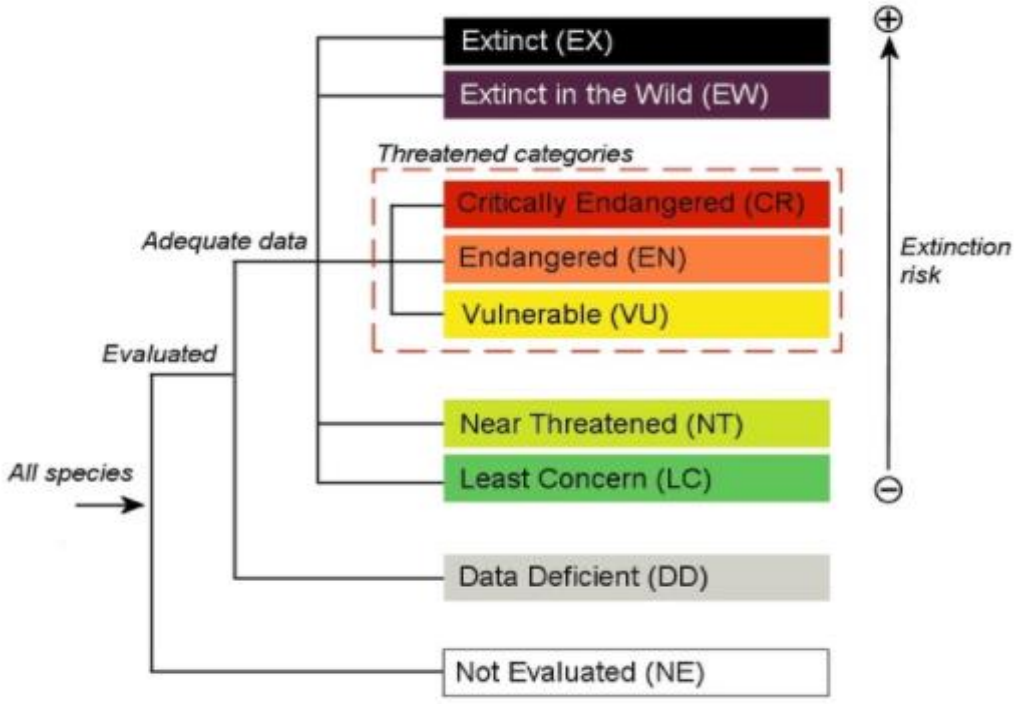
[76] https://nbagr.icar.gov.in/en/dna-bank/

Red Listed Species in India

5.27 A well-managed ecosystem, and the diversity of life it encompasses are critical for a healthy, safe and prosperous world. The International Union for Conservation of Nature (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 is a comprehensive source of information on the global extinction risk status of animal, fungus and plant species[77]. It contains explicit criteria and categories to classify the conservation status of individual species based on their probability of extinction.

5.28 The IUCN Red List categories and criteria are intended to be an easily and widely understood system for classifying species according to the risk of global 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. These nine categories are shown in Figure 5.6 below:

Figure: 5.6 IUCN Red List Categories



Source: IUCN Red List of Threatened Species™

[77] IUCN Red List of Threatened Species https://www.iucnredlist.org/about/background-history

5.29 Any species that has been assessed as Critically Endangered, Endangered or Vulnerable is called 'threatened' species. The IUCN list also includes 'Near Threatened', 'Least Concern' species, which have a lower risk of extinction, but are still important in terms of global biodiversity. Some 'Least Concern' species are undergoing slow declines and hence, it is important to monitor these species and to develop appropriate conservation actions to prevent them from becoming threatened in the future. The inclusion of the different categories of species helps track the changing status of biodiversity.

5.30 The IUCN Red List is a powerful tool to inform and catalyse action for biodiversity conservation and policy change, critical to protecting the natural resources required for survival. By providing information about range, population size, habitat and ecology, use and/or trade, threats and conservation actions, the IUCN Red List helps inform necessary conservation decisions and guide funding priorities.

5.31 The IUCN Red List relies on Assessors (trained individuals and species experts) to assess species based on the currently available data and information. The information is gathered from a range of sources, including published scientific papers, books, reports, expert knowledge, indigenous knowledge and citizen science. The Red List Authorities review the assessments, and then the IUCN Red List Unit checks the assessments before publishing them on the IUCN Red List website.

IUCN Red List Spatial Data

5.32 The IUCN Red List of Threatened Species contains global assessments for over 163,000 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 83% of these (>136,200 species) have spatial data[78]. 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 on the IUCN Red List Resources & Publications page[79].

[78] https://www.iucnredlist.org/resources/spatial-data-download
[79] https://www.iucnredlist.org/resources

5.33 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.

5.34 In order to facilitate its use, the IUCN Red List Toolbox for ArcMap[80] is also available alongside the dataset, which intersects the red list species polygon with a grid or shapefile of polygons, giving the number of species per cell or region polygon. The toolbox also enables the preparation of the Species Richness Map, which shows the number of IUCN red list species found per pixel having an area of 0.07 $degree^2$, or roughly 865 sq. km.

5.35 To understand the distribution of the red-listed species in India, IUCN spatial datasets using the IUCN Red List of Threatened Species, following data were analysed in different issues of this publication.

Table 5.14: IUCN Red List of Species data analysed for India

Year	Red List Version	Species
2020	2020-2	Mammals, Amphibians, Reptiles
2021	2020-3, 2021-1	Mammals, Amphibians, Reptiles, Plants, Mangroves and Freshwater group
2022	2021-2, 2021-3, 2022-1	
2024	2022-2, 2023-1	

5.36 In the current publication, species richness counts have been calculated using data of 2022 Version 2 and 2023 Version 1, downloaded in April, 2023 and December, 2023 respectively. The number of red listed species in India under these categories, as available in the IUCN spatial datasets, was calculated and further updated by ZSI and BSI. The category wise number of species is given in the following Table 5.15.

[80] https://www.iucnredlist.org/resources/spatialtoolsanddata

Table 5.15: Number of Species in IUCN Categories

Species			Number of Species					
		Category	Critically Endangered	Endangered	Near Threatened	Vulnerable	Least Concerned	Data Deficient
		Version	CR	EN	NT	VU	LC	DD
Mammals		2022-2	10	44	33	42	265	30
		2023-1	10	45	33	42	268	30
Aves		2022-2	18	19	78	57	1081	1
		2023-1	18	20	85	60	1089	1
Amphibians		2022-2	7	10	10	10	70	16
		2023-1	17	74	34	51	193	98
Reptiles		2022-2	26	47	37	33	360	124
		2023-1	26	48	37	33	362	124
Fresh Water Group	Crabs	2022-2			3	4	25	66
		2023-1			3	4	25	66
	Crayfish	2022-2					3	
		2023-1					3	
	Fishes (not comprehensive)	2022-2	16	68	35	81	462	115
		2023-1	18	91	36	92	491	144
	Molluscs (not comprehensive)	2022-2		5	2	6	505	155
		2023-1		5	2	6	505	155
	Odonata (not comprehensive)	2022-2	1	4	14	13	418	138
		2023-1		1	2	2	128	24
	Shrimps	2022-2		2		1	73	32
		2023-1		2		1	73	32
Plants	Magnolias	2022-2	3	2		2	10	9
		2023-1	3	2		2	10	9
	Orchids#	2022-2	28	15	1	5	23	8
		2023-1	28	15	1	5	23	8
	Balsams#	2022-2		5	1	3	3	
		2023-1		5	1	3	3	
	Musa#	2022-2	5	4	2		18	
		2023-1	5	4	2		18	

Species			Number of Species					
		Category	Critically Endangered	Endangered	Near Threatened	Vulnerable	Least Concerned	Data Deficient
		Version	CR	EN	NT	VU	LC	DD
Marine Group	Scleractinian corals*	2022-2		4	105	71	166	19
		2023-1		4	105	71	166	19
	Organ Pipe coral*	2022-2			1			
		2023-1			1			
	Hydrozoa*	2022-2	1			1	5	
		2023-1	1			1	5	
	Merostomata*	2022-2						2
		2023-1						2
	Echinodermata*	2022-2		4		5	23	35
		2023-1		4		5	23	35
	Cephalopoda*	2022-2					26	31
		2023-1					26	31
	Bivalvia*	2022-2		1	1	2	56	22
		2023-1		1	1	2	56	22
	Actinopterygii (Fishes)*	2022-2	2	13	12	31	1772	177
		2023-1	2	12	11	25	1755	172
	Chondrichthyes (Fishes)*	2022-2	22	34	17	35	11	2
		2023-1	23	34	17	35	11	2
	Reptiles*	2022-2	1	1		2	16	4
		2023-1	1	1		2	16	4
	Mammals*	2022-2		3	2	4	18	1
		2023-1		3	2	4	18	1

Source: Botanical Survey of India and Zoological Survey of India

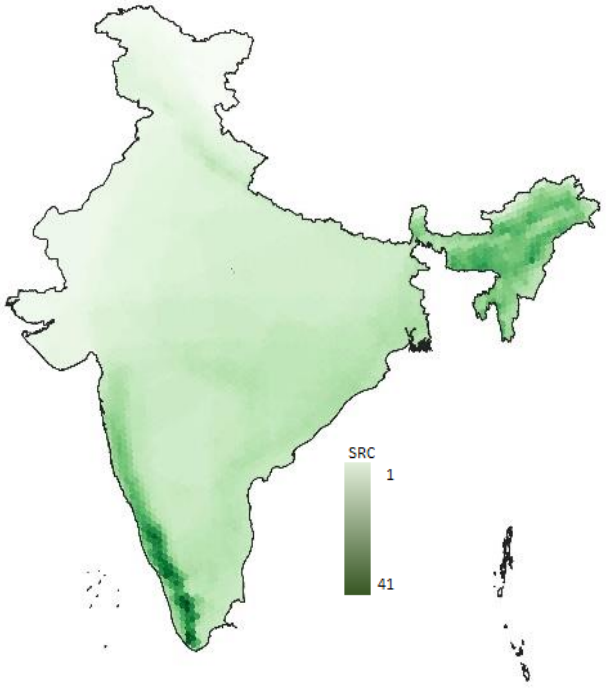
**, #: Excluded from Spatial Distribution of Species.*

5.37 From **Table 5.15**, it can be seen that most of the Red List species in India are under the 'Least Concern' category. State-level red list species counts, as compiled using the IUCN Red List Toolbox, are given in **Annexure 5.2**. The counts have been calculated using different versions of IUCN Red List data. The increase (decrease) in

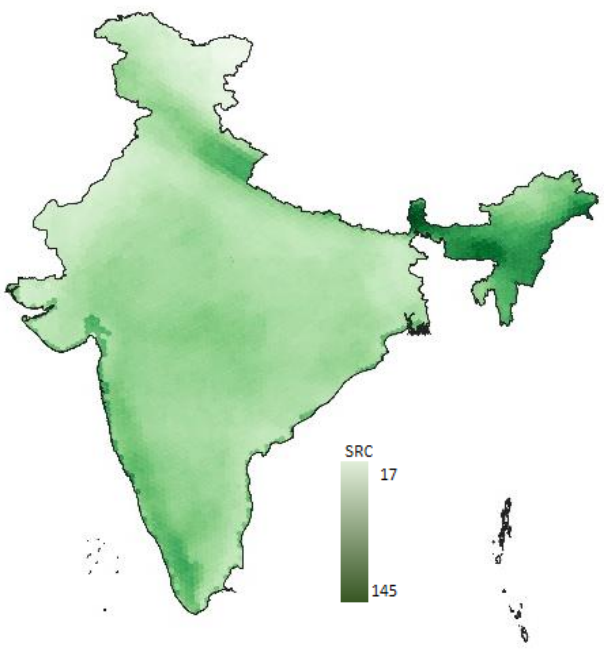
the species richness count does not necessarily show the true change in number of species for a state/region. Change can also be attributed to the increase in the number of species assessed and improvement in the knowledge of species' distribution. The richness count calculated also depends on the extent or boundaries of the shapefile used to calculate these values.

5.38 **Figure 5.7** shows the species richness of different species across the country. The species richness for different categories namely Amphibians, Reptiles, Mammals, Mangroves and Fresh Water Group has been mapped separately. Figure 5.7(b) denoting the richness of 'All Species' includes Amphibians, Mammals, Reptiles, Mangrove, Magnolias, Fresh Water Group species.

