India's Second Progress Report on Bonn Challenge: 2011 – 2020

Assessment of progress in restoration efforts across the States and Union Territories

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Available from: IUCN (International Union for Conservation of Nature)
H-4, Green Park Extension
New Delhi - 110016, India
Telefax - +91 11 2616 7742
Email: india@iucn.org

Preface

It is with great pleasure and a sense of profound responsibility that I extend my warmest greetings to the readers of this important publication, “India’s Second Progress Report on the Bonn Challenge.” As the Country Representative of IUCN India, I am honoured to present this comprehensive overview of India’s remarkable strides in achieving its pledge to restore degraded landscapes and contribute to global biodiversity conservation.

The Bonn Challenge stands as a symbol of global cooperation, urging nations to rehabilitate 350 million hectares of degraded ecosystems by 2030. India’s commitment to this initiative is not only commendable but also serves as a testament to the nation’s dedication to sustainable development.

This second progress report marks a crucial milestone in tracking India’s journey towards fulfilling its Bonn Challenge commitment. It provides a detailed account of the efforts undertaken, challenges faced, and progress made in the pursuit of landscape restoration. The thorough documentation in these pages reflects the collaborative spirit of government agencies working together to rejuvenate ecosystems and enhance biodiversity.

Yash Veer Bhatnagar
India Country Representative, IUCN

Acknowledgement

The Bonn Challenge, launched in 2011, is a global effort to restore degraded and deforested landscapes, contributing to biodiversity conservation, climate resilience, and sustainable development. The International Union for Conservation of Nature (IUCN), as the Secretariat of the Bonn Challenge, plays a pivotal role in advancing global forest landscape restoration efforts by supporting countries in planning, implementing, monitoring, and reporting progress on restoration commitments and targets through the Restoration Barometer (an online tool).

The preparation of India's Second Progress Report on the Bonn Challenge (2011–2020) has been made possible through the invaluable guidance, support, and contributions of numerous institutions and individuals.

The IUCN India team sincerely acknowledges the Ministry of Environment, Forest and Climate Change (MoEFCC), Government of India, for its steadfast commitment to forest landscape restoration and sustainable land management. We express our deep gratitude to Shri Sushil Kumar Awasthi, Director General of Forests, MoEFCC, for his continued guidance and encouragement. We are equally grateful to Shri Ramesh Pandey, Additional Director General (Wildlife), MoEFCC, for his keen interest and support in advancing this initiative. We also acknowledge with appreciation Shri Anand Mohan, Chief Executive Officer of the Compensatory Afforestation Fund Management and Planning Authority (CAMPA), for facilitating the resources necessary for undertaking this important work.

We are thankful to Dr V Clement Ben, Inspector General of Forests, National Afforestation and Eco-Development Board (NAEB), for his strategic guidance and support throughout the reporting process. Special appreciation is extended to Shri Prashant Rajagopal, Deputy Inspector General of Forests (NAEB), whose invaluable guidance and sustained engagement were instrumental in bringing this report to fruition. We also gratefully acknowledge the technical support provided by NAEB officials, particularly Shri Pamposh Koul.

We extend our sincere thanks to all Principal Chief Conservators of Forests, Nodal Officers, and Statistical Officers of the State Forest Departments for providing the data and information that form the foundation of this report. We also acknowledge the valuable contributions of officials from the Department of Land Resources, Ministry of Rural Development; the Indian Council of Forestry Research and Education (ICFRE); the United Nations Development Programme (UNDP); and the Departments of Agriculture and Horticulture for their technical inputs, collaboration, and knowledge-sharing. Special thanks are due to Smt. Zainab Hassan and Shri Ombeer Singh for their expertise and support in data collection, analysis, and report preparation.

We are honoured to acknowledge the contributions of present and former officials of MoEFCC, including former Directors General, Additional Directors General, Inspectors General, and Deputy Inspectors General, whose efforts have strengthened India's restoration agenda over the years.

Our sincere appreciation is also extended to the frontline staff of the State Forest Departments and all other stakeholders, partners, local communities and contributors whose dedication and cooperation have supported restoration efforts across the country. Their collective commitment continues to advance the shared vision of restoring degraded landscapes, enhancing ecosystem resilience, conserving biodiversity, improving livelihoods, and contributing to the ambitious restoration targets articulated by the Hon'ble Prime Minister of India, Shri Narendra Modi.

We record our special gratitude to Dr. Vivek Saxena, who was instrumental in conceptualizing this project during his tenure as Country Representative, IUCN India. Finally, we acknowledge with appreciation the entire IUCN India colleagues for their unwavering support, commitment, and collaboration throughout the duration of this project.

IUCN INDIA TEAM

मंत्री
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भारत सरकार

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BHUPENDER YADAV

FOREWORD

India's Second Progress Report on the Bonn Challenge documents the remarkable strides the nation has made in fulfilling its forest landscape restoration pledge from 2011 to 2020. This report is a testament to India's unwavering dedication to ecological sustainability and its determination to restore degraded lands for the well-being of present and future generations.

Land and forest degradation remain among the most pressing challenges of the world today. With over 97 million hectares of land under varying degrees of degradation, India recognises that the imperative to act is both urgent and profound. The Bonn Challenge, a global endeavour to rehabilitate 350 million hectares of deforested and degraded land by 2030, provides a vital framework within which India has chosen to situate its ambitions. India pledged 13 million hectares of restoration by 2020, and this commitment was subsequently scaled up to 26 million hectares by 2030 in a landmark announcement by the Hon'ble Prime Minister at the fourteenth session of the Conference of Parties to the United Nations Convention to Combat Desertification.

The report captures the breadth and depth of India's restoration efforts, drawing upon state-level data from across the country and assessed against the internationally recognised Restoration Barometer. The cumulative assessment confirms that 21.76 million hectares have been restored to date, measured against the target of 26 million hectares by 2030.

India's approach to forest landscape restoration is firmly rooted in the philosophy of convergence and co-benefit. A range of national and State-level programmes and schemes collectively address land degradation while simultaneously advancing livelihoods, water security, climate resilience, and biodiversity conservation. The report draws on this diversity of interventions to spotlight exemplary case studies from multiple landscapes.

As the nation looks towards 2030, this report serves not merely as a record of past achievements but as a renewed call to action to restore, revive, and regenerate India's precious natural heritage.

(Bhupender Yadav)

पर्यावरण भवन, जोर बाग रोड़, नई दिल्ली–110003, फोन. : 011–20819190, 011–20819187, फैक्स : 011–20819299
Paryavaran Bhawan, Jor Bagh Road, New Delhi-110003, Ph. : 011-20819190, 011-20819187, Fax : 011-20819299
ईमेल / E-mail : mefcc@gov.in

कीर्तवर्धन सिंह
KIRTI VARDHAN SINGH

राज्य मंत्री
पर्यावरण, वन एंव जलवायु परिवर्तन
विदेश मंत्रालय
भारत सरकार
MINISTER OF STATE
ENVIRONMENT, FOREST AND CLIMATE CHANGE
EXTERNAL AFFAIRS
GOVERNMENT OF INDIA

MESSAGE

India's Second Progress Report on the Bonn Challenge marks an important milestone in the national journey towards a greener, more resilient country. It reflects the depth of India's dedication to sustainable land management and forest landscape restoration, and the scale of effort that has gone into translating that dedication into measurable progress on the ground.

Forests and landscapes are the lifelines of civilisation. They sustain biodiversity, regulate water cycles, protect soils, and provide livelihoods to millions of communities, particularly those in rural and tribal areas who depend directly on the health of the natural environment. Degradation of these critical ecosystems not only undermines ecological security but also threatens the well-being of the very communities that policies seek to protect. It is therefore both a moral and practical imperative that restoration efforts be accelerated.

The Bonn Challenge has provided India with a structured and globally visible platform to demonstrate its dedication to restoration. India has emerged as one of the most ambitious adherents to this initiative, systematically expanding its pledge over the years. The progress documented in this report, across the Restoration Barometer parameters of policy, finance, knowledge, and community engagement, reflects the sustained and multi-dimensional nature of these efforts.

What stands out most prominently in this report is the comprehensive and integrated nature of India's restoration efforts. The progress documented herein reflects the sustained commitment of governments at various levels, supported by a robust policy framework, dedicated financial investments, knowledge systems, and effective implementation mechanisms. The report demonstrates how diverse restoration interventions across the country have collectively contributed to advancing national restoration goals while generating multiple environmental and developmental co-benefits.

This report is presented as both a record of achievement and a guide for future action. By documenting progress, highlighting successful approaches, and identifying areas for further attention, it provides a valuable evidence base for strengthening restoration efforts across the country. As India advances towards its 2030 targets, continued commitment, innovation, and convergence of efforts will be essential to sustaining momentum and delivering enduring outcomes for the nation's landscapes and ecosystems.

(Kirti Vardhan Singh)

कार्यालय- 5वां तल, आकाश विंग, इंदिरा पर्यावरण भवन, जोर बाग रोड, नई दिल्ली-110003, दूरभाष: 011-20819418, 011-20819421, फैक्स: 011-20819207, ई-मेल: mos.kvs@gov.in
Office- 5th Floor, Aakash Wing, Indira Paryavaran Bhawan, Jor Bagh Road, New Delhi-110003, Tel: 011-20819418, 011-20819421, Fax: 011-20819207, E-mail: mos.kvs@gov.in
कार्यालय: कर्तव्य भवन - ३, जनपथ, नई दिल्ली-110001, 011-24010779, 24010780
Office: Kartavya Bhawan - 3, Janpath, New Delhi -110001, 011-24010779, 24010780
निवास: 23, बी.आर. मेहता लेन, नई दिल्ली-110001, दूरभाष: 011-23782979
Residence: 23, B.R. Mehta Lane, New Delhi -110001, Tel: 011-23782979

तन्मय कुमार
TANMAY KUMAR

सत्यमेव जयते

सचिव
भारत सरकार
पर्यावरण, वन और जलवायु परिवर्तन मंत्रालय
SECRETARY
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MINISTRY OF ENVIRONMENT, FOREST
AND CLIMATE CHANGE

PREFACE

The 2030 Agenda for Sustainable Development, adopted unanimously by United Nations Member States in 2015, provides a shared blueprint for peace and prosperity for people and the planet. Among its 17 Sustainable Development Goals, SDG 15 specifically calls upon nations to protect, restore, and promote the sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation. India's pledge under the Bonn Challenge is a direct and concrete expression of this broader obligation, and the progress documented in this report provides tangible evidence of that pledge in action.

The Bonn Challenge, launched in 2011 and endorsed by the IUCN World Conservation Congress and the New York Declaration on Forests, has emerged as the world's foremost platform for voluntary restoration pledges. India joined this global effort in 2015 and has since become one of its most ambitious adherents, raising its restoration pledge to 26 million hectares by 2030. This Second Progress Report provides a transparent and comprehensive account of the steps taken between 2011 and 2020 to honour that commitment.

The Ministry of Environment, Forest and Climate Change has worked in close partnership with the International Union for Conservation of Nature (IUCN) to document this progress through the application of the Restoration Barometer, a rigorous assessment tool that evaluates performance across policy, finance, knowledge, and community engagement dimensions. Through this methodology, the report confirms with credible precision that 21.76 million hectares have been brought under restoration against the national Bonn Challenge target of 26 million hectares by 2030, providing an internationally credible and comparable evidence base to support adaptive management.

India's restoration landscape is characterised by its scale, diversity, and institutional depth. A wide range of national and State-level programmes and schemes have together generated significant momentum across the country, spanning afforestation, watershed rehabilitation, agroforestry, and ecosystem restoration across diverse agro-climatic zones. The engagement of State and Union Territory Forest Departments has been integral to this effort, and the data contributed by them forms the empirical backbone of this report.

The National Action Plan to Combat Desertification and Land Degradation through Forestry Interventions 2023 provides an overarching policy architecture within which the Bonn Challenge commitment is embedded. The NAP sets out the thematic and regional strategies through which restoration targets are to be achieved, and together these frameworks enable India to pursue an integrated, landscape-based approach that simultaneously addresses climate change, biodiversity loss, land degradation, and the sustainable development needs of local communities.

The contributions of all those involved in the preparation of this report are deeply appreciated, particularly the nodal officers of the States and Union Territories, the IUCN India team, and the officers of the National Afforestation and Eco-Development Board. The findings and best practices documented here will serve as a valuable resource for restoration practitioners, policymakers, and researchers, and will contribute meaningfully to India's progress towards its 2030 goals.

(Tanmay Kumar)

Place: New Delhi
Dated: June 17, 2026

इंदिरा पर्यावरण भवन, जोर बाग रोड़, नई दिल्ली-110 003 फोन : (011)-2081-9408, 2081-9308, फैक्स : (011)-2081-9238
INDIRA PARYAVARAN BHAWAN, JOR BAGH ROAD, NEW DELHI-110 003, PH. : 011-2081-9408, 2081-9308, FAX : 011-2081-9238
E-mail : secy-moef@nic.in, Website : moef.gov.in

सुशील कुमार अवस्थी
Sushil Kumar Awasthi

सत्यमेव जयते

वन महानिदेशक एवं विशेष सचिव
भारत सरकार
पर्यावरण, वन एवं जलवायु परिवर्तन मंत्रालय
DIRECTOR GENERAL OF FORESTS & SPL. SECY.
GOVERNMENT OF INDIA
MINISTRY OF ENVIRONMENT FOREST AND
CLIMATE CHANGE

MESSAGE

It gives me immense pleasure to present "India's Second Progress Report on Bonn Challenge: 2011–2020", which documents the country's sustained efforts towards Forest Landscape Restoration (FLR) and the fulfilment of its commitments under the Bonn Challenge.

India has been an active participant in this global restoration movement. In 2015, India joined the Bonn Challenge and pledged to restore 13 million hectares of degraded land by 2020, and an additional 8 million hectares by 2030, making a total commitment of 21 million hectares by 2030. This target was further enhanced to 26 million hectares by 2030 by the Hon'ble Prime Minister during the Fourteenth Session of the Conference of the Parties (COP 14) of the United Nations Convention to Combat Desertification (UNCCD). These commitments reflect India's resolve to restore degraded landscapes while simultaneously strengthening ecological security, conserving biodiversity, enhancing climate resilience, and supporting sustainable livelihoods.

This report has been jointly developed by the Ministry of Environment, Forest and Climate Change (MoEFCC) and the International Union for Conservation of Nature (IUCN), the global secretariat of the Bonn Challenge. It provides an overview of India's progress in advancing landscape restoration through a combination of policy interventions, institutional mechanisms, and on-ground actions across diverse ecological regions of the country.

A notable feature of this report is the documentation of a number of best practices from different landscapes and restoration contexts, implemented by a wide range of stakeholders. These case studies demonstrate innovative approaches, community participation, and effective restoration models that have contributed to ecological recovery and sustainable development. It is hoped that the experiences and lessons emerging from these initiatives will serve as a valuable resource for restoration practitioners and policymakers, and inspire the replication and scaling up of successful interventions.

Contd.----2/-

इंदिरा पर्यावरण भवन, जोर बाग रोड़, नई दिल्ली-110 003
फोन : 011-20819239, 20819209

Indira Paryavaran Bhawan, Jor Bagh Road, New Delhi-110 003
Ph. : 011-20819239, 20819209, E-mail : dgfindia@nic.in

India's environmental stewardship is rooted in a long-standing policy tradition. Since the National Forest Policy of 1952, the country has consistently emphasized the importance of maintaining a minimum of one-third of its geographical area under forest or tree cover, while advocating two-thirds green cover in mountainous and hilly regions. This enduring commitment continues to guide national efforts towards conservation, restoration, and sustainable management of natural resources.

The Government of India has been advancing these objectives through several flagship schemes and programmes. Further, through the CAMPA Act, 2016, substantial financial resources have been channelled to the States for the conservation, protection, improvement, and expansion of the country's forest and wildlife resources.

Alongside government-led initiatives, non-governmental organizations, research institutions, and private sector entities have also made significant contributions to landscape restoration through innovative, community-centred, and sustainability-oriented interventions. In this regard, the report is unique in capturing and showcasing restoration efforts undertaken by NGOs and private companies alongside government programmes, thereby presenting a more comprehensive picture of India's restoration journey.

I am confident that this publication will serve as an important reference for policymakers, practitioners, researchers, and all stakeholders engaged in ecosystem restoration. It also reaffirms India's commitment to global environmental goals and highlights the collective efforts being undertaken across the country to restore degraded landscapes for the benefit of present and future generations.

I commend all the organizations, institutions, and individuals who have contributed to the preparation of this report and to the larger cause of landscape restoration in India.

(Sushil Kumar Awasthi)

Place: New Delhi
Date: 23rd June, 2026

रमेश पाण्डेय, भा.व.से.
RAMESH PANDEY, I.F.S.

सत्यमेव जयते

अपर वन महानिदेशक
भारत सरकार
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ADDITIONAL DIRECTOR GENERAL OF FORESTS
GOVERNMENT OF INDIA
MINISTRY OF ENVIRONMENT, FOREST
AND CLIMATE CHANGE

MESSAGE

India's continued progress under the Bonn Challenge underscores the significance of integrated, landscape-based restoration approaches in addressing the interconnected challenges of land degradation, biodiversity loss, climate change, and livelihood security. The preparation of "India's Second Progress Report on Bonn Challenge: 2011–2020" marks an important milestone in documenting and assessing the country's efforts towards Forest Landscape Restoration (FLR) across diverse ecological, social, and institutional settings.

The report has been prepared through a collaborative process led by the Ministry of Environment, Forest and Climate Change (MoEFCC), with technical support from the International Union for Conservation of Nature (IUCN), the global Secretariat of the Bonn Challenge. It reflects the collective contributions of States, Union Territories, technical institutions, implementing agencies, and other stakeholders engaged in restoration planning, monitoring, and implementation.