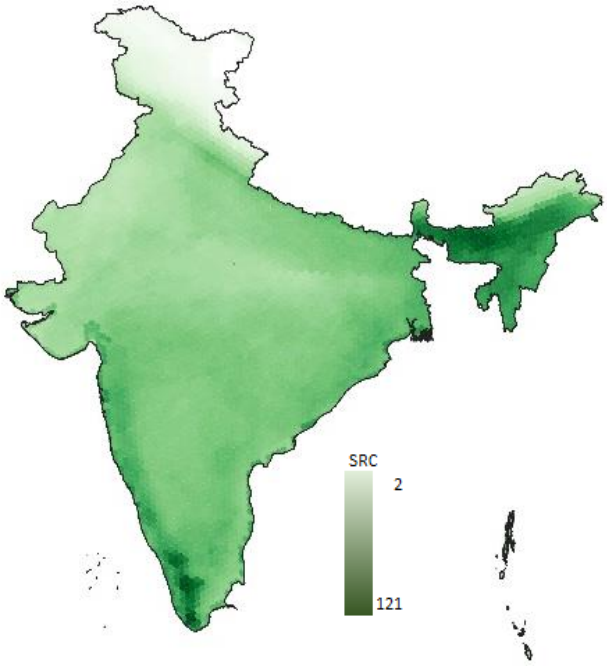
Figure 5.7: Species Richness of IUCN Red List Species



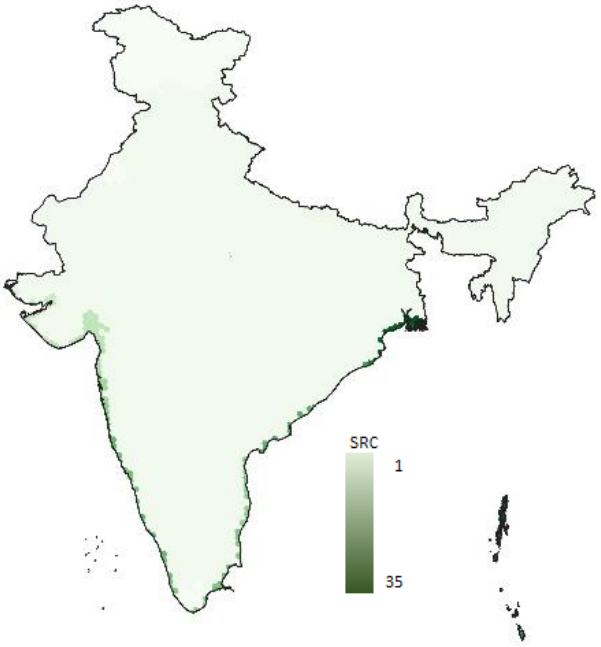
(a) Amphibians



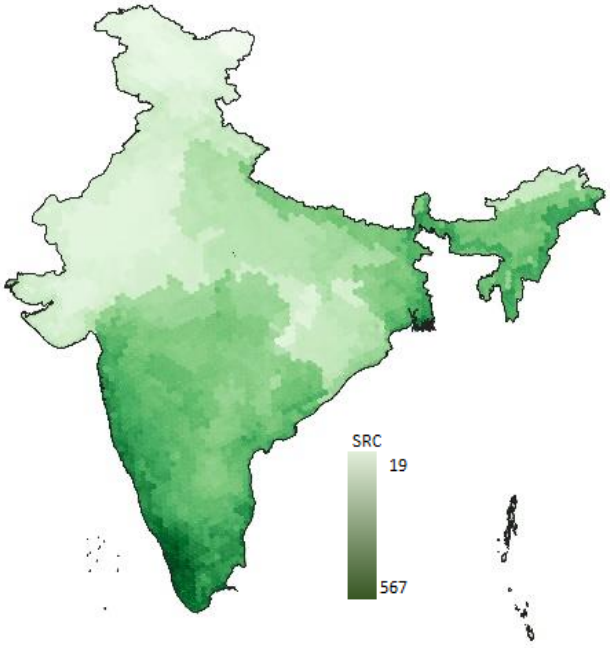
(b) Mammals



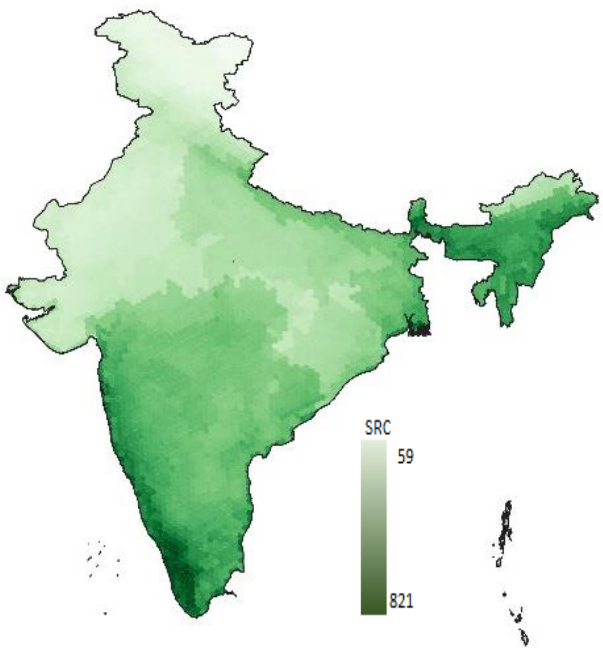
(c) Reptiles



(d) Mangroves



(e) Fresh Water Group Species



(f) All Species

Source: The IUCN Red List of Threatened Species. Version 2022-2 downloaded 11/04/2023 and Version 2023-1 downloaded on 14/12/2023

Threatened Species notified under the Biological Diversity Act, 2002

5.39 India enacted the Biological Diversity (BD) Act in 2002, and notified the Rules in 2004 and India was one of the first few countries to have enacted such a comprehensive legislation biodiversity. The Act aims to biological resources, manage their sustainable use and enable fair and equitable sharing of benefits arising out of the use and knowledge of biological resources with the local communities.

5.40 In accordance with Section 38 of the Biological Diversity Act, 2002, the Government of India, through the MoEFCC, in consultation with the State Government concerned, has notified the species that are on the verge of extinction or likely to become extinct in the near future as threatened species in 18 States and 02 Union Territories. These notifications declared 159 plants and 175 animals as threatened species across the nation and is given in Table 5.16. This notification confers power to the State Government to prohibit or regulate their collection and take appropriate steps to rehabilitate and preserve those species.

Table 5.16: List of Threatened Species Notified under Section 38 of the BD Act

Sl. No.	State/UT	Plants	Animals
1	Himachal Pradesh	8	10
2	Kerala	26	13
3	Uttar Pradesh	1	-
4	Uttarakhand	16	15
5	Mizoram	8	8
6	Orissa	1	13
7	Meghalaya	6	5
8	Goa	2	7
9	Karnataka	16	16
10	Madhya Pradesh	3	10
11	West Bengal	2	17
12	Bihar	1	6
13	Tamil Nadu	23	16
14	Tripura	1	2
15	Manipur	5	6
16	Andaman & Nicobar Islands	5	8
17	Punjab	8	5
18	Daman & Diu	-	1
19	Jammu and Kashmir	20	10
20	Assam	7	7
	Total	**159**	**175**
Grand Total (Plants + Animals)			**334**

Source: http://nbaindia.org/content/18/21/1/notifications.html.

5.41 In order to implement the objectives of the BD Act, the National Biodiversity Authority (NBA) was established in 2003 by the Central Government. The NBA is an Autonomous and Statutory body, which performs facilitative, regulatory and advisory functions for the Government of India on issues of conservation, sustainable use of biological resource and fair and equitable sharing of benefits on the use of biological resources and / or associated knowledge. Further at the state level, through State Biodiversity Boards (SBBs) and at grass root level through Biodiversity Management Committees (BMCs) the BD Act is implemented. In accordance with Section 41 of the BD Act, local bodies within their areas of jurisdiction can constitute BMCs to promote conservation, sustainable use and documentation of biological diversity which includes preservation of habitats, conservation of landraces, folk varieties and cultivars, domesticated stocks and breeds of animals and microorganisms, and chronicling of knowledge related to biological diversity. One of the main functions of the BMCs is to prepare, maintain and validate People's Biodiversity Registers (PBRs) in consultation with the local people.

Table 5.17: Status of Biodiversity Management Committees (BMCs) and People's Biodiversity Registers (PBRs) in India

S. No.	State Biodiversity Boards (SBBs)	Number of BMCs	Number of PBRs
1	Andhra Pradesh	14,157	14,157
2	Arunachal Pradesh	1,806	1,806
3	Assam	2,549	2,549
4	Bihar	9,101	9,101
5	Chhattisgarh	12,008	4,948
6	Goa	205	205
7	Gujarat	14,583	14,716
8	Haryana	6,444	6,444
9	Himachal Pradesh	3,776	3,776
10	Jharkhand	4,689	4,689
11	Karnataka	6,554	6,554
12	Kerala	1,200	1,034
13	Madhya Pradesh	23,557	23,557
14	Maharashtra	28,649	28,649
15	Manipur	2,260	199
16	Meghalaya	6,484	6,484
17	Mizoram	894	894
18	Nagaland	1,276	1,276
19	Odisha	7,256	7,256
20	Punjab	13,599	13,599
21	Rajasthan	11,882	11,882
22	Sikkim	196	196
23	Tamil Nadu	13,615	13,615
24	Telangana	13,461	13,461
25	Tripura	1,264	1,264
26	Uttarakhand	7,991	7,991
27	Uttar Pradesh	59,407	59,407
28	West Bengal	3,830	3,830
UNION TERRITORIES			
29	Andaman & Nicobar Islands	71	71
30	Chandigarh	1	1
31	Daman & Diu	44	44
32	Delhi	1	0
33	Jammu & Kashmir	4,658	4,366
34	Ladakh	195	6
35	Lakshadweep	10	10
36	Puducherry	15	0
	Total	**2,77,688**	**2,68,037**

Source: Ministry of Environment, Forest and Climate Change

India's alignment with International Agreements and Commitments

5.42 India is a signatory to several Multi-lateral Environmental Agreements (MEAs) relating to the conservation and management of wildlife such as the Convention on Biological Diversity (CBD)[81], the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES)[82] etc. There is a growing consciousness about the value of biodiversity and the need for its conservation.

5.43 The Government of India has taken several steps to protect biodiversity. India brought out the National Environment Policy (NEP) in 2006 which provided the much-needed synergy and coherence for sustainable development in all the sectoral policies. The specific provisions of sector-specific policies help in protecting biodiversity and conservation and sustainable use of natural resources. India reported its progress in implementing the National Biodiversity Action Plan to CBD in 2019.

5.44 India has adopted whole of government and whole of society approach by involving all the relevant stakeholders at national, sub-national and civil society organizations towards updating its National Biodiversity Strategy and Action Plan in alignment with the Global Biodiversity Framework to adopt its own National Biodiversity Targets. India has prepared a new set of plans in the National Biodiversity Strategy and Action Plan, 2024, in line with the Kunming-Montreal Global Biodiversity Framework for implementing the action plans for conservation and sustainable use of biodiversity.

5.45 The Kunming-Montreal Global Biodiversity Framework (GBF) was adopted during the fifteenth meeting of the Conference of the Parties (COP 15)[83]. The framework sets out an ambitious plan to implement broad-based action to bring 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.

Conclusion

5.46 India was one of the pioneering countries to enact comprehensive legislation through its Biological Diversity (BD) Act in 2002, with Rules notified in 2004. The Act aimed to conserve the nation's biological resources, use them in a sustainable manner

[81] https://www.cbd.int/countries/?country=in
[82] https://cites.org/eng/parties/country-profiles/in
[83] https://www.cbd.int/gbf

and enable fair and equitable sharing benefits arising out of the use and knowledge of biological resources with the local communities. Subsequently, the Act was amended in 2023, and the same came into force on 1st April 2024 as per the MoEFCC notification dated 18.01.2024. This amendment has now given scope to significant legal provisions for better implementation of the CBD's triple objectives of ensuring conservation of biodiversity, sustainable use and fair and equitable sharing of benefits arising from its utilization.

5.47 In addition, India has been aligning its efforts towards many of the International Agreements and is committed to actions as agreed upon. Conservation of biodiversity has focused on eliminating Alien Invasive Species, initiatives to conserve IUCN Red listed species, plant and animal genetic resources through its gene banks etc. At the national level, strong institutional frameworks and mechanisms have been set up like BMCs, documenting nation's biodiversity through PBRs and giving inputs to the SBBs. Additionally, India has established Biodiversity Heritage Sites (BHSs) with the aim to preserve the unique and fragile ecosystems as well as regulating the Access and Benefit Sharing (ABS) mechanism to ensure that the benefits reach the deserving conservers and holders of traditional knowledge.

5.48 The very existence of legislation and policies is proof that some consensus has developed concerning the importance of conserving species and ecosystems. This publication provides information about biodiversity and enables one to get a fair idea about the biodiversity scenario of the country. Biodiversity impacts many aspects of sustainability and keeping a tap on it is vital for both environmental, social, and economic development.

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Annexure

Annexure 2.1 (a): Physical Asset Account for Energy- Coal

	Type of Energy Resource						
	Coal (Proved Category)						
	Million tonnes						
	2015-16	**2016-17**	**2017-18**	**2018-19**	**2019-20**	**2020-21**	**2021-22**
Opening stock of mineral and energy resources (Closing for last FY)	**69,818**	**73,292**	**75,184**	**77,740**	**81,141**	**85,562**	**95,905**
Additions in stock:							
Discoveries	6,473	4,971	5,729	6,827	7,857	13,708	9,926
Upward appraisals							
TOTAL ADDITION TO THE STOCK	**6,473**	**4,971**	**5,729**	**6,827**	**7,857**	**13,708**	**9,926**
Reduction in Stock:							
Extraction	638	655	675	729	731	716	778
Sterilization Loss	2,361	2,424	2,498	2,697	2,705	2,649	2,879
Downwards reappraisals							
TOTAL REDUCTION IN STOCK	**2,999**	**3,079**	**3,173**	**3,426**	**3,436**	**3,365**	**3,657**
Closing Stock of mineral and energy resources	**73,292**	**75,184**	**77,740**	**81,141**	**85,562**	**95,905**	**1,02,174**

Source: Geological Survey of India
*Sterilization Loss for Coal = Extraction*3.7*

Annexure 2.1 (b) : Physical Asset Account for Energy- Lignite

	Type of Energy Resource						
	Lignite (Proved Category)						
	Million tonnes						
	2015-16	**2016-17**	**2017-18**	**2018-19**	**2019-20**	**2020-21**	**2021-22**
Opening stock of mineral and energy resources (Closing for last FY)	**2,364**	**2,527**	**2,326**	**2,116**	**2,167**	**2,161**	**2,401**
Additions in stock:							
Discoveries	359	0	0	247	181	405	6
Upward appraisals							
TOTAL ADDITION TO THE STOCK	**359**	**0**	**0**	**247**	**181**	**405**	**6**
Reduction in Stock:							
Extraction	44	45	47	44	42	37	48
Sterilization Loss	152	156	163	152	145	128	166
Downwards reappraisals							
TOTAL REDUCTION IN STOCK	**196**	**201**	**210**	**196**	**187**	**165**	**214**
Closing Stock of mineral and energy resources	**2,527**	**2,326**	**2,116**	**2,167**	**2,161**	**2,401**	**2,193**

Source: Geological Survey of India

*Sterilization Loss for Lignite = Extraction*3.46*

Annexure 2.1 (c) : Physical Asset Account for Energy- Crude Oil

	Type of Energy Resource						
	Crude Oil (2P Reserve)						
	Million BBL						
	2015-16	**2016-17**	**2017-18**	**2018-19**	**2019-20**	**2020-21**	**2021-22**
Opening stock of mineral and energy resources (Closing for last FY)	**4,659**	**4,554**	**4,428**	**4,358**	**3,701**	**3,592**	**3,352**
Additions in stock:							
Discoveries	180	131	187	425	247	88	157
Upward appraisals	0	7	4	0	0	28	0
TOTAL ADDITION TO THE STOCK	**180**	**138**	**191**	**425**	**247**	**115**	**157**
Reduction in Stock:							
Extraction	271	264	262	251	236	224	218
Sterilization Loss							
Downwards reappraisals	14	0	0	832	120	0	0
TOTAL REDUCTION IN STOCK	**285**	**264**	**262**	**1,082**	**356**	**224**	**218**
Closing Stock of mineral and energy resources	**4,554**	**4,428**	**4,358**	**3,701**	**3,592**	**3,484**	**3,291**

Source: M/o Petroleum and Natural Gas.