A notable feature of this report is its application of structured methodologies and reporting frameworks aligned with internationally accepted FLR principles and the Bonn Challenge Barometer approach. The report captures restoration efforts across a wide range of landscapes, including forests, agroforestry systems, degraded watersheds, grasslands, and community-managed ecosystems. It also highlights the multiple ecological, economic, and social benefits generated through restoration interventions, including enhanced biodiversity conservation, improved ecosystem services, increased climate resilience, and strengthened livelihood opportunities for local communities.

The findings presented in this report reaffirm India's commitment to achieving its restoration goals while contributing to broader national and global priorities relating to climate action, land degradation neutrality, biodiversity conservation, and sustainable development. Equally important, the report demonstrates the value of partnerships and multi-stakeholder engagement in advancing restoration outcomes at scale.

I am confident that this publication will serve as a valuable reference for policymakers, practitioners, researchers, and development partners, fostering greater understanding, collaboration, and innovation in the field of Forest Landscape Restoration. It is hoped that the experiences and insights documented herein will further strengthen restoration efforts within India and contribute meaningfully to the global discourse on ecosystem restoration and sustainable land management.

(Ramesh Pandey)

जल विंग, पंचम तल, इंदिरा पर्यावरण भवन, जोर बाग रोड़, नई दिल्ली-110 003, फोन: 011-20819180
Jal Wing, 5th Floor, Indira Paryavaran Bhawan, Jor Bagh Road, New Delhi-110 003, Ph. : 011-20819180
E-mail : ramesh.pandey@nic.in

आज़ादी का अमृत महोत्सव

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Abbreviations

ABT	Aichi Biodiversity Targets
AFD	Assam Forest Department
AGB	Above Ground Biomass
AJY	Ama Jungle Yojana
ANR	Assisted Natural Regeneration
APCCF	Additional Principal Chief Conservator of Forests
APFDC	Andhra Pradesh Forest Development Corporation
AR5	Fifth Assessment Report
AR6	Sixth Assessment Report
ATREE	Ashoka Trust for Research in Ecology and the Environment
BCCC	Bonn Challenge Consultative Committee
BCCSAP	Bangladesh Climate Change Strategy and Action Plan
BFD	Bangladesh Forest Department
BGB	Below Ground Biomass
BMZ	German Federal Ministry for Economic Cooperation and Development
BTAP	Billion Trees Afforestation Project
CAMPA	Compensatory Afforestation Fund Management and Planning Authority
CBA	Cost-Benefit Analysis
CBD	Convention on Biological Diversity
CCF	Chief Conservator of Forest
CF	Carbon Fraction/Conservator of Forest
CO_2e	Carbon dioxide equivalent
COP	Conference of the Parties
CREL	Climate Resilient Ecosystems and Livelihoods
CSAFE	Carbon Stock Assessment of Forest Ecosystems
CSOs	Civil Society Organisations
CSS	Carbon Stock Studies
DGF&SS	Director General of Forests and Special Secretary
DLD	Desertification and Land Degradation
DoLR	Department of Land Resources
DPTA	Delhi Preservation of Trees Act

Abbreviations

ERT	Elephant Rescue Team
ESIP	Ecosystem Services Improvement Project
FCA/VSESA	Forest Conservation Act/Van *(Sanrakshan Evam Samvardhan)* Adhiniyam
FD	Forest Department
FES	Forest Ecosystem Services
FES	Foundation for Ecological Security
FFPM	Forest Fire Prevention and Management
FITGC	Forest Information Technology and Geomatic Centre
FLR	Forest Landscape Restoration
FRA	Forest Rights Act
FSI	Forest Survey of India
GBF	Global Biodiversity Framework
GEF	Global Environment Facility
GFRA	Global Forest Resources Assessments
GHGs	Greenhouse Gases
GIM	Green India Mission
GIS	Geographic Information System
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit
GLF	Global Landscapes Forum
GoI	Government of India
GoIWB	Government of West Bengal
ha	Hectare
HADP	Hill Area Development Programme
HP-FES	Himachal Pradesh Forest Ecosystem Services
IDWH	Integrated Development of Wildlife Habitats
IGC	Increasing Green Cover
IGF	Inspector General of Forests
IGNP	Indira Gandhi Nahar Pariyojana
INR	Indian Rupee
IPCC	Intergovernmental Panel on Climate Change
ISFR	India State of Forest Report

Abbreviations

IUCN	International Union for Conservation of Nature
JAF	Jhum Agroforestry
JFF	Jhum Fallow Forestry
JFMC	Joint Forest Management Committee
JICA	Japan International Cooperation Agency
KAPY	Krushi Aranya Protsaha Yojane
KNCTS	Khonoma Nature Conservation and Tragopan Sanctuary
LC 2012	Livestock Census of 2012
LDA	Land Degradation Atlas of India
LDN	Land Degradation Neutrality
LDNTS	Land Degradation Neutrality Target Setting
LPG	Liquefied Petroleum Gas
LULUCF	Land Use, Land-Use Change and Forestry
LUP	Local Union Parishad
M&E	Monitoring and Evaluation
MFF	Mangroves for the Future
MGNREGA	Mahatma Gandhi National Rural Employment Guarantee Act
MoEFCC	Ministry of Environment, Forest and Climate Change
MRV	Monitoring, Reporting and Verification
MT	Metric Tonnes
$MtCO_2e$	Million Tonnes of Carbon Dioxide Equivalent
NAEB	National Afforestation and Eco-development Board
NAMA	Nationally Appropriate Mitigation Action
NAP	National Afforestation Programme
NBA	National Biodiversity Authority
NBM	National Bamboo Mission
NBS	Nature-based Solutions
NBTs	National Biodiversity Targets
NDC	Nationally Determined Contributions
NFMP	Nagaland Forest Management Project
NFP	National Forest Policy
NGHP	New Green Highways Policy

Abbreviations

NGO	Non-governmental Organisation
NGP	Namami Gange Programme
NH	National Highway
NNWPC 14	New National Working Plan Code 2014
NTFP	Non-timber Forest Produce
NWA	National Water Award
OFSDP	Odisha Forestry Sector Development Project
ONEs	Open Natural Ecosystems
PCCF	Principal Chief Conservator of Forests
PPP	Public-Private Partnerships
R&B	Results and Benefits
R&D	Research and Development
RB	Restoration Barometer
RBPT	Roadside Beautification and Plantation in Tripura
RDF	Rehabilitation of Degraded Forests
REDD	Reducing Emissions from Deforestation and Forest Degradation
RMB	Ridge Management Board
ROAM	Restoration Opportunities Assessment Methodology
ROOT	Restoration Opportunities Optimisation Tool
RRRC	Refugee Relief and Repatriation Commissioner
SAPCC	State Action Plan on Climate Change
SCAF	State Compensatory Afforestation Fund
SDFC	Skill Development of Forest Communities
SDG	Sustainable Development Goals
SFD	State Forest Department
SFDWP	Solan Forest Divisional Working Plan
SHGs	Self-Help Groups
SMAF	Sub-Mission on Agroforestry
SUFAL	Sustainable Forests and Livelihoods
t.d.m	Tonnes Dry Matter
tC	Tonnes of Carbon

Abbreviations

TFC	Thirteenth Finance Commission
TGA	Total Geographical Area
TKHH	Telangana Ku Haritha Haram
UNCCD	United Nations Convention to Combat Desertification
UNFCCC	United Nations Framework Convention on Climate Change
UNHCR	United Nations High Commissioner for Refugees
USAID	United States Agency for International Development
UT	Union Territory
VCF	Village Conservation Forum
VFDS	Village Forest Development Societies
VSY	Vanavaran Sanvardhan Yojana, Uttar Pradesh
WB	World Bank
WBADMIP	West Bengal Accelerated Development of Minor Irrigation Project
WGDP	Western Ghats Development Programme
WPA	Wildlife (Protection) Act 1972
WRI	World Resources Institute
WUAs	Water Users' Associations
WWF	World Wildlife Fund

EXECUTIVE SUMMARY

This report presents India's comprehensive progress towards the Bonn Challenge pledge from 2011 to 2020. Launched in 2011, the Bonn Challenge is a voluntary global restoration pledge. In 2015, India undertook one of Asia's largest pledges, aiming to restore 13 million hectares (ha) of degraded and deforested land by 2020 and an additional eight million hectares by 2030. The Bonn Challenge has already leveraged political support and financial resources for the restoration of millions of hectares across the world. As a result, India's 2030 target has been enhanced to 26 million hectares and announced by the Honourable Prime Minister of India during COP 14 of the United Nations Convention to Combat Desertification (UNCCD), held in September 2019. Over the past decade, India has taken promising steps to realise this ambitious vision.

The Restoration Barometer, developed by IUCN, is the primary tool currently used by national and local governments worldwide to track progress towards implementing the Bonn Challenge. This tool provides a snapshot of restoration progress and identifies gaps. This enables the effective allocation of financial and technical resources to maximise the benefits derived from future restoration initiatives. The tool comprises two sets of indicators:

1. **Success Factors**: These include policies and institutional frameworks, financial flows, technical planning, and monitoring systems that enable the resources necessary to implement Forest Landscape Restoration (FLR).
2. **Results and Benefits**: These include the outcomes of FLR actions in terms of land area brought under restoration, and the corresponding climate, biodiversity, and socio-economic benefits from restoration.

Alongwith a detailed national and state-wide assessment of Bonn Challenge's progress, the report provides a brief overview of the Bonn Challenge and the Restoration Barometer. It also examines alignment with other goals and commitments and features selected case studies.

All 28 states and 7 Union Territories (UTs)[1] reported their progress in accordance with the Restoration Barometer and collectively succeeded in bringing 21.76 million hectares of land under restoration. A summary of key results from leading States on Bonn Challenge progress in India, covering the period from 2011 to 2020, is provided below:

Although this report offers a fairly accurate compilation of India's Bonn Challenge achievements over the past decade, its

States with maximum area brought under restoration	*(in million ha)*
Telangana	4.18
Madhya Pradesh	3.78
Odisha	2.64
Gujarat	1.73
Andhra Pradesh	1.61

Source: State Forest Departments and DoLR

[1] The UT of Daman and Diu, merged with the UT of Dadra and Nagar Haveli in January 2020, has submitted combined data for both UTs. Similarly, the Union Territory of Jammu and Kashmir, which was divided into the separate UTs of Jammu and Kashmir and Ladakh in 2019, has provided aggregated data.

States with highest carbon sequestration *(in million tC without mortality)*	
Madhya Pradesh	96.22
Telangana	64.13
Odisha	60.38
Maharashtra	38.06
Gujarat	37.56

States with highest carbon sequestration *(in million tC with mortality)*	
Madhya Pradesh	57.73
Telangana	50.66
Odisha	47.70
Gujarat	29.67
Andhra Pradesh	19.79

States with highest carbon sequestration *(in million tCO_2e without mortality)*	
Madhya Pradesh	353.14
Telangana	235.35
Odisha	221.59
Maharashtra	139.67
Gujarat	137.84

States with highest carbon sequestration *(in million tCO_2e with mortality)*	
Madhya Pradesh	211.88
Telangana	185.92
Odisha	175.06
Gujarat	108.89
Maharashtra	97.77

States with highest man-days of jobs created *(in million)*	
Gujarat	185.13
Telangana	153.76
Madhya Pradesh	134.21
Uttarakhand	118.89
Odisha	98.56

States with highest financial flow towards restoration *(in million Indian Rupees)*	
Gujarat	101,917.00
Madhya Pradesh	70,515.40
Telangana	52,079.39
Uttarakhand	51,176.50
Kerala	45,675.28

Source: State Forest Departments and DoLR

compilation of India's Bonn Challenge achievements over the past decade, its comprehensiveness relies on data provided by the States and Union Territories. The data included in this report was gathered by IUCN India in collaboration with the Ministry of Environment, Forest and Climate Change (MoEFCC) and sourced from the Forest Departments of the States and UTs, as well as the Department of Land Resources (DoLR).

The report features case studies of restoration efforts in the States of Assam, Himachal Pradesh, Tripura, and West Bengal in India, along with brief case studies from Bangladesh. By highlighting these examples, the report aims to engage a broader group of practitioners and assist them in upscaling their practices. Additionally, it provides a summary of lessons learned from the application of the Restoration Opportunities Assessment Methodology (ROAM) and capacity-building programmes on Forest Landscape Restoration (FLR) conducted in partnership with the State Forest Departments and other relevant government institutions.

This report provides key insights into India's Bonn Challenge pledge and achievements from 2011 to 2020 for a range of stakeholders, including government bodies, the scientific community, research institutions, Non-Governmental Organisations (NGOs), and private organisations. It offers a detailed update on the progress made towards achieving the Bonn Challenge, including state-level analysis of the area restored, financial expenditure, climate mitigation, and socio-economic impacts. The report also discusses the challenges encountered and presents recommendations for further action to be undertaken by the country.

1.0 INTRODUCTION

1.1 India's forests and the role of the land use, land-use change, and forestry sector in the country

Forests were originally a State subject under the Indian Constitution. However, following the 42nd Amendment in 1980,[2] forests were reclassified as a concurrent subject. This change has led to national priorities and schemes significantly influencing forest management in India. Despite this, regional priorities continue to significantly influence decision-making in forest management. Many schemes and projects are tailored to specific States, often with geographically defined boundaries. Although some schemes include inter-state implementation plans, they are frequently limited by geographic or administrative constraints inherent in their design.

In India, forests are crucial for development across multiple dimensions, providing a diverse range of environmental, social, and economic benefits. They are fundamental to sustaining life and contribute significantly to advancing various targets within the Sustainable Development Goals (SDGs) (Figure 1).[3]

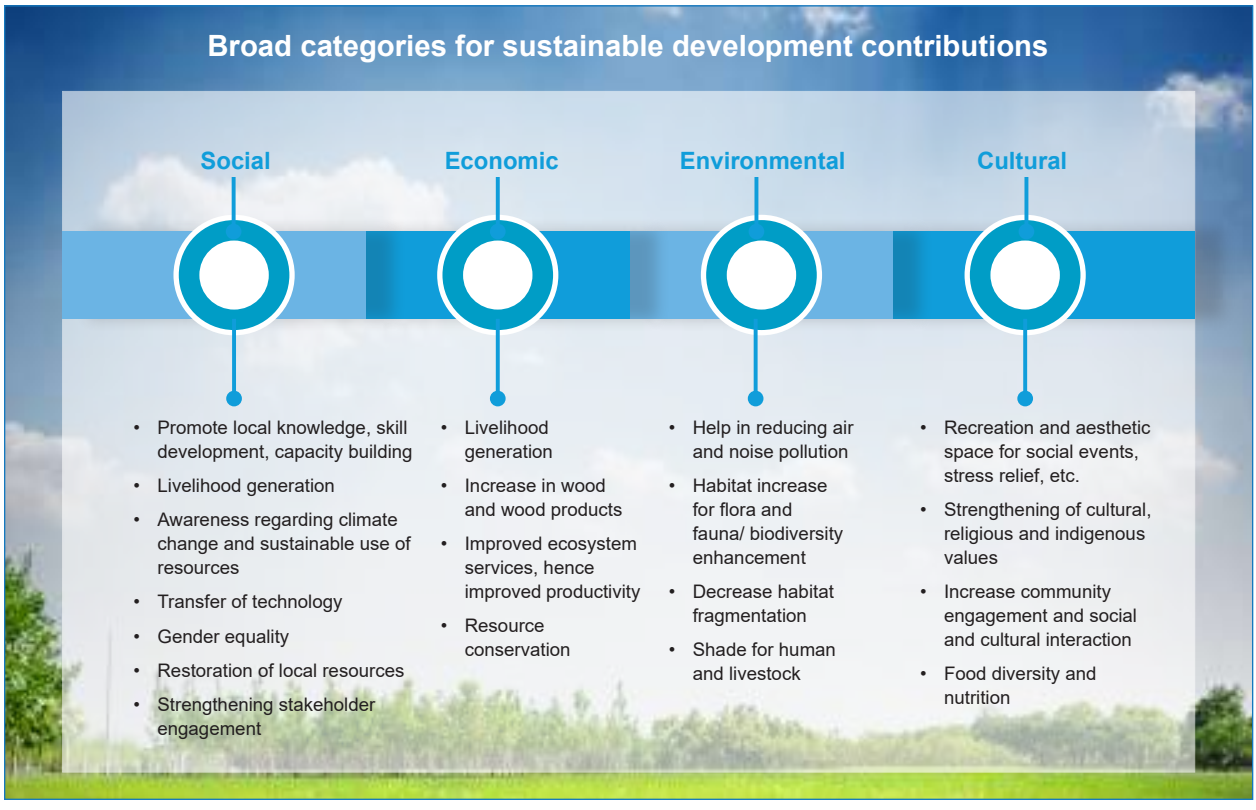


Figure 1: Broad categories for the contribution of forests to achieving the Sustainable Development Goals

[2] 42nd Amendment, https://legislative.gov.in/constitution-forty-second-amendment-act-1976

[3] Forests and SDGs, https://www.wri.org/insights/forests-and-sdgs-taking-second-look

India's total forest cover is 713,789 square kilometres (km^2), which constitutes 21.71% of its Total Geographical Area (TGA), according to the India State of Forest Report (ISFR) 2021.[4] This marks a net increase of 1,540 sq km in forest cover since 2019. The Forest Survey of India (FSI) attributes this growth primarily to enhanced conservation, management, afforestation, agroforestry, and tree plantation activities. Over the past decade, from 2011 to 2021, the carbon stock in the country's forests has risen from 6,663 million tonnes to 7,204 million tonnes, an increase of 541 million tonnes.[5] Additionally, the total tree cover has reached 95,748 sq km. The tree cover in India increased by 721 square kilometers between 2019 and 2021.[6] According to the official employment statistics of the Global Forest Resources Assessments (GFRA) 2020,[7] the global forest-related workforce numbered at least 12.5 million full-time employees in 2015. Asia accounted for more than 70% (8.90 million people employed) of total employment globally, led by India (6.23 million people employed) in the forestry sector.