Remarks:

1. A uniform conversion factor of 1 Ton = 7.33 BBL is considered for all fields.
2. Opening stock for year 2021-22 has been back calculated as PRMS compilation started in year 2021.
3. Difference in Closing stock for 2020-21 & opening stock of 2021-22 is due to introduction/adoption of PRMS in year 2021.
4. ONGC adopted PRMS system w.e.f. 01.04.2019, hence the above figures does not include 2C figures from 2019-20 onwards.
5. Opening Stock of Mineral and energy resources (last FY) from 2015-16 to 2019-20 taken from final Annual PNG Statistics Report 2019-20 (mopng.gov.in) after deducting 2C reserves as applicable.

Annexure 2.1 (d) : Physical Asset Account for Energy- Natural Gas

	Type of Energy Resource						
	Natural Gas (2P Reserve)						
	MMSCM						
	2015-16	**2016-17**	**2017-18**	**2018-19**	**2019-20**	**2020-21**	**2021-22**
Opening stock of mineral and energy resources (Closing for last FY)	**12,51,990**	**12,27,500**	**12,89,703**	**13,39,573**	**11,56,220**	**11,56,126**	**6,63,831**
Additions in stock:							
Discoveries	43,080	93,970	83,740	74,020	40,300	30,250	19,753
Upward appraisals	0	130	0	0	7,990	740	
TOTAL ADDITION TO THE STOCK	**43,080**	**94,100**	**83,740**	**74,020**	**48,290**	**30,990**	**19,753**
Reduction in Stock:							
Extraction	32,249	31,897	32,649	32,873	31,184	28,672	34,024
Sterilization Loss							
Downwards reappraisals	35,321	0	1,221	2,24,500	17,200	16,400	
TOTAL REDUCTION IN STOCK	**67,570**	**31,897**	**33,870**	**2,57,373**	**48,384**	**45,072**	**34,024**
Closing Stock of mineral and energy resources	**12,27,500**	**12,89,703**	**13,39,573**	**11,56,220**	**11,56,126**	**11,42,043**	**6,49,560**

Source: M/o Petroleum and Natural Gas

Remarks:

1. Opening stock for year 2021-22 has been back calculated as PRMS compilation started in year 2021.
2. Difference in Closing stock for 2020-21 & opening stock of 2021-22 is due to introduction/adoption of PRMS in year 2021.
3.ONGC adopted PRMS system w.e.f. 01.04.2019, hence the above figures does not include 2C figures from 2019-20 onwards.
4. Opening Stock of Mineral and energy resources (last FY) from 2015-16 to 2019-20 taken from final Annual PNG Statistics Report 2019-20 (mopng.gov.in) after deducting 2C reserves as applicable.
5. Downwards reappraisals: DSF Surrender

Annexure 2.2 (a): Physical Supply Table of Energy- 2015-16

PHYSICAL SUPPLY TABLE (Unit: PJ)	Production (Incl. household own account) & generation of residuals							Accumulation	Imports	Flows from the Environment	Total
	Industries (by ISIC)						Households				
	Agriculture Forestry & Fishery	Mining& Quarrying	Manufacturing	Electricity, gas, steam & air conditioning supply	Transportation & Storage	Other Industries					
	(ISIC A)	(ISIC B)	(ISIC C)	(ISIC D)	(ISIC M)						
Energy from natural inputs:											
Natural resource inputs											
Coal#										11958	11958
Lignite											
Crude Oil										1581	1581
Natural Gas										1242	1242
Nuclear										408	408
Inputs from RES										244	244
Hydro										437	437
Total										**15870**	**15870**
Energy Products:											
Production of energy products by SIEC class:											
Coal#		11958							4482		16440
Lignite											
Crude Oil		1581							8680		10260
Oil Products			9,888						1187		11075
Natural Gas		1242							824		2066

PHYSICAL SUPPLY TABLE (Unit: PJ)	Production (Incl. household own account) & generation of residuals							Accumulation	Imports	Flows from the Environment	Total
	Industries (by ISIC)						Households				
	Agriculture Forestry & Fishery	Mining& Quarrying	Manufacturing	Electricity, gas, steam & air conditioning supply	Transportation & Storage	Other Industries					
	(ISIC A)	(ISIC B)	(ISIC C)	(ISIC D)	(ISIC M)						
Electricity				4810					**19**		4829
Total		**14780**	**9888**	**4810**					**15192**		**44671**
Energy Residuals:											
Distribution		808		867							1675
Extraction											
Other Losses											
Other Energy Residuals	661	632	2900	286	1817	13596	1949				21841
Total energy residuals	**661**	**1440**	**2900**	**1153**	**1817**	**13596**	**1949**				**23516**
Other Residual Flows:											
Residuals from end-use for non-energy purposes											
Energy from solid waste											
TOTAL SUPPLY	**661**	**16220**	**12788**	**5963**	**1817**	**13596**	**1949**		**15192**	**15870**	**84056**

Includes Lignite

Total may not add up due to rounding off

Annexure 2.2 (b): Physical Use Table of Energy-2015-16

PHYSICAL USE TABLE (Unit: PJ)	Intermediate consumption, Use of energy resources, receipt of energy losses							Final Consumption	Accumulation	Export	Statistical difference	Flows to the Environment	Total
	Industries (by ISIC)							Households					
	Agriculture Forestry & Fishery	Mining & Quarrying	Manufacturing	Electricity, gas, steam & air conditioning supply	Transportation & Storage	Construction	Other Industries						
	(ISIC A)	(ISIC B)	(ISIC C)	(ISIC D)	(ISIC M)								
Energy from natural inputs:													
Natural resource inputs													
Coal#		11958											11958
Lignite													
Crude Oil		1581											1581
Natural Gas		1242											1242
Nuclear				408									408
Inputs from RES				244									244
Hydro				437									437
Total		**14780**		**1090**									**15870**
Energy Products:													

PHYSICAL USE TABLE (Unit: PJ)	Intermediate consumption, Use of energy resources, receipt of energy losses							Final Consumption	Accumulation	Export	Statistical difference	Flows to the Environment	Total
	Industries (by ISIC)							Households					
	Agriculture Forestry & Fishery	Mining & Quarrying	Manufacturing	Electricity, gas, steam & air conditioning supply	Transportation & Storage	Construction	Other Industries						
	(ISIC A)	(ISIC B)	(ISIC C)	(ISIC D)	(ISIC M)								
Transformation of energy products by SIEC class													
Coal#				9373									9373
Lignite													
Crude Oil			9964										9964
Oil Products				38									38
Natural Gas				419									419
Electricity													
Total Transformed Energy			**9964**	**9830**									**19794**
End-use of energy products by SIEC class:													
Coal#	0	0	1540		0	205	5326	0	-161	44	112		7067
Lignite													

PHYSICAL USE TABLE (Unit: PJ)	Intermediate consumption, Use of energy resources, receipt of energy losses							Final Consumption	Accumulation	Export	Statistical difference	Flows to the Environment	Total
	Industries (by ISIC)							Households					
	Agriculture Forestry & Fishery	Mining & Quarrying	Manufacturing	Electricity, gas, steam & air conditioning supply	Transportation & Storage	Construction	Other Industries						
	(ISIC A)	(ISIC B)	(ISIC C)	(ISIC D)	(ISIC M)								
Crude Oil							803				-507		296
Oil Products	30	53	575		1531	31	4484	1089		2636	610		11038
Natural Gas	7	578	786		226	0	55	0		**0**	**-6**		1646
Electricity	624	0	0	286	60	0	2929	860		19	53		4829
Total End Use for Energy purposes	**661**	**632**	**2900**	**286**	**1817**	**236**	**13596**	**1949**	**-161**	**2699**	**262**		**24877**
End-use of energy products for non-energy purposes													
Energy Residuals:													
Distribution												1675	1675
Extraction												0	0

PHYSICAL USE TABLE (Unit: PJ)	Intermediate consumption, Use of energy resources, receipt of energy losses							Final Consumption	Accumulation	Export	Statistical difference	Flows to the Environment	Total
	Industries (by ISIC)							Households					
	Agriculture Forestry & Fishery	Mining & Quarrying	Manufacturing	Electricity, gas, steam & air conditioning supply	Transportation & Storage	Construction	Other Industries						
	(ISIC A)	(ISIC B)	(ISIC C)	(ISIC D)	(ISIC M)								
Other Losses												0	0
Other Energy Residuals												21841	21841
Total energy residuals												**23516**	**23516**
Other Residual Flows:													
Residuals from end-use for non-energy purposes									0				**0**
Energy from solid waste													
TOTAL USE	**661**	**15412**	**12864**	**11206**	**1817**	**236**	**13596**	**1949**	**-161**	**2699**	**262**	**23516**	**84057**

 # Includes Lignite **Total may not add up due to rounding off**

Annexure 2.3 (a): Physical Supply Table of Energy-2016-17

PHYSICAL SUPPLY TABLE (Unit: PJ)	Production (Incl. household own account) & generation of residuals										
	Industries (by ISIC)						Households	[illegible]	Imports	Flows from the Environment	Total
	Agriculture Forestry & Fishery	Mining & Quarrying	Manufacturing	Electricity, gas, steam & air conditioning supply	Transportation & Storage	Other Industries					
	(ISIC A)	(ISIC B)	(ISIC C)	(ISIC D)	(ISIC M)						
Energy from natural inputs:											
Natural resource inputs											
Coal#										12154	12154
Lignite											
Crude Oil										1541	1541
Natural Gas										1228	1228
Nuclear										414	414
Inputs from RES										302	302
Hydro										441	441
Total										**16080**	**16080**
Energy Products:											
Production of energy products by SIEC class:											
Coal#		12154							4236		16390
Lignite											
Crude Oil		1541							9154		10695

PHYSICAL SUPPLY TABLE (Unit: PJ)	Production (Incl. household own account) & generation of residuals										
	Industries (by ISIC)						Households	[illegible]	Imports	Flows from the Environment	Total
	Agriculture Forestry & Fishery (ISIC A)	Mining & Quarrying (ISIC B)	Manufacturing (ISIC C)	Electricity, gas, steam & air conditioning supply (ISIC D)	Transportation & Storage (ISIC M)	Other Industries					
Oil Products			10,391						1441		11831
Natural Gas		1228							957		2185
Electricity				5068					**20**		5088
Total		**14923**	**10391**	**5068**					**15808**		**46190**
Energy Residuals:											
Distribution		862		897							1759
Extraction											
Other Losses											
Other Energy Residuals	724	633	2746	292	2005	13878	2030				22308
Total energy residuals	724	1494	2746	1189	2005	13878	2030				24066
Other Residual Flows:											
Residuals from end-use for non-energy purposes											
Energy from solid waste											
TOTAL SUPPLY	**724**	**16418**	**13137**	**6257**	**2005**	**13878**	**2030**		**15808**	**16080**	**86336**

 # Includes Lignite

Total may not add up due to rounding off

Annexure 2.3 (b): Physical Use Table of Energy-2016-17

PHYSICAL USE TABLE (Unit: PJ)	Intermediate consumption, Use of energy resources, receipt of energy losses							Final Consumption	Accumulation	Export	Statistical difference	Flows to the Environment Imports	Total
	Industries (by ISIC)							Households					
	Agriculture Forestry & Fishery	Mining& Quarrying	Manufacturing	Electricity, gas, steam & air conditioning supply	Transportation & Storage	Construction	Other Industries						
	(ISIC A)	(ISIC B)	(ISIC C)	(ISIC D)	(ISIC M)								
Energy from natural inputs:													
Natural resource inputs													
Coal#		12154											12154
Lignite													
Crude Oil		1541											1541
Natural Gas		1228											1228
Nuclear				414									414
Inputs from RES				302									302
Hydro				441									441
Total		**14923**		**1157**									16080
Energy Products:													
Transformation of energy products by SIEC class													
Coal#				9686									9686
Lignite													

PHYSICAL USE TABLE (Unit: PJ)	Intermediate consumption, Use of energy resources, receipt of energy losses							Final Consumption	Accumulation	Export	Statistical difference	Flows to the Environment Imports	Total
	Industries (by ISIC)							Households					
	Agriculture Forestry & Fishery	Mining& Quarrying	Manufacturing	Electricity, gas, steam & air conditioning supply	Transportation & Storage	Construction	Other Industries						
	(ISIC A)	(ISIC B)	(ISIC C)	(ISIC D)	(ISIC M)								
Crude Oil			10499										10499
Oil Products				34									34
Natural Gas				447									447
Electricity													
Total Transformed Energy			**10499**	**10168**									**20666**
End-use of energy products by SIEC class:													
Coal# Lignite	0	0	1370		0	149	5179	0	-300	50	256		6704
Crude Oil							859				-663		196
Oil Products	29	56	587		1647	31	4725	1109		2857	756		11797
Natural Gas	7	577	789		301	0	63	0		0	2		1739
Electricity	688	0	0	292	56	0	3052	921		24	54		5088
Total End Use for Energy purposes	724	633	2746	292	2005	180	13878	2030	-300	2932	405		25524

PHYSICAL USE TABLE (Unit: PJ)	Intermediate consumption, Use of energy resources, receipt of energy losses							Final Consumption	Accumulation	Export	Statistical difference	Flows to the Environment Imports	Total
	Industries (by ISIC)							Households					
	Agriculture Forestry & Fishery	Mining& Quarrying	Manufacturing	Electricity, gas, steam & air conditioning supply	Transportation & Storage	Construction	Other Industries						
	(ISIC A)	(ISIC B)	(ISIC C)	(ISIC D)	(ISIC M)								
End-use of energy products for non-energy purposes													
Energy Residuals:													
Distribution												1759	1759
Extraction												0	0
Other Losses												0	0
Other Energy Residuals												22308	22308
Total energy residuals												**24066**	**24066**
Other Residual Flows:													
Residuals from end-use for non-energy purposes									0				**0**
Energy from solid waste													**0**
TOTAL USE	**724**	**15556**	**13245**	**11616**	**2005**	**180**	**13878**	**2030**	**-300**	**2932**	**405**	**24066**	**86337**