The GFRA 2020 also places India among the top ten countries globally for forest area, growing stock, and average annual net gain in forest area. Notably, the report highlights a significant increase in community-managed forest areas in India, largely due to Joint Forest Management (JFM) initiatives. JFM is a participatory management regime involving the government and local communities. The community-managed forest areas expanded from zero in 1990 to approximately 25 million hectares by 2015.[7]

Global climatic patterns are undeniably changing, primarily due to human activities that surge Greenhouse Gas (GHG) emissions. The Intergovernmental Panel on Climate Change (IPCC) Fifth Assessment Report (AR5) highlights the increase in terrestrial and oceanic surface temperatures, rising sea levels, and the decline of glaciers and Arctic sea ice. The IPCC's special report on "Global Warming of 1.5°C" estimates that human activities have induced approximately 1.0°C of global warming above pre-industrial levels, with a likely range of 0.8°C to 1.2°C. If the current rate of increase continues, global temperatures are anticipated to reach 1.5°C between 2030 and 2050. The United Nations Framework Convention on Climate Change (UNFCCC) cautions that stabilising global temperatures beyond this threshold will become increasingly challenging. The IPCC's Sixth Assessment Report (AR6) 2021 reaffirms that climate change is widespread, accelerating, and intensifying, with anthropogenic emissions remaining a principal driver of the climate emergency.

In India, the Land Use, Land-Use Change, and Forestry (LULUCF) sector serves as the primary avenue for CO_2 sequestration, positioning it as a critical sector for climate mitigation initiatives. In 2016, the sector offset 15% of the country's CO_2 emissions, acting as a net sink of 307,820 Gigagrams of Carbon Dioxide equivalent (GgCO2e), representing an increase of 2.2% compared to 2014. Grassland remains the sole land-use category contributing emissions within this sector.[8]

The following sections outline India's commitment to the Bonn Challenge and monitor progress using data provided by States and Union Territories through the Restoration Barometer tool.

[4] IFSR 2021, https://fsi.nic.in/forest-report-2021-details

[5] IFSR 2021, https://fsi.nic.in/isfr-2021/chapter-9.pdf

[6] ISFR 2021, https://fsi.nic.in/isfr-2021/chapter-6.pdf

[7] Global Forest Resources Assessment 2020, https://www.fao.org/3/ca9825en/ca9825en.pdf

[8] India Third Biennial Update Report to the United Nations Framework Convention on Climate Change, https://unfccc.int/sites/default/files/resource/INDIA_%20BUR-3_20.02.2021_High.pdf

With respect to total CO_2 removals in 2016, 76.18% corresponds to cropland, followed by 23.28% of forest land and 0.54% of settlements – India BUR 3, 2021

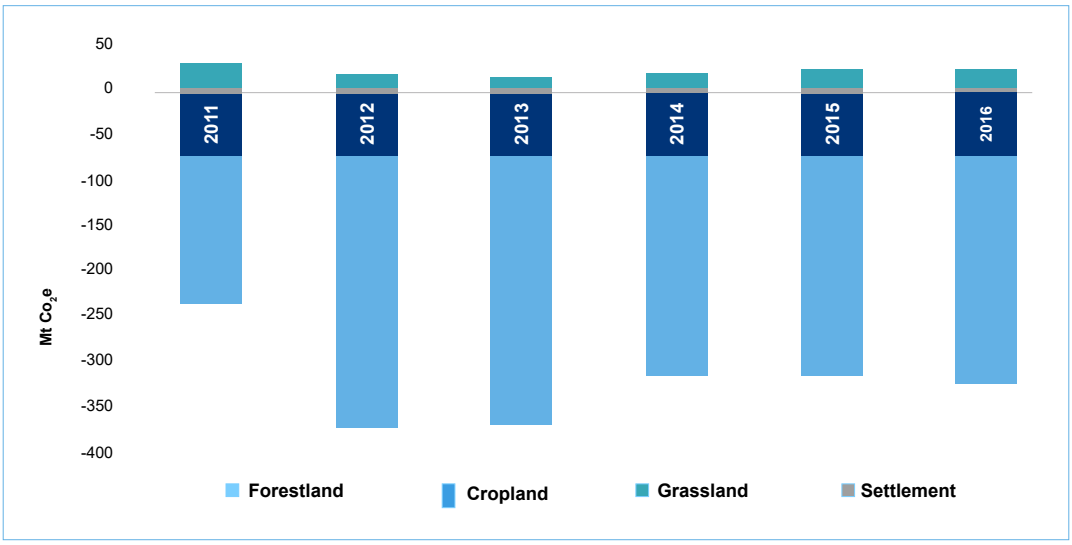


Figure 2: GHG emissions and removals (MtCO2e) by LULUCF subcategories, 2011–2016 (adapted from India's BUR 3, 2021)

1.2 Overview of the Bonn Challenge

The Bonn Challenge is a global initiative aimed at restoring 150 million hectares of degraded and deforested landscapes by 2020, with an additional target of 350 million ha by 2030.[9]

Since the Bonn Challenge was launched in 2011, many countries have made voluntary commitments to restore degraded and deforested land. In response to this global initiative, several multilateral agreements and international policy frameworks have recognised the urgent need to scale up restoration efforts. Notable restoration goals are outlined in the Convention on Biological Diversity (CBD), the United Nations Framework Convention on Climate Change (UNFCCC), the United Nations Convention to Combat Desertification (UNCCD), as well as in the Sustainable Development Goals (SDGs), the Rio+20 Land Degradation Neutrality (LDN) Goal, and the United Nations Global Forest Goals and Targets.

Since its inception in 2011

- More than 70 pledgers represent over 60 countries.
- Surpassed the 150 million hectares milestone for pledges in 2017.
- Restoring 210 million hectares of degraded and deforested land.

Figure 3: Progress under the Bonn Challenge

Although voluntary, the Bonn Challenge aligns closely with multilateral environmental agreements and other global objectives. For example, the restoration of forest carbon stocks is recognised under the Reducing Emissions from Deforestation and Forest Degradation (REDD+) framework and Article five of the Paris Agreement.

At the national level, the National Action Plan to Combat Desertification (NAPCD) also recognises the Bonn Challenge as a complementary global initiative supporting India's land restoration objectives.

As of September 2018, 41 of the 46 countries committed to the Bonn Challenge had integrated incorporated restoration targets within their Nationally Determined Contributions (NDCs).[10]

[9] The Bonn Challenge, https://www.bonnchallenge.org/

[10] Application of the Barometer in 2018, Dave, R., Saint-Laurent, C., Murray, L., Antunes Daldegan, G., Brouwer, R., de Mattos Scaramuzza, C.A., Raes, L., Simonit, S., Catapan, M., García Contreras, G., Ndoli, A., Karangwa, C., Perera, N., Hingorani, S. and Pearson, T. (2019). Second Bonn Challenge progress report. Application of the Barometer in 2018. Gland, Switzerland: IUCN. xii + 80pp.

To achieve a comprehensive overview of India's progress, assessments using the Barometer framework were conducted across all Indian States and Union Territories (28 States and 7 UTs).

India has pledged to restore 26 million hectares of degraded and deforested land by 2030.[11] According to the first Bonn Challenge Progress Report of 2018, India had restored 9.8 million hectares between 2011 to 2017.[12]

(A) Alignment with other targets and commitments

The Bonn Challenge is an international restoration initiative that aligns with various national visions, strategies, and targets. Progress towards the Bonn Challenge commitment reinforces both the domestic policy goals of the Government of India and its international commitments. This section examines how India's Bonn Challenge pledge integrates with key targets and obligations outlined in other global frameworks.

Convention on Biological Diversity (CBD): India has exceeded the global target of 17% and its National Biodiversity Targets (NBT) of 20% for terrestrial area-based conservation. Through collaborative efforts involving government agencies, NGOs, and local communities, India has contributed to the restoration of ecologically significant land. The Bonn Challenge's emphasis on ecological integrity and human well-being complements India's biodiversity targets. India's Bonn Challenge commitment is aligned with the CBD's Kunming-Montreal Global Biodiversity Framework (GBF), specifically targets two and three, which aim to restore, conserve, and manage 30% of the world's terrestrial and marine areas.

Nationally Determined Contributions (NDCs) Target: In its NDC submitted to the United Nations Framework Convention on Climate Change (UNFCCC), India has committed to creating an additional carbon sink of 2.5 to three billion tonnes of CO_2 equivalent through increased forest and tree cover by 2030. Initially, India committed to restoring 13 million hectares of degraded land by 2020, with an additional eight million hectares by 2030. This target was subsequently increased to 26 million hectares by 2030 by the Hon'ble Prime Minister during COP 14 of the United Nations Convention to Combat Desertification (UNCCD). This commitment enhances India's potential for climate change mitigation, aligns with its ambitious NDCs, and strengthens ecosystem and societal resilience.

Paris Agreement: The Paris Agreement aims to limit global warming to well below 2°C, preferably to 1.5°C, compared to pre-industrial levels. Article five encourages countries to enhance carbon sinks and reservoirs through efforts such as the prevention of deforestation and forest degradation prevention (REDD+). The Agreement operates on a five-year cycle, with countries required to submit updated NDCs periodically. The Bonn Challenge supports India's climate action goals, contributes to reducing GHG emissions, and aids in achieving land use and forestry targets under the Paris Agreement.

United Nations Sustainable Development Goals (SDGs): Advancing the Bonn Challenge will contribute significantly to the SDGs, particularly SDG 1 (No Poverty), SDG 2 (Zero Hunger), SDG 13 (Climate Action), and SDG 15 (Life on Land). It will also indirectly support other SDGs, as detailed in section 1.3(A). With over 700 million people in India, particularly in rural areas, relying on forests and agriculture, achieving the Bonn Challenge targets will bolster the rural economy and enhance the livelihoods and well-being of local communities, including women, youth, and marginalised groups.

[11] PM keynote address, https://pib.gov.in/PressReleasePage.aspx?PRID=1727045

[12] Bonn Challenge and India, https://portals.iucn.org/library/efiles/documents/2018-026-En.pdf

United Nations Convention to Combat Desertification (UNCCD): As a signatory to the UNCCD, India's efforts to restore degraded ecosystems through the Bonn Challenge align with the Convention's objectives. This integrated approach addresses ecosystem restoration, land desertification, the SDGs, and climate change mitigation and adaptation. The Restoration Barometer (discussed further in section 1.3(C)) can be used to monitor progress in combating land degradation and addressing climate change.

1.3 Forest Landscape Restoration

At the core of the Bonn Challenge is the Forest landscape restoration (FLR) approach. The FLR approach is an ecosystem-based or nature-based solution with a proven track record of positively impacting both lives and landscapes worldwide. FLR can help mitigate and reverse land degradation, restore ecological integrity, and enhance human social, environmental, and economic well-being. It aims to restore and build forest assets for both people and nature. The International Union for Conservation of Nature (IUCN) and the World-Wide Fund for Nature (WWF) first proposed FLR at the beginning of the 21st century as a systematic framework for managing landscapes to complement forest conservation and sustainable management efforts.[13]

Land degradation is one of the most pressing environmental challenges and will only worsen in the absence of prompt restorative actions. According to the Global Environment Facility (GEF), approximately 25% of the world's total land area has been degraded.[14] In the context of India, the Desertification and Land Degradation (DLD) Atlas of India, 2021, indicates a cumulative increase of 1.45 million hectares (0.44% of the total geographical area)[15] experiencing degradation between 2011–13 and 2018–19. A degraded ecosystem gradually loses its ability to provide essential services, negatively impacting climate, communities, and biodiversity. A sustainable future can only be ensured when a balance between ecological and socio-economic well-being is achieved.

[13] Forest Landscape Restoration, WWF and IUCN, https://d2ouvy59p0dg6k.cloudfront.net/downloads/wwfiucnflrleaflet.pdf

[14] Land Degradation, https://www.thegef.org/what-we-do/topics/land-degradation#:~:text=Land%20degradation%20is%20one%20of,land%20area%20has%20been%20degraded

[15] DLD Atlas of India, 2021, https://vedas.sac.gov.in/static/atlas/dsm/DLD_Atlas_SAC_2021.pdf - 97.85 million ha area of the country is undergoing land degradation i.e., 29.77% of the TGA of the country.

(A) FLR principles

A successful Forest landscape restoration (FLR) model should be dynamic, focusing on building and enhancing the socio-ecological resilience of landscapes while optimising for both current and future needs. FLR is founded on six key guiding principles.[16]

Focus on landscapes	FLR takes place within and across entire landscapes, not individual sites, representing mosaics of interacting land uses and management practices under various tenure and governance systems. It is at this scale that ecological, social and economic priorities can be balanced.
Maintain and enhance natural ecosystems within landscapes	FLR does not lead to the conversion or destruction of natural forests or other ecosystems. It enhances the conservation, recovery, and sustainable management of forests and other ecosystems.
Engage stakeholders and support participatory governance	FLR actively engages stakeholders at different scales, including vulnerable groups, in planning and decision making regarding landuse, restoration goals and strategies, implementation methods, benefit sharing, monitoring and review processes.
Tailor to the local context using a variety of approaches	FLR uses a variety of approaches that are adapted to the local social, cultural, economic and ecological values, needs, and landscape history. It draws on the latest science, best practice, and traditional and indigenous knowledge, and applies that information in the context of local capacities and existing or new governance structures.
Restore multiple functions for multiple benefits	FLR interventions aim to restore multiple ecological, social and economic functions across a landscape and generate a range of ecosystem goods and services that benefit multiple stakeholder groups.
Manage adaptively for long-term resilience	FLR seeks to enhance the resilience of the landscape and its stakeholders over the medium and long-term. Restoration approaches should enhance species and genetic diversity and be adjusted over time to reflect changes in climate and other environmental conditions, knowledge, capacities, stakeholder needs, and societal values. As restoration progresses, information from monitoring activities, research, and stakeholder guidance should be integrated into management plans.

Figure 4: Guiding principles for successful Forest landscape restoration (FLR) model

FLR can directly contribute to the achievement of several Sustainable Development Goals (SDGs). The figure below illustrates which SDGs are most closely supported by FLR initiatives.

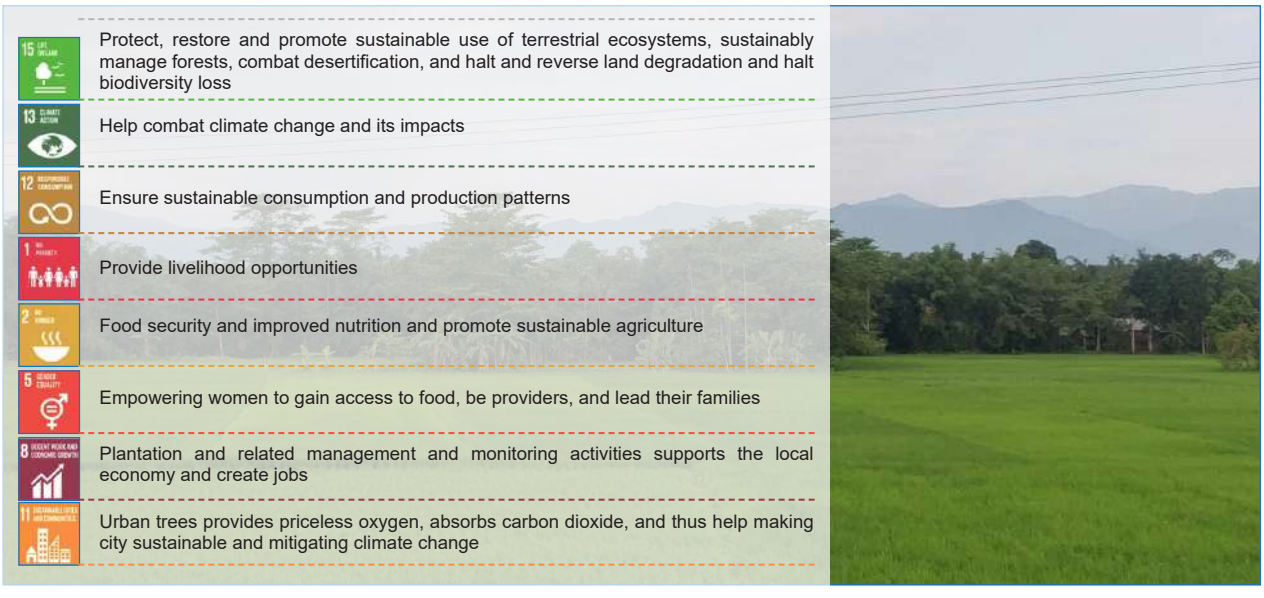


Figure 5: Increasing forest and tree cover and its contribution to SDGs

[16] Biodiversity guidelines for forest landscape restoration opportunities assessments, https://portals.iucn.org/library/sites/library/files/documents/2018-022-En.pdf

(B) FLR options framework

The FLR Options Framework categorises land uses into three main types, each encompassing distinct restoration practices:

Forest land: An area where forests are, or are intended to become the dominant land feature. This can include both protected and productive forests. If the land is devoid of trees, it can be restored through planting or natural regeneration. Degraded forests can be rejuvenated through ecological restoration.

Agricultural land: Land that is actively managed for food production. If the land is under permanent management, it can be restored through agroforestry. It can be restored through improved fallow practices if it is under intermittent management.