 # Includes Lignite

Total may not add up due to rounding off

Annexure 2.4 (a): Physical Supply Table of Energy-2017-18

PHYSICAL SUPPLY TABLE (Unit: PJ)	Production (Incl. household own account) & generation of residuals							Accumulation	Imports	Flows from the Environment	Total
	Industries (by ISIC)						Households				
	Agriculture Forestry & Fishery	Mining & Quarrying	Manufacturing	Electricity, gas, steam & air conditioning supply	Transportation & Storage	Other Industries					
	(ISIC A)	(ISIC B)	(ISIC C)	(ISIC D)	(ISIC M)						
Energy from natural inputs:											
Natural resource inputs											
Coal#										12140	12140
Lignite											
Crude Oil										1527	1527
Natural Gas										1257	1257
Nuclear										418	418
Inputs from RES										375	375
Hydro										455	455
Total										**16173**	**16173**
Energy Products:											
Production of energy products by SIEC class:											
Coal#		12140							4619		16760
Lignite											
Crude Oil		1527							9432		10959
Oil Products			10,851						1420		12271
Natural Gas		1257							1057		2314

PHYSICAL SUPPLY TABLE (Unit: PJ)	Production (Incl. household own account) & generation of residuals							Accumulation	Imports	Flows from the Environment	Total
	Industries (by ISIC)						Households				
	Agriculture Forestry & Fishery	Mining & Quarrying	Manufacturing	Electricity, gas, steam & air conditioning supply	Transportation & Storage	Other Industries					
	(ISIC A)	(ISIC B)	(ISIC C)	(ISIC D)	(ISIC M)						
Electricity				5341					18		5359
Total		**14925**	**10851**	**5341**					16547		**47663**
Energy Residuals:											
Distribution		909		934							1843
Extraction											0
Other Losses											0
Other Energy Residuals	754	657	2935	296	2218	14443	2099				23401
Total energy residuals	754	1566	2935	1230	2218	14443	2099				**25244**
Other Residual Flows:											
Residuals from end-use for non-energy purposes											
Energy from solid waste											
TOTAL SUPPLY	**754**	**16491**	**13786**	**6570**	**2218**	**14443**	**2099**		**16547**	**16173**	**89080**

Includes Lignite

Total may not add up due to rounding off

Annexure 2.4 (b): Physical Use Table of Energy-2017-18

PHYSICAL USE TABLE (Unit: PJ)	Intermediate consumption, Use of energy resources, receipt of energy losses							Final Consumption	Accumulation	Export	Statistical difference	Flows to the Environment Imports	Total
	Industries (by ISIC)												
	Agriculture Forestry & Fishery	Mining& Quarrying	Manufacturing	Electricity, gas, steam & air conditioning supply	Transportation & Storage	Construction	Other Industries	Households					
	(ISIC A)	(ISIC B)	(ISIC C)	(ISIC D)	(ISIC M)								
Energy from natural inputs:													
Natural resource inputs													
Coal#		12140											12140
Lignite													
Crude Oil		1527											1527
Natural Gas		1257											1257
Nuclear				418									418
Inputs from RES				375									375
Hydro				455									455
Total	**0**	**14925**	**0**	**1248**	**0**		**0**						**16173**
Energy Products:													
Transformation of energy products by SIEC class													
Coal#				105640									105640
Lignite													

PHYSICAL USE TABLE (Unit: PJ)	Intermediate consumption, Use of energy resources, receipt of energy losses							Final Consumption	Accumulation	Export	Statistical difference	Flows to the Environment Imports	Total
	Industries (by ISIC)							Households					
	Agriculture Forestry & Fishery (ISIC A)	Mining& Quarrying (ISIC B)	Manufacturing (ISIC C)	Electricity, gas, steam & air conditioning supply (ISIC D)	Transportation & Storage (ISIC M)	Construction	Other Industries						
Crude Oil			10780										10780
Oil Products				31									31
Natural Gas				463									463
Electricity													0
Total Transformed Energy	**0**	**0**	**10780**	**11059**	**0**		**0**						**21839**
End-use of energy products by SIEC class:													
Coal#	0	0	1593		0	186	5187	0	335	42	-1149		6195
Lignite	0	0	0		0	0	0	0	0	0			0
Crude Oil							906				-727		179
Oil Products	30	57	572		1805	36	5064	1114		2913	650		12240
Natural Gas	**7**	600	769		350	0	73	0		**0**	**52**		1851
Electricity	717	0	0	296	63	0	3214	985		26	58		5359

PHYSICAL USE TABLE (Unit: PJ)	Intermediate consumption, Use of energy resources, receipt of energy losses							Final Consumption	Accumulation	Export	Statistical difference	Flows to the Environment Imports	Total
	Industries (by ISIC)							Households					
	Agriculture Forestry & Fishery	Mining& Quarrying	Manufacturing	Electricity, gas, steam & air conditioning supply	Transportation & Storage	Construction	Other Industries						
	(ISIC A)	(ISIC B)	(ISIC C)	(ISIC D)	(ISIC M)								
Total End Use for Energy purposes	**754**	**657**	**2935**	**296**	**2218**	**222**	**14443**	**2099**	**335**	**2981**	**-1116**		**25823**
End-use of energy products for non-energy purposes													
Energy Residuals:													
Distribution												1843	1843
Extraction												0	0
Other Losses												0	0
Other Energy Residuals												23401	23401
Total energy residuals												**25244**	**25244**
Other Residual Flows:													
Residuals from end-use for non-energy purposes									0				**0**

PHYSICAL USE TABLE (Unit: PJ)	Intermediate consumption, Use of energy resources, receipt of energy losses							Final Consumption	Accumulation	Export	Statistical difference	Flows to the Environment Imports	Total
	Industries (by ISIC)							Households					
	Agriculture Forestry & Fishery	Mining& Quarrying	Manufacturing	Electricity, gas, steam & air conditioning supply	Transportation & Storage	Construction	Other Industries						
	(ISIC A)	(ISIC B)	(ISIC C)	(ISIC D)	(ISIC M)								
Energy from solid waste													
TOTAL USE	**754**	**15582**	**13715**	**12603**	**2218**	**222**	**14443**	**2099**	**335**	**2981**	**-1116**	**25244**	**89079**

Includes Lignite

Total may not add up due to rounding off

Annexure 2.5 (a): Physical Supply Table of Energy-2018-19

PHYSICAL SUPPLY TABLE (Unit: PJ)	Production (Incl. household own account) & generation of residuals							Accumulation	Imports	Flows from the Environment	Total
	Industries (by ISIC)						Households				
	Agriculture Forestry & Fishery	Mining & Quarrying	Manufacturing	Electricity, gas, steam & air conditioning supply	Transportation & Storage	Other Industries					
	(ISIC A)	(ISIC B)	(ISIC C)	(ISIC D)	(ISIC M)						
Energy from natural inputs:											
Natural resource inputs											
Coal#										130100	130100
Lignite											
Crude Oil										1464	1464
Natural Gas										1266	1266
Nuclear										413	413
Inputs from RES										470	470
Hydro										487	487
Total										**17108**	**17108**
Energy Products:											
Production of energy products by SIEC class:											
Coal#		13010							5179		18189
Lignite											
Crude Oil		1464							9692		11155
Oil Products			11,184						1387		12571
Natural Gas		1266							1107		2373

PHYSICAL SUPPLY TABLE (Unit: PJ)	Production (Incl. household own account) & generation of residuals							Accumulation	Imports	Flows from the Environment	Total
	Industries (by ISIC)						Households				
	Agriculture Forestry & Fishery	Mining & Quarrying	Manufacturing	Electricity, gas, steam & air conditioning supply	Transportation & Storage	Other Industries					
	(ISIC A)	(ISIC B)	(ISIC C)	(ISIC D)	(ISIC M)						
Electricity				5706					**16**		5722
Total		**15739**	**11184**	**5706**					**17380**		**50010**
Energy Residuals:											
Distribution		922		973							1894
Extraction											
Other Losses											
Other Energy Residuals	809	700	3190	300	2389	15413	2200				25001
Total energy residuals	**809**	**1622**	**3190**	**1273**	**2389**	**15413**	**2200**				**26895**
Other Residual Flows:											
Residuals from end-use for non-energy purposes											
Energy from solid waste											
TOTAL SUPPLY	**809**	**17361**	**14375**	**6980**	**2389**	**15413**	**2200**		**17380**	**17108**	**94014**

Includes Lignite

Total may not add up due to rounding off

Annexure 2.5 (b): Physical Use Table of Energy- 2018-19

PHYSICAL USE TABLE (Unit: PJ)	Intermediate consumption, Use of energy resources, receipt of energy losses							Final Consumption	Accumulation	Export	Statistical difference	Flows to the Environment	Total
	Industries (by ISIC)												
	Agriculture Forestry & Fishery	Mining& Quarrying	Manufacturing	Electricity, gas, steam & air conditioning supply	Transportation & Storage	Construction	Other Industries	Households					
	(ISIC A)	(ISIC B)	(ISIC C)	(ISIC D)	(ISIC M)								
Energy from natural inputs:													
Natural resource inputs													
Coal#		130100											130100
Lignite													
Crude Oil		1464											1464
Natural Gas		1266											1266
Nuclear				413									413
Inputs from RES				470									470
Hydro				487									487
Total		**15739**		**1369**									**17108**
Energy Products:													
Transformation of energy products by SIEC class													
Coal#				111910									111910
Lignite													

PHYSICAL USE TABLE (Unit: PJ)	Intermediate consumption, Use of energy resources, receipt of energy losses							Final Consumption	Accumulation	Export	Statistical difference	Flows to the Environment	Total
	Industries (by ISIC)							Households					
	Agriculture Forestry & Fishery	Mining& Quarrying	Manufacturing	Electricity, gas, steam & air conditioning supply	Transportation & Storage	Construction	Other Industries						
	(ISIC A)	(ISIC B)	(ISIC C)	(ISIC D)	(ISIC M)								
Crude Oil			11006										11006
Oil Products				36									36
Natural Gas				462									462
Electricity													0
Total Transformed Energy			**11006**	**11689**									**22695**
End-use of energy products by SIEC class:													
Coal# Lignite	0	0	1833		0	223	5792	0	121	38	-1010		6997
Crude Oil							918				-768		150
Oil Products	33	67	606		1946	45	5168	1162		2659	850		12536
Natural Gas	**7**	634	751		375	0	79	0		**0**	**64**		1910
Electricity	768	0	0	300	68	0	3455	1038		30	62		5722

PHYSICAL USE TABLE (Unit: PJ)	Intermediate consumption, Use of energy resources, receipt of energy losses							Final Consumption	Accumulation	Export	Statistical difference	Flows to the Environment	Total
	Industries (by ISIC)							Households					
	Agriculture Forestry & Fishery	Mining& Quarrying	Manufacturing	Electricity, gas, steam & air conditioning supply	Transportation & Storage	Construction	Other Industries						
	(ISIC A)	(ISIC B)	(ISIC C)	(ISIC D)	(ISIC M)								
Total End Use for Energy purposes	**809**	**700**	**3190**	**300**	**2389**	**268**	**15413**	**2200**	**121**	**2727**	**-802**		**27316**
End-use of energy products for non-energy purposes													
Energy Residuals:													
Distribution												1894	1894
Extraction												0	0
Other Losses												0	0
Other Energy Residuals												25001	25001
Total energy residuals												**26895**	**26895**
Other Residual Flows:													
Residuals from end-use for non-energy purposes									0				**0**

PHYSICAL USE TABLE (Unit: PJ)	Intermediate consumption, Use of energy resources, receipt of energy losses							Final Consumption	Accumulation	Export	Statistical difference	Flows to the Environment	Total
	Industries (by ISIC)												
	Agriculture Forestry & Fishery	Mining& Quarrying	Manufacturing	Electricity, gas, steam & air conditioning supply	Transportation & Storage	Construction	Other Industries	Households					
	(ISIC A)	(ISIC B)	(ISIC C)	(ISIC D)	(ISIC M)								
Energy from solid waste													
TOTAL USE	**809**	**16440**	**14196**	**13358**	**2389**	**268**	**15413**	**2200**	**121**	**2727**	**-802**	**26895**	**94014**

Includes Lignite

Total may not add up due to rounding off

Annexure 2.6 (a): Physical Supply Table of Energy-2019-20

PHYSICAL SUPPLY TABLE (Unit: PJ)	Production (Incl. household own account) & generation of residuals							Accumulation	Imports	Flows from the Environment	Total
	Industries (by ISIC)						Households				
	Agriculture Forestry & Fishery	Mining& Quarrying	Manufacturing	Electricity, gas, steam & air conditioning supply	Transportation & Storage	Other Industries					
	(ISIC A)	(ISIC B)	(ISIC C)	(ISIC D)	(ISIC M)						
Energy from natural inputs:											
Natural resource inputs											
Coal#										129230	129230
Lignite											
Crude Oil										1376	1376
Natural Gas										1201	1201
Nuclear										507	507
Inputs from RES										521	521
Hydro										562	562
Total										17090	17090
Energy Products:											
Production of energy products by SIEC class:											
Coal#		12923							5485		18407
Lignite											
Crude Oil		1376							9711		11088
Oil Products			11,209						1802		13012

PHYSICAL SUPPLY TABLE (Unit: PJ)	Production (Incl. household own account) & generation of residuals							Accumulation	Imports	Flows from the Environment	Total
	Industries (by ISIC)						Households				
	Agriculture Forestry & Fishery (ISIC A)	Mining& Quarrying (ISIC B)	Manufacturing (ISIC C)	Electricity, gas, steam & air conditioning supply (ISIC D)	Transportation & Storage (ISIC M)	Other Industries					
Natural Gas		1201							1305		2506
Electricity				5844					**23**		5867
Total		**15500**	**11209**	**5844**					**18326**		**50879**
Energy Residuals:											
Distribution		1013		975							1988
Extraction											0
Other Losses											0
Other Energy Residuals	800	766	3127	300	2510	15270	2294				25066
Total energy residuals	800	1779	3127	1275	2510	15270	2294				**27053**
Other Residual Flows:											
Residuals from end-use for non-energy purposes											0
Energy from solid waste											
TOTAL SUPPLY	**800**	**17279**	**14336**	**7118**	**2510**	**15270**	**2294**		**18326**	**17090**	**95023**

Includes Lignite

Total may not add up due to rounding off

Annexure 2.6 (b): Physical Use Table of Energy- 2019-20

PHYSICAL USE TABLE (Unit: PJ)	Intermediate consumption, Use of energy resources, receipt of energy losses							Final Consumption	Accumulation	Export	Statistical difference	Flows to the Environment Imports	Total
	Industries (by ISIC)							Households					
	Agriculture Forestry & Fishery	Mining& Quarrying	Manufacturing	Electricity, gas, steam & air conditioning supply	Transportation & Storage	Construction	Other Industries						
	(ISIC A)	(ISIC B)	(ISIC C)	(ISIC D)	(ISIC M)								
Energy from natural inputs:													
Natural resource inputs													
Coal#		12923											12923
Lignite													
Crude Oil		1376											1376
Natural Gas		1201											1201
Nuclear				507									507
Inputs from RES				521									521
Hydro				562									562
Total		**15500**		**1590**									**17090**
Energy Products:													
Transformation of energy products by SIEC class													