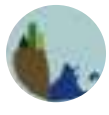
Land use	Land sub-type	General Category of FLR option		Description
Forest land Land where forest is, or is planned to become the dominant land use > Suitable for wide-scale restoration	If the land is without trees, there are two options:	1. Planted forests and woodlots		Planting of trees on formerly forested land. Native species or exotics and for various purposes, fuelwood, timber, building, poles, fruit production, etc.
		2. Natural regeneration		Natural regeneration of formerly forested land. Often the site is highly degraded and no longer able to fulfil its past function – e.g. agriculture. If the site is heavily degraded and no longer has seed sources, some planting will probably be required.
	If the land is degraded forests:	3. Silviculture		Enhancement of existing forests and woodlands of diminished quality and stocking, e.g., by reducing fire and grazing and by liberation thinning, enrichment planting etc.
Agricultural land Land which is being managed to produce food > Suitable for mosaic restoration	If the land is under permanent management:	4. Agroforestry		Establishment and management of trees on active agricultural land (under shifting agriculture), either through planting or regeneration, to improve crop productivity, provide dry season fodder, increase soil fertility, enhance water retention, etc.
	If it is under intermittent management:	5. Improved fallow		Establishment and management of trees on fallow agricultural land to improve productivity, e.g. through fire control, extending the fallow period, etc., with the knowledge and intention that eventually this land will revert back to active agriculture.
Protective land and buffers Land that is vulnerable to, or critical in safeguarding against, catastrophic events > Suitable for mangrove restoration, watershed protection and erosion control	If degraded mangrove:	6. Mangrove restoration		Establishment or enhancement of mangroves along coastal areas and in estuaries.
	If other protective land or buffer:	7. Watershed protection and erosion control		Establishment and enhancement of forests on very steep sloping land, along water courses, in areas that naturally flood and around critical water bodies.

Figure 6: Land-use categories applicable under FLR

Protective lands and buffers: The land that is either vulnerable to or essential in protecting against climatic or other environmental events. While the land may support agriculture or forestry, it holds additional significance in safeguarding lives, property, and ecosystem services. It is generally-but not exclusively-closely linked with coastal and freshwater ecosystems. FLR interventions may include mangrove restoration, watershed protection and erosion control, establishment of wildlife reserves, managed plantations, riparian plantings, and other activities.

(C) The Restoration barometer

The Restoration Barometer, established in 2016, was developed to monitor and assess progress towards the Bonn Challenge commitment. This structured framework is designed to identify, assess, and track global Forest landscape restoration (FLR) commitments. The Barometer evaluates progress across two core dimensions: success factors and results and benefits. By analysing these dimensions, it provides a comprehensive overview of FLR implementation, its enabling conditions, and key challenges that require attention to accelerate progress.

The following sections outline the two dimensions of the Restoration Barometer and their respective indicators:

Applying the Barometer enabled the States to report on their actions, identify obstacles, and address data collection and reporting gaps. The Barometer comprises two broad indicator categories:

1. Success Factors: This category encompasses policies, institutional frameworks, financial flows, technical planning, and monitoring systems that facilitate the resource allocation essential for implementing FLR.
2. Results and Benefits: This category focuses on FLR outcomes, specifically the land area restored, and the associated climate, biodiversity, and socio-economic benefits derived from these restoration efforts.

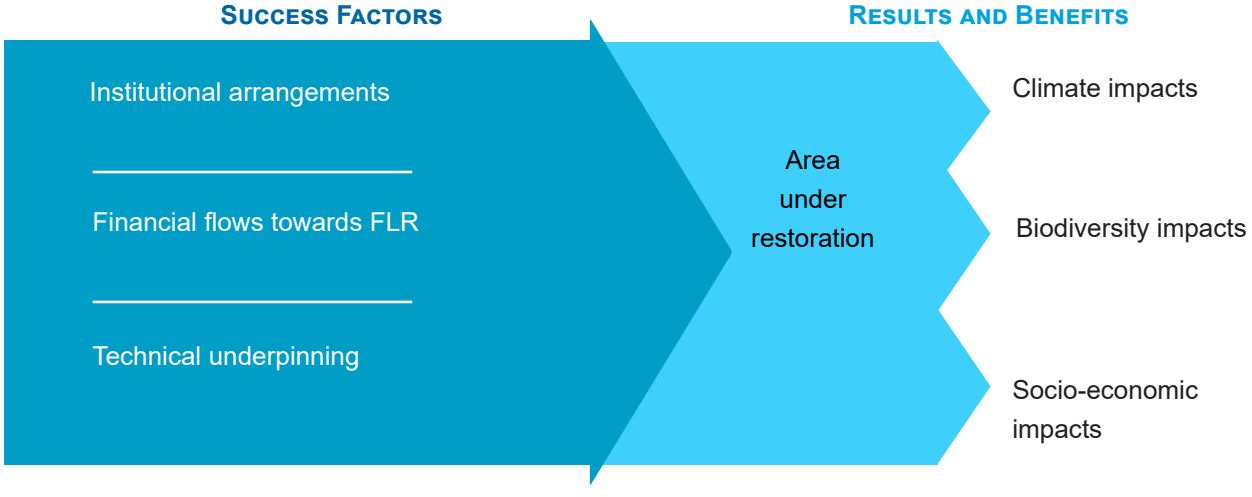


Figure 7: Dimensions and indicators of the Restoration Barometer

Success factor
Policies and institutional arrangements Successful FLR is incentivised and supported by policies, plans, and strategies. This indicator documents the policies adapted, enacted, or implemented after a Bonn Challenge pledge was made, and the institutions responsible for them at different scales.
Financial flows Funding for FLR comes from a wide variety of sources. This indicator measures financial flows from four distinct areas: domestic public expenditure, private investment, international donor support, and domestic philanthropic and non-profit support. Funding for capacity building, nurseries and seed banks, and stakeholder engagement can be included.
Technical planning Adequate planning to identify where, how, and why FLR efforts are undertaken is critical for ensuring long-term positive impacts and meaningful outcomes. To guide and plan FLR implementation, many pledgers have followed formal frameworks such as IUCN's Restoration Opportunities Assessment Methodology (ROAM) and use the Restoration Opportunities Optimisation Tool (ROOT). Formal restoration planning may also have been undertaken as part of other separate but related land-use policy efforts, such as the United Nations Convention to Combat Desertification (UNCCD) Land Degradation Neutrality Target Setting.
Monitoring Successful implementation of FLR requires that efforts are tracked and monitored over time. This indicator documents whether and how these monitoring systems have been developed and/or applied, and supports reporting using the Barometer.

Result and benefits
Hectares brought under restoration This indicator documents the extent to which pledges are being met through implementation efforts since 2010. In the context of FLR, 'under restoration' is defined as a set of measures put in place, operating within or influencing the landscape that slow and then reverse the status of key ecological, social, and economic indicators related to the health of the landscape.
Climate impacts This indicator reports on the carbon sequestration potential directly related to the hectares under restoration and the type of restoration activities implemented. In addition, countries can also report on how restoration is expected to reduce the vulnerability of populations to climate change-related hazards.
Biodiversity benefits For this indicator, Bonn Challenge pledgers can report on restoration actions taking place in areas of high biodiversity importance, such as Key Biodiversity Areas, protected areas, and other areas of conservation importance.
Socio-economic impacts The Barometer has selected a single indicator for socio-economic impacts – the number of jobs created – to address the complications faced when attempting to assess the full range of socio-economic benefits that may flow from FLR. Given that employment data is often broken down into distinct categories, the Barometer incorporates flexibility to designate by job duration, gender, or job type (i.e., maintenance vs. implementation).

The Restoration Barometer supports pledgers and countries in identifying, evaluating, and monitoring their restoration commitments. In addition to facilitating reporting under the Bonn Challenge, the Barometer's outcomes will progressively contribute to a range of other reporting frameworks, including those under the Convention on Biological Diversity (CBD), the United Nations Framework Convention on Climate Change (UNFCCC) Biennial Reporting, Nationally Determined Contributions (NDCs), and the Sustainable Development Goals (SDGs).

Table 1: Methodological steps for tracking Bonn Challenge progress

Tiers	Description
1	Responses representing estimates or broad generalisations with no or little supporting empirical data, presented with low confidence in their accuracy.
2	Responses that are more grounded in data, ground assessments or evaluations, but are still considered generalisations and are presented with a moderate level of confidence.
3	Responses grounded in data, ground measurements, peer-reviewed studies, and evaluations, presented with a high level of confidence.

To ensure data integrity and reporting accuracy, all data submitted to the Restoration Barometer are classified according to a tiered system. The three tiers are as follows:

Higher-tier methods provide more accurate assessments. The data presented in this report regarding the area brought under restoration are classified as Tier-3.

1.4 Scope of the report

In alignment with India's National Forest Policy of 1988, Nationally Determined Contributions (NDCs),[17] National Biodiversity Targets (NBTs) and National Action Plan to Combat Desertification as well as sub-national targets set by various Indian States and other international and voluntary commitments related to restoration and carbon markets, numerous organisations across the country have been actively engaged in diverse restoration initiatives. Each initiative is unique, encompassing various landscapes managed and supported by different stakeholders, with varying coverage periods across programmes. This report represents an ongoing effort to analyse and assess the restoration activities undertaken in India. It provides an evaluation of India's progress towards the Bonn Challenge from 2011 to 2020, based on data provided by relevant agencies.