PHYSICAL USE TABLE (Unit: PJ)	Intermediate consumption, Use of energy resources, receipt of energy losses							Final Consumption	Accumulation	Export	Statistical difference	Flows to the Environment Imports	Total
	Industries (by ISIC)							Households					
	Agriculture Forestry & Fishery	Mining& Quarrying	Manufacturing	Electricity, gas, steam & air conditioning supply	Transportation & Storage	Construction	Other Industries						
	(ISIC A)	(ISIC B)	(ISIC C)	(ISIC D)	(ISIC M)								
Coal#				11205									11205
Lignite													
Crude Oil			10885										10885
Oil Products				37									37
Natural Gas				427									427
Electricity													
Total Transformed Energy			**10885**	**11669**									**22554**
End-use of energy products by SIEC class:													
Coal#	0	0	1750		0	205	5524	0	-576	30	268		7202
Lignite													
Crude Oil							1010				-808		202
Oil Products	31	71	596		2002	46	5145	1182		2868	1034		12975

PHYSICAL USE TABLE (Unit: PJ)	Intermediate consumption, Use of energy resources, receipt of energy losses							Final Consumption	Accumulation	Export	Statistical difference	Flows to the Environment Imports	Total
	Industries (by ISIC)							Households					
	Agriculture Forestry & Fishery	Mining& Quarrying	Manufacturing	Electricity, gas, steam & air conditioning supply	Transportation & Storage	Construction	Other Industries						
	(ISIC A)	(ISIC B)	(ISIC C)	(ISIC D)	(ISIC M)								
Natural Gas	**8**	695	780		439	0	63	0		**0**	**95**		2080
Electricity	761	0	0	300	69	0	3527	1112		34	64		5867
Total End Use for Energy purposes	**800**	**766**	**3127**	**300**	**2510**	**251**	**15270**	**2294**	**-576**	**2932**	**653**		**28325**
End-use of energy products for non-energy purposes													
Energy Residuals:													
Distribution												1988	1988
Extraction												0	0
Other Losses												0	0
Other Energy Residuals												25066	25066
Total energy residuals												**27053**	**27053**
Other Residual Flows:													

PHYSICAL USE TABLE (Unit: PJ)	Intermediate consumption, Use of energy resources, receipt of energy losses							Final Consumption	Accumulation	Export	Statistical difference	Flows to the Environment Imports	Total
	Industries (by ISIC)							Households					
	Agriculture Forestry & Fishery	Mining& Quarrying	Manufacturing	Electricity, gas, steam & air conditioning supply	Transportation & Storage	Construction	Other Industries						
	(ISIC A)	(ISIC B)	(ISIC C)	(ISIC D)	(ISIC M)								
Residuals from end-use for non-energy purposes									0				**0**
Energy from solid waste													**0**
TOTAL USE	**800**	**16266**	**14012**	**13559**	**2510**	**251**	**15270**	**2294**	**-576**	**2932**	**653**	**27053**	**95023**

Includes Lignite

Total may not add up due to rounding off

Annexure 2.7 (a): Physical Supply Table of Energy- 2020-21

PHYSICAL SUPPLY TABLE (Unit: PJ)	Production (Incl. household own account) & generation of residuals							Accumulation	Imports	Flows from the Environment	Total
	Industries (by ISIC)						Households				
	Agriculture Forestry & Fishery (ISIC A)	Mining& Quarrying (ISIC B)	Manufacturing (ISIC C)	Electricity, gas, steam & air conditioning supply (ISIC D)	Transportation & Storage (ISIC M)	Other Industries					
Energy from natural inputs:											
Natural resource inputs											
Coal#										12467	12467
Lignite											
Crude Oil										1305	1305
Natural Gas										1110	1110
Nuclear										469	469
Inputs from RES										556	556
Hydro										542	542
Total										**16450**	**16450**
Energy Products:											
Production of energy products by SIEC class:											
Coal#		12467							4837		17305
Lignite											
Crude Oil		1305							8406		9711
Oil Products			9,957						1797		11754

PHYSICAL SUPPLY TABLE (Unit: PJ)	Production (Incl. household own account) & generation of residuals							Accumulation	Imports	Flows from the Environment	Total
	Industries (by ISIC)						Households				
	Agriculture Forestry & Fishery (ISIC A)	Mining& Quarrying (ISIC B)	Manufacturing (ISIC C)	Electricity, gas, steam & air conditioning supply (ISIC D)	Transportation & Storage (ISIC M)	Other Industries					
Natural Gas		1110							1279		2390
Electricity				5754					**34**		5788
Total		**14882**	**9957**	**5754**					**16354**		**46948**
Energy Residuals:											
Distribution		978		981							1959
Extraction											0
Other Losses											0
Other Energy Residuals	834	780	3046	290	2032	14527	2446				23955
Total energy residuals	834	1759	3046	1270	2032	14527	2446				**25914**
Other Residual Flows:											
Residuals from end-use for non-energy purposes											0
Energy from solid waste											
TOTAL SUPPLY	**834**	**16641**	**13003**	**7024**	**2032**	**14527**	**2446**		**16354**	**16450**	**89312**

Includes Lignite

Total may not add up due to rounding off

Annexure 2.7 (b): Physical Use Table of Energy- 2020-21

PHYSICAL USE TABLE (Unit: PJ)	Intermediate consumption, Use of energy resources, receipt of energy losses							Final Consumption	Accumulation	Export	Statistical difference	Flows to the Environment Imports	Total
	Industries (by ISIC)												
	Agriculture Forestry & Fishery	Mining& Quarrying	Manufacturing	Electricity, gas, steam & air conditioning supply	Transportation & Storage	Construction	Other Industries	Households					
	(ISIC A)	(ISIC B)	(ISIC C)	(ISIC D)	(ISIC M)								
Energy from natural inputs:													
Natural resource inputs													
Coal#		124670											124670
Lignite													
Crude Oil		1305											1305
Natural Gas		1110											1110
Nuclear				469									469
Inputs from RES				556									556
Hydro				542									542
Total		**14882**		**1568**									**16450**
Energy Products:													
Transformation of energy products by SIEC class													
Coal#				10196									10196
Lignite													

PHYSICAL USE TABLE (Unit: PJ)	Intermediate consumption, Use of energy resources, receipt of energy losses							Final Consumption	Accumulation	Export	Statistical difference	Flows to the Environment Imports	Total
	Industries (by ISIC)												
	Agriculture Forestry & Fishery	Mining& Quarrying	Manufacturing	Electricity, gas, steam & air conditioning supply	Transportation & Storage	Construction	Other Industries	Households					
	(ISIC A)	(ISIC B)	(ISIC C)	(ISIC D)	(ISIC M)								
Crude Oil			9489										9489
Oil Products				32									32
Natural Gas				420									420
Electricity													
Total Transformed Energy			**9489**	**10648**									**20137**
End-use of energy products by SIEC class:													
Coal#	0	0	1608		0	162	5466	0	-482	85	271		7109
Lignite													
Crude Oil							976				-754		222
Oil Products	30	75	605		1605	53	4657	1255		2474	969		11722
Natural Gas	**7**	705	833		374	0	59	0		**0**	**-8**		1970
Electricity	797	0	0	290	53	0	3369	1191		34	54		5788
Total End Use for Energy purposes	**834**	**780**	**3046**	**290**	**2032**	**214**	**14527**	**2446**	**-482**	**2593**	**532**		**26812**
End-use of energy products for non-energy purposes													
Energy Residuals:													

PHYSICAL USE TABLE (Unit: PJ)	Intermediate consumption, Use of energy resources, receipt of energy losses							Final Consumption	Accumulation	Export	Statistical difference	Flows to the Environment Imports	Total
	Industries (by ISIC)							Households					
	Agriculture Forestry & Fishery	Mining& Quarrying	Manufacturing	Electricity, gas, steam & air conditioning supply	Transportation & Storage	Construction	Other Industries						
	(ISIC A)	(ISIC B)	(ISIC C)	(ISIC D)	(ISIC M)								
Distribution												1959	1959
Extraction												0	0
Other Losses												0	0
Other Energy Residuals												23955	23955
Total energy residuals												**25914**	**25914**
Other Residual Flows:													
Residuals from end-use for non-energy purposes									0				**0**
Energy from solid waste													**0**
TOTAL USE	**834**	**15663**	**12535**	**12505**	**2032**	**214**	**14527**	**2446**	**-482**	**2593**	**532**	**25914**	**89313**

Includes Lignite Total may not add up due to rounding off

Annexure 2.8 (a): Physical Supply Table of Energy- 2021-22

PHYSICAL SUPPLY TABLE (Unit: PJ)	Production (Incl. household own account) & generation of residuals							Accumulation	Imports	Flows from the Environment	Total
	Industries (by ISIC)						Households				
	Agriculture Forestry & Fishery	Mining & Quarrying (ISIC B)	Manufacturing	Electricity, gas, steam & air conditioning supply	Transportation & Storage	Other Industries					
	(ISIC A)	(ISIC B)	(ISIC C)	(ISIC D)	(ISIC M)						
Energy from natural inputs:											
Natural resource inputs											
Coal										13091	13091
Lignite										453	453
Crude Oil										1270	1270
Natural Gas										1318	1318
Nuclear										514	514
Inputs from RES										640	640
Hydro										547	547
Total										**17834**	**17834**
Energy Products:											
Production of energy products by SIEC class:											
Coal		13091							4856		17948
Lignite		453							0		453
Crude Oil		1270							9088		10358
Oil Products			10,859						1671		12530

PHYSICAL SUPPLY TABLE (Unit: PJ)	Production (Incl. household own account) & generation of residuals							Accumulation	Imports	Flows from the Environment	Total
	Industries (by ISIC)						Households				
	Agriculture Forestry & Fishery	Mining & Quarrying (ISIC B)	Manufacturing	Electricity, gas, steam & air conditioning supply	Transportation & Storage	Other Industries					
	(ISIC A)	(ISIC B)	(ISIC C)	(ISIC D)	(ISIC M)						
Natural Gas		1318							1202		2519
Electricity				6099					**29**		6127
Total		**16133**	**10859**	**6099**					**16845**		**49936**
Energy Residuals:											
Distribution		1045		981							2026
Extraction											0
Other Losses											0
Other Energy Residuals	857	859	3185	312	2408	14386	2486				24493
Total energy residuals	**857**	**1904**	**3185**	**1293**	**2408**	**14386**	**2486**				**26519**
Other Residual Flows:											
Residuals from end-use for non-energy purposes											0
Energy from solid waste											
TOTAL SUPPLY	**857**	**18037**	**14044**	**7392**	**2408**	**14386**	**2486**		**16845**	**17834**	**94288**

Total may not add up due to rounding off

Annexure 2.8 (b): Physical Use Table of Energy- 2021-22

PHYSICAL USE TABLE (Unit: PJ)	Intermediate consumption, Use of energy resources, receipt of energy losses							Final Consumption	Accumulation	Export	Statistical diff	Flows to the Environment	Total
	Industries (by ISIC)												
	Agriculture Forestry & Fishery	Mining& Quarrying	Manufacturing	Electricity, gas, steam & air conditioning supply	Transportation & Storage	Construction	Other Industries	Households					
	(ISIC A)	(ISIC B)	(ISIC C)	(ISIC D)	(ISIC M)								
Energy from natural inputs:													
Natural resource inputs													
Coal		13091											13091
Lignite		453											453
Crude Oil		1270											1270
Natural Gas		1318											1318
Nuclear				514									514
Inputs from RES				640									640
Hydro				547									547
Total		**16133**		**1701**									**17834**
Energy Products:													
Transformation of energy products by SIEC class													
Coal				11961									11961
Lignite				370									370

PHYSICAL USE TABLE (Unit: PJ)	Intermediate consumption, Use of energy resources, receipt of energy losses							Final Consumption	Accumulation	Export	Statistical diff	Flows to the Environment	Total
	Industries (by ISIC)							Households					
	Agriculture Forestry & Fishery (ISIC A)	Mining& Quarrying (ISIC B)	Manufacturing (ISIC C)	Electricity, gas, steam & air conditioning supply (ISIC D)	Transportation & Storage (ISIC M)	Construction	Other Industries						
Crude Oil			10342										10342
Oil Products				36									36
Natural Gas				393									393
Electricity													
Total Transformed Energy			**10342**	**12761**									**23103**
End-use of energy products by SIEC class:													
Coal	0	0	1639		0	154	4893	0	708	37	-1445		5987
Lignite	0	0	42		0	26	31	0	15	0	-30		84
Crude Oil							1042				-1026		16
Oil Products	28	72	649		1839	40	4746	1263		2746	1111		12494
Natural Gas	**6**	786	855		490	0	77	0		**0**	**-89**		2126
Electricity	823	0	0	312	79	0	3597	1223		33	60		6128
Total End Use for Energy purposes	**857**	**859**	**3185**	**312**	**2408**		**14386**	**2486**	**723**	**2817**	**-1419**		**26834**

PHYSICAL USE TABLE (Unit: PJ)	Intermediate consumption, Use of energy resources, receipt of energy losses							Final Consumption	Accumulation	Export	Statistical diff	Flows to the Environment	Total
	Industries (by ISIC)												
	Agriculture Forestry & Fishery	Mining& Quarrying	Manufacturing	Electricity, gas, steam & air conditioning supply	Transportation & Storage	Construction	Other Industries	Households					
	(ISIC A)	(ISIC B)	(ISIC C)	(ISIC D)	(ISIC M)								
End-use of energy products for non-energy purposes													
Energy Residuals:													
Distribution												2026	2026
Extraction												0	0
Other Losses												0	0
Other Energy Residuals												24493	24493
Total energy residuals												**26519**	**26519**
Other Residual Flows:													
Residuals from end-use for non-energy purposes									0				**0**
Energy from solid waste													**0**
TOTAL USE	**857**	**16992**	**13527**	**14774**	**2408**	**0**	**14386**	**2486**	**723**	**2817**	**-1419**	**26519**	**94290**

Total may not add up due to rounding off.

Annexure 3.1 (a): Coastal Water Quality Index- 2020-21

State	Year: 2020-21			
	No. of Locations Monitored	At Shore (<1 km) CWQI Score Status	At nearshore (2 km) CWQI Score Status	At offshore (5 km) CWQI Score Status
Andhra Pradesh	At Shore - 8 At Nearshore - 15 At Offshore - 20	50	46	51
Goa	At Shore - 3 At Nearshore - 3 At Offshore - 3	50	52	55
Gujarat	At Shore - 8 At Nearshore - 9 At Offshore - 11	50	50	45
Karnataka	At Shore - 5 At Nearshore - 5 At Offshore - 5	45	50	57
Kerala	At Shore - 8 At Nearshore - 11 At Offshore - 11	46	52	58
Odisha				
Maharashtra	At Shore - 3 At Nearshore - 6 At Offshore - 9	42	42	51
Tamil Nadu	At Shore - 8 At Nearshore - 10 At offshore - 17	51	54	57

State	Year: 2020-21			
	No. of Locations Monitored	At Shore (<1 km) CWQI Score Status	At nearshore (2 km) CWQI Score Status	At offshore (5 km) CWQI Score Status
West Bengal				
Andaman and Nicobar Islands	At Shore - 7 At Nearshore - 1	55	70	
Daman & Diu				
Lakshadweep				
Puducherry	At Shore - 1 At Nearshore - 2 At offshore - 2	56	57	63

Source: NCCR, Ministry of Earth Sciences

Range for coastal water quality is as follows: 1) 0-20 – Very Poor 2) 21-40 -Poor 3) 41-60 -Moderate 4) 61-80 - Good 5) 81-100 – Very Good

Annexure 3.1 (b): Coastal Water Quality Index- 2021-22

State	Year: 2021-22			
	No. of Locations Monitored	At Shore (<1 km) CWQI Score Status	At nearshore (2 km) CWQI Score Status	At offshore (5 km) CWQI Score Status
Andhra Pradesh	At Shore - 7 At Nearshore - 8 At Offshore - 10	53	51	60
Goa	At Nearshore - 2 At Offshore - 2		58	54
Gujarat				
Karnataka	At Shore - 2 At Nearshore - 3 At Offshore - 3	42	49	57
Kerala	At Shore - 4 At Nearshore - 1 At Offshore - 5	40	41	40
Odisha	At Shore - 3 At Nearshore - 4 At Offshore - 4	61	55	63
Maharashtra				
Tamil Nadu	At Shore - 4 At Nearshore - 5 At offshore - 9	47	47	50
West Bengal	At Offshore - 5			48
Andaman and Nicobar Islands	At Shore - 28 At Nearshore - 4	47	53	

State	Year: 2021-22			
	No. of Locations Monitored	At Shore (<1 km) CWQI Score Status	At nearshore (2 km) CWQI Score Status	At offshore (5 km) CWQI Score Status
Daman & Diu				
Lakshadweep	At Shore - 13 At Nearshore - 2	47	49	
Puducherry	At Shore - 1 At Nearshore - 2 At offshore - 2	52	53	57

Source: NCCR, Ministry of Earth Sciences

Range for coastal water quality is as follows: 1) 0-20 – Very Poor 2) 21-40 -Poor 3) 41-60 -Moderate 4) 61-80 - Good 5) 81-100 – Very Good

Annexure 3.1 (c): Coastal Water Quality Index-2020-23

State	Year: 2022-23			
	No. of Locations Monitored	At Shore (<1 km) CWQI Score Status	At nearshore (2 km) CWQI Score Status	At offshore (5 km) CWQI Score Status
Andhra Pradesh	At Shore - 6 At Nearshore - 7 At Offshore - 10	76	76	76
Goa	At Shore - 2 At Nearshore - 2 At Offshore - 2	53	57	65
Gujarat	At Shore - 7 At Nearshore - 7 At Offshore - 7	44	43	41
Karnataka	At Shore - 3 At Nearshore - 3 At Offshore - 3	58	57	61
Kerala	At Shore - 2 At Nearshore - 6 At Offshore - 7	68	56	67
Odisha	At Shore - 3 At Nearshore - 4 At Offshore - 4	76	73	72
Maharashtra	At Shore - 4 At Nearshore - 4 At Offshore 4	50	51	55

State	Year: 2022-23			
	No. of Locations Monitored	At Shore (<1 km) CWQI Score Status	At nearshore (2 km) CWQI Score Status	At offshore (5 km) CWQI Score Status
Tamil Nadu	At Shore - 9 At Nearshore - 15 At offshore - 17	56	59	62
West Bengal	At Shore - 2 At Nearshore - 2 At offshore 2	45	47	45
Andaman and Nicobar Islands	At Shore - At Nearshore -	43		
Daman & Diu	At Shore - 2 At Nearshore - 2 At offshore - 2	44	47	41
Lakshadweep	At Shore - 4 At Nearshore - 2	81	92	
Puducherry	At Shore - 1 At Nearshore - 2 At offshore - 2	83	73	63

Source: NCCR, Ministry of Earth Sciences

Range for coastal water quality is as follows: 1) 0-20 – Very Poor 2) 21-40 -Poor 3) 41-60 -Moderate 4) 61-80 - Good 5) 81-100 – Very Good

Annexure 3.1 (d) : Coastal Water Quality Index- 2023-24

State	Year: 2023-24			
	No. of Locations Monitored	At Shore (<1 km) CWQI Score Status	At nearshore (2 km) CWQI Score Status	At offshore (5 km) CWQI Score Status
Andhra Pradesh	At Shore - 7 At Nearshore - 8 At Offshore - 10	54	58	61
Goa	At Shore - 1 At Nearshore - 1 At Offshore - 1	46	53	67
Gujarat	At Shore - 3 At Nearshore - 3 At Offshore - 3	60	62	58
Karnataka	At Shore - 4 At Nearshore - 4 At Offshore - 4	65	65	73
Kerala	At Shore - 5 At Nearshore - 7 At Offshore - 7	74	75	79
Odisha	At Shore - 4 At Nearshore - 4 At Offshore - 4	51	55	64
Maharashtra	At Shore - 1 At Nearshore - 5 At Offshore 5	41	57	62

State	Year: 2023-24			
	No. of Locations Monitored	At Shore (<1 km) CWQI Score Status	At nearshore (2 km) CWQI Score Status	At offshore (5 km) CWQI Score Status
Tamil Nadu	At Shore - 5 At Nearshore - 9 At offshore - 9	55	58	67
West Bengal	At Shore - 2 At Nearshore - 2 At offshore - 2	41	42	45
Andaman and Nicobar Islands	At Shore - 14 At Nearshore - 3 At offshore - 3	52	56	65
Daman & Diu	At Shore - 1 At Nearshore - 2 At offshore - 2	53	42	50
Lakshadweep	At Shore - At Nearshore -			
Puducherry	At Shore - 1 At Nearshore - 2 At offshore - 2	56	45	60

Source: NCCR, Ministry of Earth Sciences

Range for coastal water quality is as follows: 1) 0-20 – Very Poor 2) 21-40 -Poor 3) 41-60 -Moderate 4) 61-80 - Good 5) 81-100 – Very Good

Annexure 3.2 (a): Faunal diversity of Andaman and Nicobar Islands

Kingdom	Phylum	Number of Species					
		World (living + fossil)	World (living)	India	Percentage	Andaman & Nicobar	Percentage
Protista	Phylum Protozoa (Foraminiferans & Ciliates)	36,400 (excluding fossil)	36,400	3,525	9.68	276	7.82
Animalia	Phylum Mesozoa	122	122	10	8.19	-	-
	Phylum Porifera	11,055	8,838	545	6.16	153	28.07
	Phylum Cnidaria	17,702	11,522	1,428	12.39	976	68.35
	Phylum Ctenophora	199	199	19	9.54	3	15.79
	Phylum Platyhelminthes	29,488	29,487	1,760	5.96	57	3.24
	Phylum Rotifera	2,049	2,049	466	22.74	112	24.03
	Phylum Gastrotricha	828	828	162	19.56	18	11.11
	Phylum Kinorhyncha	196	196	10	5.1	5	50
	Phylum Nematoda	25,043	25,033	2,949	11.78	147	4.98
	Phylum Acanthocephala	1,461	1,330	301	22.63	8	2.66
	Phylum Spiuncula	156	156	41	26.28	27	65.85
	Phylum Echiura	198	198	47	23.73	7	14.89
	Phylum Annelida	17,426	17,388	1,029	5.91	332	32.26
	Phylum Onychophora	187	183	1	0.54	-	-
	Phylum Arthropoda	13,02,809	12,57,040	75,793	6.02	4,838	6.38
	Subphylum Chelicerata	1,15,992	1,13,773	5,991	5.26	168	2.8
	Class Arachnida	1,14,275	1,12,442	5,953	5.29	159	2.67
	Class Merostomata	103	4	2	50	-	-
	Class Pycnogonida	1,346	1,335	36	2.69	9	25
	Subphylum Crustacea	73,141	67,735	3,835	5.66	1,079	28.14
	Subphylum Hexapoda	10,80,760	10,63,533	65,589	6.16	3,572	5.44
	Class Collembola	8,187	8,162	329	4.03	18	5.47
	Class Diplura	976	975	18	1.84	-	-
	Class Protura	816	816	20	2.45	-	-
	Class Insecta	10,70,781	10,53,578	65,222	6.19	3,554	5.44

Kingdom	Phylum	Number of Species					
		World (living + fossil)	World (living)	India	Percentage	Andaman & Nicobar	Percentage
	Subphylum Myriapoda	12,010	11,999	378	3.15	19	5.03
	Class Chilopoda	3,118	3,112	101	3.24	17	16.83
	Class Diplopoda	7,842	7,837	270	3.44	2	0.74
	Class Symphyla	204	204	7	3.43	-	-
	Phylum Phoronida	16	16	3	18.75	2	66.67
	Phylum Bryozoa (Ectoprota)	11,652	6,186	327	5.28	53	16.21
	Phylum Entoprocta	186	186	10	5.37	-	-
	Phylum Brachiopoda	7,390	392	8	2.04	2	25
	Phylum Chaetognatha	186	170	44	25.88	20	45.45
	Phylum Tardigrada	1,335	1,167	30	2.57	4	13.33
	Phylum Mollusca	1,18,062	84,978	5,205	6.12	1,351	25.96
	Phylum Nemertea	1,368	1,368	6	0.43	2	33.33
	Phylum Echinodermata	20,550	7,550	778	10.3	478	61.44
	Phylum Hemichordata	162	139	14	10.07	1	7.14
	Phylum Chordata	89,955	71,526	6,656	9.3	2,137	32.11
	Subphylum Cephalochordata	33	33	6	18.18	-	-
	Subphylum Urochordata	2,804	2,804	528	18.83	76	14.39
	Subphylum Vertebrata [= Craniata]	88,512	68689	6,122	8.91	2,061	33.67
	Class Pisces	37,172	34,362	3,364	9.78	1,576	46.85
	Class Amphibia	8,007	7,667	407	5.3	16	3.93
	Class Reptilia	16123	10,450	584	5.58	69	11.82
	Class Aves	11,241	10,357	1,340	12.93	344	25.67
	Class Mammalia	15,969	5,853	427	7.29	56	13.11
	Total (Animalia)	16,64,289	15,29,953	97,642	6.38	10,733	10.99
	Grand Total (Protista + Animalia)	**17,00,689**	**15,66,353**	**1,01,167**	**6.45**	**11,009**	**10.88**

Source: Zoological Survey of India, MoEFCC

Annexure 3.2 (b): Marine faunal diversity of Coasts of India

Kingdom	Phylum	Number of Species				
		World (living)	India	Percentage	Coasts of India	Percentage
Protista	Phylum Protozoa (Foraminifera, Ciliata)	36,400	3,525	9.68	702	19.91
Animalia	Phylum Mesozoa	122	10	8.19	6	60
	Phylum Porifera	8,838	549	6.21	453	82.51
	Phylum Cnidaria	11,522	1,445	12.54	901	62.35
	Phylum Ctenophora	199	19	9.54	16	84.21
	Phylum Platyhelminthes	29,487	1,772	6	647	36.51
	Phylum Rotifera	2,049	467	22.79	112	23.98
	Phylum Gastrotricha	828	162	19.56	40	24.69
	Phylum Gnathostomulida	72	4	5.55	1	25
	Phylum Kinorhyncha	196	10	5.1	9	90
	Phylum Nematoda	25,033	2,970	11.86	473	15.92
	Phylum Acanthocephala	1,330	302	22.7	-	-
	Phylum Sipuncula	156	41	26.28	32	97.56
	Phylum Echiura	198	47	23.73	43	91.49
	Phylum Annelida	17,388	1,034	5.94	570	55.22
	Phylum Onychophora	183	1	0.54	-	-
	Phylum Arthropoda	12,57,040	76,149	6.05	2023	2.65
	Subphylum Chelicerata	1,13,773	6,045	5.31	30	0.5
	Class Arachnida	1,12,442	6,007	5.34	-	-
	Class Merostomata	4	2	50	2	100
	Class Pycnogonida	1,335	36	2.69	28	77.78
	Subphylum Crustacea	67,735	3,885	5.73	1987	51.14
	Subphylum Hexapoda	10,63,533	65,837	6.19	6	0.01
	Class Collembola	8,162	333	4.07	-	-
	Class Diplura	975	18	1.84	-	-

	Class Protura	816	20	2.45	-	-
	Class Insecta	10,53,578	65,466	6.21	-	-
	Subphylum Myriapoda	11,999	382	3.18	-	-
	Class Chilopoda	3,112	101	3.24	-	-
	Class Diplopoda	7,837	271	3.45	-	-
	Class Symphyla	204	10	4.9	-	-
	Phylum Phoronida	16	3	18.75	2	66.67
	Phylum Bryozoa (Ectoprota)	6,186	336	5.43	245	72.91
	Phylum Entoprocta	186	10	5.37	3	30
	Phylum Brachiopoda	392	8	2.04	8	100
	Phylum Chaetognatha	170	44	25.88	29	65.91
	Phylum Tardigrada	1,167	30	2.57	4	13.33
	Phylum Mollusca	84,978	5,212	6.13	2690	51.61
	Phylum Nemertea	1,368	8	0.58	8	100
	Phylum Echinodermata	7,550	779	10.31	440	56.48
	Phylum Hemichordata	139	14	10.07	13	92.86
	Phylum Chordata	71,526	6,639	9.28	2413	36.34
	Subphylum Cephalochordata	33	9	18.18	9	100
	Subphylum Urochordata	2,804	531	18.93	219	41.24
	Subphylum Vertebrata [= Craniata]	66689	6,199	9.29	2185	35.24
	Class Pisces	34,362	3,396	9.88	1905	56.09
	Class Amphibia	7,667	417	5.43	-	-
	Class Reptilia	10,450	614	5.17	31	5.05
	Class Aves	10,357	1,343	12.96	224	16.68
	Class Mammalia	5,853	429	7.32	25	5.83
	Total (Animalia)	15,28,247	98,161	6.42	11,181	11.39
	Grand Total (Protista + Animalia)	**15,64,647**	**1,01,686**	**6.49**	**11,883**	**11.68**

Source: Zoological Survey of India, MoEFCC

Annexure 3.2 (c): Occurrence of seagrass associated fauna in Indian waters

Sl. No.	Faunal groups	India	Gulf of Mannar & Palk Bay	Andaman and Nicobar Islands	Lakshadweep
1	Foraminiferans	48	29	48	9
2	Sponges	21	11	6	14
3	Jelly fishes	4	4	3	2
4	Polychaetes	39	10	26	12
5	Nematodes	10	9	2	1
6	Polyclads	6		6	2
7	Sipunculates	2		2	
8	Brachyurans	63	41	44	1
9	Shrimps	18	5	13	
10	Copepods	120	61	71	6
11	Ostracods	12		12	
12	Molluscs	295	115	132	157
13	Opisthobranchs	14	8	11	4
14	Echinodermata	77	30	57	21
15	Tunicates	4		4	
16	Fishes	315	125	220	205
17	Reptiles	10	9	6	4
18	Mammal	1	1	1	
	Total	1059	458	661	438

Source: Zoological Survey of India, MoEFCC

Annexure 3.2 (d): Marine faunal diversity of Indian Deep-sea

Kingdom	Phylum	Number of Species				
		World (living)	India	Percentage	Indian Deep-sea	Percentage
Protista	Phyla Foraminifera, Ciliophora, Radiozoa and Myzozoa	36,400	3545	9.73	1032	29.11
Animalia	Phylum Mesozoa	122	10	8.19		
	Phylum Porifera	8838	550	6.22	36	6.55
	Phylum Cnidaria	11522	1453	12.61	253	17.41
	Phylum Ctenophora	199	19	9.54	7	36.84
	Phylum Platyhelminthes	29487	1789	6.06		
	Phylum Rotifera	2049	467	22.79		
	Phylum Gastrotricha	828	163	19.68		
	Phylum Kinorhyncha	196	10	5.1		
	Phylum Nematoda	25033	2984	11.92	538	18.09
	Phylum Acanthocephala	1330	306	23		
	Phylum Sipuncula	156	41	26.28	16	39.02
	Phylum Echiura	198	47	23.73	1	2.13
	Phylum Annelida	17388	1035	5.95	131	12.66
	Phylum Onychophora	183	1	0.54		0
	Phylum Arthropoda	1257040	76461	6.08	1007	1.32
	Subphylum Chelicerata	113773	6083	5.34	8	0.13
	Class Arachnida	112442	6045	5.37		
	Class Merostomata	4	2	50		
	Class Pycnogonida	1335	36	2.69		
	Subphylum Crustacea	67735	3909	5.77	999	25.56
	Subphylum Hexapoda	1063533	66087	6.21		
	Class Collembola	8162	339	4.15		

Kingdom	Phylum	Number of Species				
		World (living)	India	Percentage	Indian Deep-sea	Percentage
	Class Diplura	975	18	1.84		
	Class Protura	816	20	2.45		
	Class Insecta	1053578	65710	6.23		
	Subphylum Myriapoda	11999	382	3.18		
	Class Chilopoda	3112	101	3.24		
	Class Diplopoda	7837	271	3.45		
	Class Symphyla	204	10	4.9		
	Phylum Phoronida	16	3	18.74		
	Phylum Bryozoa (Ectoprota)	6186	337	5.44	311	92.28
	Phylum Entoprocta	186	10	5.37		
	Phylum Brachiopoda	392	8	2.04	2	25
	Phylum Chaetognatha	170	44	25.88	35	79.55
	Phylum Tardigrada	1167	31	2.65		
	Phylum Mollusca	84978	5227	6.15	150	2.87
	Phylum Nemertea	1368	6	0.43		
	Phylum Echinodermata	7550	784	10.38	230	29.34
	Phylum Hemichordata	139	14	10.07		
	Phylum Chordata	71526	6816	9.52	662	9.71
	Subphylum Cephalochordata	33	6	18.18		
	Subphylum Urochordata	2804	531	18.93	53	9.98
	Subphylum Vertebrata	66689	6279	9.41	569	9.06
	[= Craniata]	34362	3439	10	443	12.88
	Class Pisces	7667	427	5.56		
	Class Amphibia	10450	641	6.13	23	3.59
	Class Reptilia	10357	1343	12.96	72	5.36

Kingdom	**Phylum**	**Number of Species**				
		World (living)	India	Percentage	Indian Deep-sea	Percentage
	Class Aves	5853	429	7.32	31	7.23
	Class Mammalia	1528247	98616	6.45	3339	3.39
Grand Total (Protista + Animalia)		1564647	102161	6.52	4371	4.28

Source: Zoological Survey of India, MoEFCC

Annexure 4.1: Number of Soil Samples used for Soil Nutrient Index

Sl. No.	State	Number of Samples											
		Macronutrients						Micronutrients					
		Nitrogen	Phosphorous	Potassium	OC	EC	pH	Copper	Boron	Sulphur	Iron	Zinc	Manganese
1	Andhra Pradesh	1,29,159	1,29,092	1,29,165	1,28,948	1,29,141	1,29,116	1,28,319	1,28,905	1,29,150	1,27,901	1,26,723	1,27,585
2	Arunachal Pradesh	2,267	2,241	2,122	2,264	2,267	2,267	2,219	724	2,263	2,259	2,172	2,254
3	Assam	2,83,862	2,83,862	2,83,855	2,83,860	2,83,857	2,83,861	2,83,862	2,83,862	2,83,861	2,83,862	2,83,862	2,79,929
4	Bihar	2,48,554	2,48,579	2,48,557	2,47,987	2,49,330	2,49,420	2,47,523	2,48,376	2,48,394	2,47,858	2,47,423	2,46,116
5	Chhattisgarh	1,60,541	1,56,948	1,60,540	1,60,292	1,60,519	1,60,497	1,60,169	1,56,894	1,56,964	1,60,326	1,59,995	1,60,054
6	Goa	6,473	5,979	6,471	6,471	6,471	6,469	6,435	4,570	4,414	6,460	6,413	6,454
7	Gujarat	1,59,230	1,59,229	1,59,230	1,58,983	1,59,221	1,59,213	1,59,176	1,58,935	1,59,228	1,59,219	1,59,184	1,58,223
8	Haryana	34,724	2,96,951	2,96,895	2,96,679	2,97,154	2,97,147	2,68,794	99,243	2,96,944	2,97,047	2,96,102	2,93,814
9	Himachal Pradesh	11,282	12,303	12,303	12,291	10,953	12,302	9,180	3,278	4,277	9,187	9,180	8,851
10	Jharkhand	84,002	84,040	84,081	83,983	84,003	83,936	79,210	78,414	83,248	79,691	79,616	78,843
11	Karnataka	2,21,416	2,21,423	2,21,427	2,21,418	2,21,422	2,21,425	2,21,393	2,21,215	2,21,419	2,21,424	2,21,409	2,17,850
12	Madhya Pradesh	2,87,434	2,87,230	2,87,229	2,86,206	2,87,165	2,87,338	2,84,906	2,76,735	2,80,159	2,85,604	2,85,162	2,83,789
13	Maharashtra	2,27,863	2,28,087	2,28,111	2,27,300	2,27,935	2,28,048	2,25,633	2,27,472	2,27,948	2,25,979	2,25,811	2,25,107
14	Meghalaya	12,999	12,999	12,998	12,988	12,999	12,997	12,889	8,080	8,087	12,996	12,913	12,734
15	Mizoram	5,167	5,168	5,167	5,166	1,004	5,160	502	504	506	505	497	502
16	Nagaland	14,752	14,752	14,752	14,724	14,746	14,748	14,526	14,747	14,752	14,751	14,740	14,678
17	Odisha	10,622	13,188	13,188	13,187	13,188	13,187	9,569	13,077	13,181	9,573	13,160	9,568
18	Punjab	5,265	39,948	39,911	52,486	53,187	53,220	40,154	326	40,176	40,222	39,391	39,819
19	Rajasthan	15,270	2,48,694	2,48,823	2,48,644	2,48,830	2,48,784	2,48,478	956	1,75,266	2,48,857	2,47,839	2,46,105
20	Sikkim	15,031	15,014	15,035	14,984	15,035	15,016	14,945	14,836	15,028	15,025	15,002	14,931
21	Tamil Nadu	2,51,770	2,51,768	2,51,774	2,51,731	2,51,729	2,51,692	2,51,539	2,51,494	2,51,758	2,51,697	2,51,383	2,47,145
22	Tripura	15,167	15,165	15,166	15,162	15,153	15,148	15,092	15,167	15,165	15,172	15,165	15,145
23	Uttar Pradesh	4,85,007	4,84,988	4,85,013	4,84,138	4,84,977	4,84,856	4,84,697	4,84,314	4,84,978	4,84,915	4,84,052	4,79,289

Sl. No.	State	Number of Samples											
		Macronutrients						Micronutrients					
		Nitrogen	Phosphorous	Potassium	OC	EC	pH	Copper	Boron	Sulphur	Iron	Zinc	Manganese
24	Uttarakhand		52,991	53,000	52,903	52,983	52,997	52,818	52,973	53,000	52,945	52,695	52,175
25	West Bengal	2,87,958	2,87,947	2,87,962	2,87,877	2,83,763	2,87,834	2,85,515	2,85,893	2,86,120	2,86,116	2,86,040	2,83,280
26	Andaman & Nicobar	533	533	533	533	533	533	533	533	533	533	533	533
27	Jammu and Kashmir	57,474	57,707	57,709	57,550	57,637	57,704	54,058	33,374	51,591	54,148	55,033	53,601
28	Puducherry	2,996	2,996	2,996	151	2,994	2,996	2,995			2,996	2,993	2,991

Source: INM Division, Ministry of Agriculture and Farmers Welfare

Annexure 5.1: Plants consumed in Different Indian Botanical Gardens and Regional Centres

Name of threatened Species	Category of threatened species
Acharya Jagadish Chandra Bose Indian Botanic Garden, Howrah	
Actinodaphne lawsonii Gamble	Vulnerable
Aloe jucunda Reynolds	Critically Endangered
Anthoshorea roxburghii (G.Don) P.S.Ashton & J.Heck.	Endemic and Vulnerable
Aporosa cardiosperma (Gaertn.) Merr.	Vulnerable
Boswellia ovalifoliolata N.P.Balakr. & A.N.Henry	Endemic & Vulnerable
Cayratia pedata (Lam.) Juss. ex Gagnep.	Vulnerable
Chloroxylon swietenia DC.	Vulnerable
Commiphora wightii (Arn.) Bhandari	Critically Endangered
Cycas beddomei Dyer	Endemic & Endangered
Cycas circinalis L.	Endangered
Dalbergia latifolia Roxb.	Vulnerable
Decalepis hamiltonii Wight &Arn.	Endangered and Endemic
Diospyros ferrea (Willd.) Bakh.	Vulnerable and native
Enterolobium contortisiliquum (Vell.) Morong	Endangered/Endemic to Sikkim
Ficus dalhousiae (Miq.) Miq.	Endemic and Vulnerable
Frerea indica Dalzell	CR/ Endemic to W. Ghats. Maharashtra
Garcinia indica (Thouars) Choisy	Vulnerable
Hildegardia populifolia (DC.) Schott & Endl.	Endemic and Critically Endangered
Hopea ponga (Dennst.) Mabb.	Vulnerable
Hydnocarpus pentandrus (Buch.-Ham.) Oken	Vulnerable
Iris japonica Thunb.	Endangered
Kalanchoe beharensis Drake	Vulnerable
Muehlenbeckia platyclada (F.Muell.) Meisn.	Endangered
Myristica malabarica Lam.	Vulnerable

Name of threatened Species	Category of threatened species
Phyllanthus indofischeri **Bennet**	Endemic and Vulnerable
Podocarpus costalis **C.Presl**	EN/ Endemic to W. Himalaya, Uttarakhand (Garhwal Himalaya
Prioria pinnata **(Roxb. ex DC.) Breteler**	Vulnerable
Prunus ceylanica **(Wight) Miq.**	Endangered
Pterocarpus dalbergioides **Roxb. ex DC.**	Endemic and Vulnerable
Pterocarpus santalinus **L.f.**	Endemic & Endangered
Santalum album **L.**	Vulnerable
Syzygium alternifolium **(Wight) Walp.**	Endemic & Endangered
Vateria indica **L.**	Vulnerable
Adonidia merrillii **(Becc.) Becc.**	Vulnerable
Araucaria heterophylla **(Salisb.) Franco**	Vulnerable
Bentinckia condapanna **Berry ex Roxb.**	Endangered
Bentinckia nicobarica **(Kurz) Becc.**	Endangered
Chloroxylon swietenia **DC.**	Endangered
Commiphora wightii **(Arn.) Bhandari**	Critically Endangered
Corypha taliera **Roxb.**	Extinct in the Wild
Cycas circinalis **L.**	Endangered
Dalbergia latifolia **Roxb.**	Vulnerable
Dipterocarpus alatus **Roxb. ex G.Don**	Vulnerable
Dipterocarpus turbinatus **C.F.Gaertn.**	Vulnerable
Dypsis decaryi **(Jum.) Beentje & J. Dransf.**	Vulnerable
Guaiacum officinale L.	Vulnerable
Handroanthus chrysanthus **(Jacq.) S.O.Grose**	Vulnerable
Hopea odorata **Roxb.**	Vulnerable
Hydnocarpus pentandrus **(Buch.-Ham.) Oken**	Vulnerable
Hyophorbela genicaulis **(L. H. Bailey) H. E. Moore**	Critically Endangered

Name of threatened Species	Category of threatened species
Hyophorbe verschaffeltii (W. Bull ex J. Dix) H. Wendl.	Critically Endangered
Khaya senegalensis (Desr.) A.Juss.	Vulnerable
Latania loddigesii Mart.	Endangered
Latania lontaroides (Gaertn.) H.E.Moore	Endangered
Livistona drudei F. Muell. ex Drude	Endangered
Livistona saribus (Lour.) Merr. ex A. Chev.	Vulnerable
Normanbya Normanbyi (W.Hill) L.H.Bailey	Vulnerable
Pterocarpus dalbergioides (Baker) Kuntze (synonym- Brachypterum microphyllum Miq.)	Vulnerable
Pterocarpus dalbergioides Roxb. ex DC.	Vulnerable
Pterocarpus indicus Willd.	Endangered
Pterocarpus santalinus L.f.	Endangered
Rhopaloblaste augusta (Kurz) H. E. Moore	Vulnerable
Saraca asoca (Roxb.) W.J.de Wilde	Vulnerable
Swietenia humilis Zucc.	Endangered
Swietenia macrophylla King	Vulnerable
Syzygium caryophyllatum (L.) Alston	Endangered
Tecomella undulata (Sm.) Seem.	Endangered
Tectona grandis L.f.	Endangered
Botanic Garden of Indian Republic, Noida	
Name of threatened Species	**Category of threatened species**
Hardwickia pinnata Roxb. ex DC.	Rare
Dalbergia latifolia Roxb.	Vulnerable
Indopiptadenia oudhensis (Brandis) Brenan	Vulnerable
Dalbergia lanceolaria L.f.	Rare
Dalbergia sericea (Willd.) Bojer	Rare
Erythrina arborescens Roxb.	Rare

Name of threatened Species	Category of threatened species
Millettia peguensis **Ali**	Rare
Ougeinia oojeinensis **(Roxb.) Hochr.**	Rare
Syzygium jambos **(L.) Alston**	Rare
Barringtonia acutangula **(L.) Gaertn.**	Rare
Diospyros malabarica **(Desr.) Kostel.**	Rare
Erythrina suberosa **Roxb.**	Rare
Psilotum nudum **(L.) P.Beauv.**	Threatened
Commiphora wightii **(Arn.) Bhandari**	Critically Endangered
Saraca asoca (Roxb.) **W.J.de Wilde**	Vulnerable
Hildegardia populifolia **(DC.) Schott & Endl.**	Critically Endangered
Cycas beddomei **Dyer**	Endangered
Myristica malabarica **Lam.**	Vulnerable
Ginkgo biloba **L.**	Endangered
Pterocarpus santalinus **L.f.**	Endangered
Swietenia mahagoni **(L.) Jacq.**	Near threatened
Zamia fischeri **Miq. ex Lem.**	Endangered
Commiphora stocksiana **(Engl.) Engl.**	Endangered
Syzygium stocksii **(Duthie) Gamble**	Vulnerable
Calophyllum apetalum **Blanco**	Vulnerable
Khaya senegalensis **(Desr.) A.Juss.**	Vulnerable

Regional Centre	Name of threatened Species	Category of threatened species
Arid Zone Regional Centre, Jodhpur	*Commiphora wightii* Arn. Bhandari	Critically endangered
	Aquilaria malaccensis Lam.	Endangered

Regional Centre	Name of threatened Species	Category of threatened species
Arunachal Pradesh Regional Centre, Itanagar	*Pterocarpous santalinus* L.f.	Endangered
	Phoebe goalparensis Hutch.	Vulnerable
	Citrus × sinensis (L.) Osbeck	Near threatened
	Ormosia fordiana Oliv.	Endangered
Andaman and Nicobar Regional Centre, Port Blair	*Bentinckia nicobarica* (Kurz) Becc.	Endangered under criteria C2a.
	Ceropegia andamanica Sreek., Veenakumari & Prashanth	Critically endangered
	Mesua manii (King) Kosterm.	Critically Endangered under criteria B1+2c.
	Myristica andamanica Hook.f.	Vulnerable under criteria B1+2c.
	Semecarpus kurzii Engl.	Endangered under criteria B2ab(iii)
Eastern Regional Centre, Shillong	*Acanthephippium striatum* Lindl.	Vulnerable
	Acanthus leucostachyus Wall. ex Nees	Vulnerable
	Adinandra griffithii Dyer	Endangered
	Agrostophyllum brevipes King & Pantl.	Vulnerable
	Begonia roxburghii (Miq.) A.DC.	Endangered
Northern Regional Centre, Dehradun	*Catamixis baccharoides* Thomson	Endangered
	Selaginella adunca A.Braun ex Hieron.	Vulnerable
	Dioscorea deltoidea Wall. ex Griseb	Vulnerable
	Boucerosia frerei (G.D.Rowley) Meve & Liede	Vulnerable
	Phlomoides superba (Royle ex Benth.) Kamelin & Makhm.	Near threatened
	Trachycarpus takil Becc.	Endangered
	Cycas beddomei Dyer	Critically endangered
	Phlogacanthus phyrsiformis (Roxb.ex Hardw) Mabb.	Vulnerable
	Rhododendron edgeworthii Hook.f.	Vulnerable
	Rhododendron Griffithianum Wight	Vulnerable

Regional Centre	Name of threatened Species	Category of threatened species
Sikkim Himalayan Regional Centre, Gangtok	*Rhododendron vaccinioides* Hook.f.	Vulnerable
	Aeschynanthus micranthus C.B. Clarke	Endangered
Southern Regional Centre, Coimbatore	*Acampe praemorsa* (Roxb.) Blatt. & McCann	Vulnerable
	Aerides crispa Lindl.	Endemic, Vulnerable
	Anoectochilus elatus Lindl.	Endemic, Vulnerable
	Arundina graminifolia (D. Don) Hochr.	Endemic,Vulnerable
	Calanthe masuca (D. Don) Lindl.	Vulnerable
	Bentinckia condappana Berry ex Roxb.	Endangered
	Euphorbia vajravelui Binojk. & N.P. Balakr.	Endangered
	Garcinia imberti Bourd	Endangered
	Cyathea nilgirensis Holttum	Endangered
	Barleria grandiflora Dalzell.	Endangered
Western Regional Centre	Ariopsis macrosperma N.V.Page, Ingalh. & Sardesai Araceae	Endemic
	Barleria sepalosa C.B.Clarke	Endangered
	Boucerosia frerei (G.D.Rowley) Meve & Liede	Endangered
	Nothopegia castaneifolia (Roth) Ding Hou	Critically endangered
	Prunus ceylanica (Wight) Miq.	Endangered
	Garcinia indica (Thouars) Choisy	Vulnerable

Regional Centre	Name of threatened Species	Category of threatened species
	Beilschmiedia dalzellii (Meisn.) Kosterm.	Vulnerable
	Syzygium stocksii (Duthie) Gamble	Vulnerable
	Santalum album L. (Santalaceae) VU	Vulnerable
	Aphanamixis polystachya (Wall.) R.Parker	Vulnerable

Source: Botanical Survey of India

Annexure 5.2: Species Richness Count of IUCN Red List of Threatened Species

Sr. No.	State/UTs	Species Richness Count						Species Richness Count					
		Amphibians		Mammals		Reptiles		Marine (Mangrove)		Plant (Magnolias)		Fresh Water Group	
												Crabs	
		2022-2	2023-1	2022-2	2023-1	2022-2	2023-1	2022-2	2023-1	2022-2	2023-1	2022-2	2023-1
1	Andhra Pradesh	24	34	124	124	130	131	22	22			11	11
2	Arunachal Pradesh	83	115	199	199	140	140	2	2	6	6	32	32
3	Assam	72	94	181	181	154	154	2	2	5	5	34	34
4	Bihar	27	31	128	128	113	113	2	2	1	1	15	15
5	Chhattisgarh	21	26	82	83	83	83	2	2			6	6
6	Goa	31	46	108	108	96	97	20	20			5	5
7	Gujrat	19	23	118	119	127	127	12	12			6	6
8	Haryana	13	16	94	95	70	70	2	2			9	9
9	Himachal Pradesh	17	23	125	125	74	74	2	2			9	9
10	Jharkhand	20	25	82	82	96	96	2	2	1	1	9	9
11	Karnataka	85	116	147	147	156	157	22	22	1	1	13	13
12	Kerala	114	193	142	142	188	190	23	23	1	1	29	29
13	Madhya Pradesh	17	25	93	94	102	102	2	2			6	6
14	Maharashtra	48	64	132	133	158	159	21	21			11	11
15	Manipur	47	66	147	147	115	115	2	2	2	2	21	21
16	Meghalaya	58	85	145	145	137	137	2	2	2	2	19	19
17	Mizoram	40	72	131	131	114	114	2	2	1	1	17	17
18	Nagaland	57	80	140	140	118	118	2	2	5	5	26	26

Sr. No.	State/UTs	Species Richness Count						Species Richness Count					
		Amphibians		Mammals		Reptiles		Marine (Mangrove)		Plant (Magnolias)		Fresh Water Group	
												Crabs	
		2022-2	2023-1	2022-2	2023-1	2022-2	2023-1	2022-2	2023-1	2022-2	2023-1	2022-2	2023-1
19	Odisha	24	31	113	113	131	132	34	34			10	10
20	Punjab	10	13	91	92	64	64	2	2			8	8
21	Rajasthan	12	17	89	90	96	96	2	2			6	6
22	Sikkim	27	41	162	162	94	94	2	2	1	1	12	12
23	Tamil Nadu	99	164	149	149	227	229	27	27	1	1	29	29
24	Telangana	21	26	83	83	82	82	2	2			5	5
25	Tripura	38	55	99	99	109	109	2	2			12	12
26	Uttar Pradesh	20	26	123	124	109	109	2	2			10	10
27	Uttarakhand	26	35	143	143	90	90	2	2			10	10
28	West Bengal	56	73	213	213	191	192	35	35	2	2	24	24
29	Andaman and Nicobar Islands	14	16	53	53	82	83	34	34			2	2
30	Chandigarh	9	10	57	57	48	48	2	2			5	5
31	Dadra & Nagar Haveli and Daman & Diu	31	42	160	160	146	147	14	14	0		8	8
32	Delhi	11	12	52	53	53	53	2	2			6	6
33	Jammu and Kashmir*	16	17	156	157	81	81	2	2			7	7
34	Ladakh												

Sr. No.	State/UTs	Species Richness Count						Species Richness Count					
		Amphibians		Mammals		Reptiles		Marine (Mangrove)		Plant (Magnolias)		Fresh Water Group	
												Crabs	
		2022-2	2023-1	2022-2	2023-1	2022-2	2023-1	2022-2	2023-1	2022-2	2023-1	2022-2	2023-1
35	Lakshadweep			25		7		11					
36	Puducherry	20	25	103	103	100	101	18	18			9	9

Source: The IUCN Red List of Threatened Species. Version 2022-2 downloaded 11/04/2023 and Version 2023-1 downloaded on 14/12/2023

** Unified data for Ladakh and Jammu and Kashmir*

Annexure 5.2: Species Richness Count of IUCN Red List of Threatened Species

Sr. No.	State/UTs	Species Richness Count						Species Richness Count					
		Fresh Water Group						Fresh Water Group					
		Crayfish		Fish		Molluscs		Odonata		Plants		Shrimp	
		2022-2	2023-1	2022-2	2023-1	2022-2	2023-1	2022-2	2023-1	2022-2	2023-1	2022-2	2023-1
1	Andhra Pradesh			197	206	72	72	65	31	255	253	18	18
2	Arunachal Pradesh	2	2	159	161	129	129	122	56	121	117	12	12
3	Assam	2	2	153	154	158	158	150	58	120	117	21	21
4	Bihar			121	125	124	124	116	49	108	105	15	15
5	Chhattisgarh			88	91	87	87	79	34	198	196	16	16
6	Goa			140	146	47	47	70	33	237	234	13	13
7	Gujrat			140	146	53	53	60	30	213	211	10	10
8	Haryana	1	1	59	64	64	64	69	31	80	78	9	9
9	Himachal Pradesh	2	2	74	86	74	74	74	34	89	87	9	9
10	Jharkhand			103	107	103	103	97	42	92	89	17	17
11	Karnataka			236	269	66	66	129	43	348	345	27	27
12	Kerala			260	290	49	49	129	39	333	331	38	38
13	Madhya Pradesh			77	80	69	69	70	33	218	216	14	14
14	Maharashtra			181	197	69	69	86	36	291	288	22	22
15	Manipur			150	152	129	129	111	51	117	114	11	11
16	Meghalaya	1	1	108	109	105	105	117	49	104	101	17	17
17	Mizoram			109	109	152	152	112	51	118	115	16	16
18	Nagaland			128	129	128	128	119	55	118	115	12	12
19	Odisha			187	195	105	105	96	40	203	200	12	12
20	Punjab	1	1	56	62	39	39	61	30	86	84	4	4

Sr. No.	State/UTs	Species Richness Count						Species Richness Count					
		Fresh Water Group						Fresh Water Group					
		Crayfish		Fish		Molluscs		Odonata		Plants		Shrimp	
		2022-2	2023-1	2022-2	2023-1	2022-2	2023-1	2022-2	2023-1	2022-2	2023-1	2022-2	2023-1
21	Rajasthan			69	75	62	62	65	33	89	87	9	9
22	Sikkim	2	2	106	110	124	124	123	54	109	106	10	10
23	Tamil Nadu			288	314	60	60	127	42	345	343	31	31
24	Telangana			106	112	59	59	65	31	231	229	13	13
25	Tripura			114	116	111	111	93	44	102	99	9	9
26	Uttar Pradesh			109	121	96	96	103	49	97	95	12	12
27	Uttarakhand	2	2	101	111	92	92	93	48	96	94	9	9
28	West Bengal	2	2	226	232	151	151	141	57	122	119	21	21
29	Andaman and Nicobar Islands			103	105	38	38	60	30	70	68	9	9
30	Chandigarh			42	45	32	32	53	24	69	67	4	4
31	Dadra & Nagar Haveli and Daman & Diu	0	0	87	89	87	87	105	51	196	384	18	18
32	Delhi			51	53	57	57	59	28	77	75	7	7
33	Jammu and Kashmir*	3	3	83	96	54	54	64	36	87	85	5	5
34	Ladakh												
35	Lakshadweep			34	34	4		5		3			
36	Puducherry			194	197	53	53	64	31	261	259	13	13

Source: The IUCN Red List of Threatened Species. Version 2022-2 downloaded 11/04/2023 and Version 2023-1 downloaded on 14/12/2023

** Unified data for Ladakh and Jammu and Kashmir*

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