1.4.1 Methodology followed

(A) Data collation

The following methodology was followed to collate data relevant to the Restoration Barometer:

A Bonn Challenge Consultative Committee (BCCC) was established on 26 August 2019 under the chairmanship of the Director General of Forests and Special Secretary, MoEFCC. The committee's role was to provide guidance on the project and monitor achievements related to commitments under the Bonn Challenge. Their contributions were integral to compiling the report. The committee convened the following meetings:

i. The first meeting of the BCCC took place on 5 November 2019.

ii. The second meeting was held on 21 July 2022 (hybrid mode).

iii. The third meeting occurred on 8 June 2023.

iv. The fourth meeting was conducted on 11 September 2023.

[17] Nationally Determined Contributions Registry, https://www4.unfccc.int/sites/ndcstaging/PublishedDocuments/India%20First/INDIA%20INDC%20TO%20UNFCCC.pdf

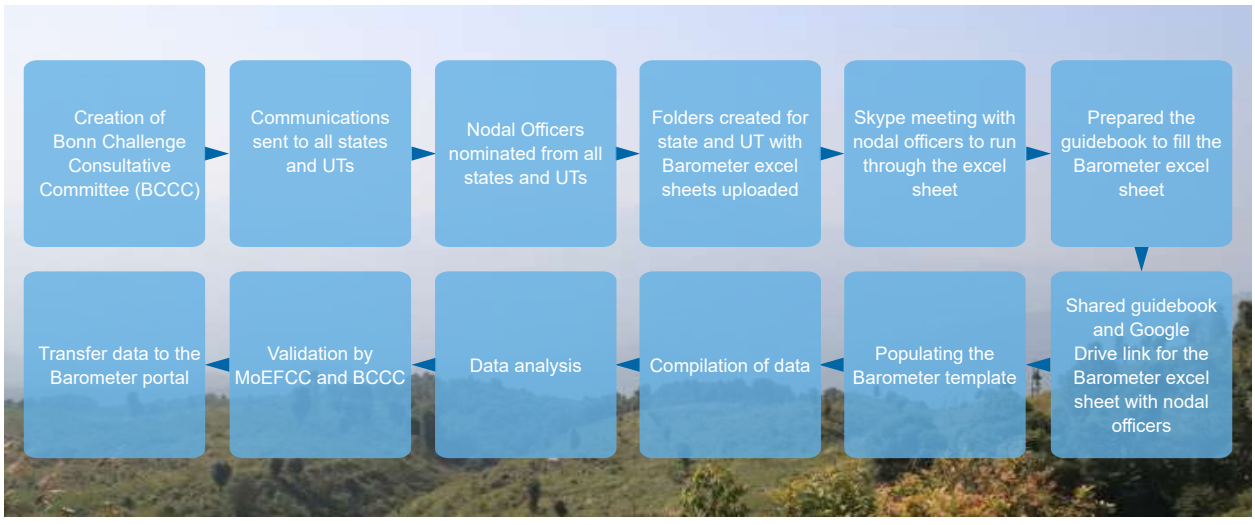
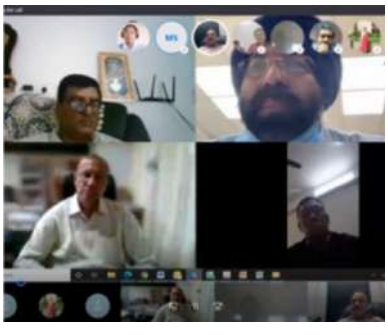


Figure 8: Bonn Challenge data collation methodology

The IUCN formally requested all States and Union Territories to appoint a nodal officer as the primary contact for data collation. Each State and UT designated nodal officers from their respective Forest Departments. The IUCN organised three meetings with these nodal officials to inform them about the IUCN-MoEFCC project on the Bonn Challenge and to enhance their understanding and capabilities regarding the Restoration Barometer tool, its parameters, and the reporting mechanism.

Following these introductory meetings, a Google Drive link was created for each State and UT to facilitate communication. The Barometer template (excel sheet) was uploaded online, and links were distributed to the respective States and UTs. Additionally, a WhatsApp group was established to ensure an effective communication channel with all nodal officers. These officers then provided data in the excel sheet concerning the restoration efforts of their respective States, UTs, and departments.

The data collection process was meticulously structured with explicit instructions for each data entry field. An excel sheet was disseminated to the nodal officers of all States and UTs, facilitating consistent data entry through dropdown menus and text fields. Each protocol indicator was thoroughly explained to the States by the IUCN India team.

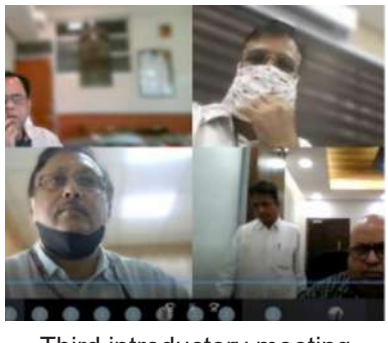


First introductory meeting

17 April 2020

Second introductory meeting

29 May 2020



Third introductory meeting

25 June 2020

Figure 9: Nodal officers' meeting to raise awareness about the Restoration Barometer to track implementation, monitoring, and reporting of their Bonn Challenge progress

Initially, data submitted by the States and UTs was not accompanied by the official signatures. Following the advice of the BCCC, the IUCN subsequently requested all States and UTs to submit signed and approved Restoration Barometer sheets. However, out of 35 States and UTs, only 22 States and 6 UTs provided the signed and approved data in the second round of submissions. This process ensured a consistent, transparent, and robust evaluation of progress towards meeting the Bonn Challenge commitments. It is important to note that data provided was self-assessed and validated by the respective State and UT Forest Departments. The IUCN has compiled all data received from the States and UTs after multiple rounds of follow-ups.

(B) Estimation of carbon sequestration

To estimate carbon sequestration for areas brought under restoration, the IPCC Good Practice Guidance (2003) was referred. This methodology incorporates three scenarios based on the annual average increment of Aboveground Biomass (AGB), which is influenced by the area's annual rainfall. The scenarios are as follows: best case (high annual increment of AGB), base case (average annual increment of AGB), and worst case (low annual increment of AGB).

During the BCCC meetings, members recommended the inclusion of plantation mortality rates in the carbon sequestration estimates. Consequently, the report examines two scenarios under each of the three assumptions: one scenario assumes a 0% mortality rate, while the other reflects the mortality rate reported by the State and UTs.

For the carbon sequestration analysis, the Base Case assumption was employed under both scenarios, as it provides a balanced estimate without extreme values.[18]

For the carbon sequestration analysis, the Base Case assumption was used under both scenarios, as it provides a balanced estimate without extreme values.

In addition to compiling data for national reporting, IUCN also conducted capacity-building workshops and Restoration Opportunities Assessment Methodology (ROAM) assessments. Brief details of these components are provided below, but their comprehensive descriptions are beyond the scope of this report. State-wise proceedings from the capacity-building workshops are available, and separate reports have been prepared for the ROAM process in the five focus states.

[18] Mortality rates were not available for 22 states/UT at the time of publication of this report. In cases where this data was not available, law of averages was applied assigning average mortality rates to states for which mortality rates were not available. In cases, where states/UT reported mortality rates of plantation, the same was used.

Restoration Opportunities Assessment Methodology (ROAM): IUCN India employed the ROAM framework, developed in collaboration with the World Resources Institute (WRI), to identify priority restoration areas in five Indian states: Haryana, Karnataka, Madhya Pradesh, Maharashtra, and Nagaland. The ROAM assessment segmented each state into sub-regions based on agro-ecological zones and district boundaries. Major land degradation issues and drivers were identified through literature reviews and spatial analysis. The ten most severely degraded patches in each sub-region were designated as priority landscapes for restoration, with Forest landscape restoration (FLR) interventions selected based on the analysis. The identified opportunities, strategies, and interventions were validated through stakeholder consultations and expert interviews. Additionally, a Cost-Benefit Analysis (CBA) was conducted using methods such as Benefits Transfer, Avoided Costs, and Direct Value from market costs, supported by secondary literature. Detailed information on the ROAM process can be found in Annex II.

Capacity building on FLR: Supported by the Ministry of Environment, Forest and Climate Change (MoEFCC), capacity building workshops were conducted to enhance the capabilities of government officials, foster stakeholder collaboration, and facilitate knowledge sharing on FLR approaches. These workshops were held in Haryana, Karnataka, Madhya Pradesh, Maharashtra, and Nagaland. These three-day workshops engaged approximately 30-40 participants each. The workshops featured presentations from experts and resource persons from renowned national and international organisations, including state forestry department officials. The sessions yielded valuable recommendations, highlighting the need for FLR-supportive policies, people-centric approaches, consideration of local contexts, landscape-level restoration practices, and an effective monitoring framework. These workshops provided a collaborative platform for various departments to discuss and advance FLR initiatives cohesively. Summary proceedings from the workshops are available in Annex III.

2.0 NATIONAL PROGRESS ON FOREST LANDSCAPE RESTORATION IN INDIA

In India, representatives from the Ministry of Environment, Forest and Climate Change (MoEFCC), the National Biodiversity Authority (NBA), IUCN, and officials from State and Union Territory Forest Departments have actively engaged in high-level consultations on the Bonn Challenge since March 2017. These consultations have showcased inspiring success stories of Forest landscape restoration (FLR) implementation and progress.

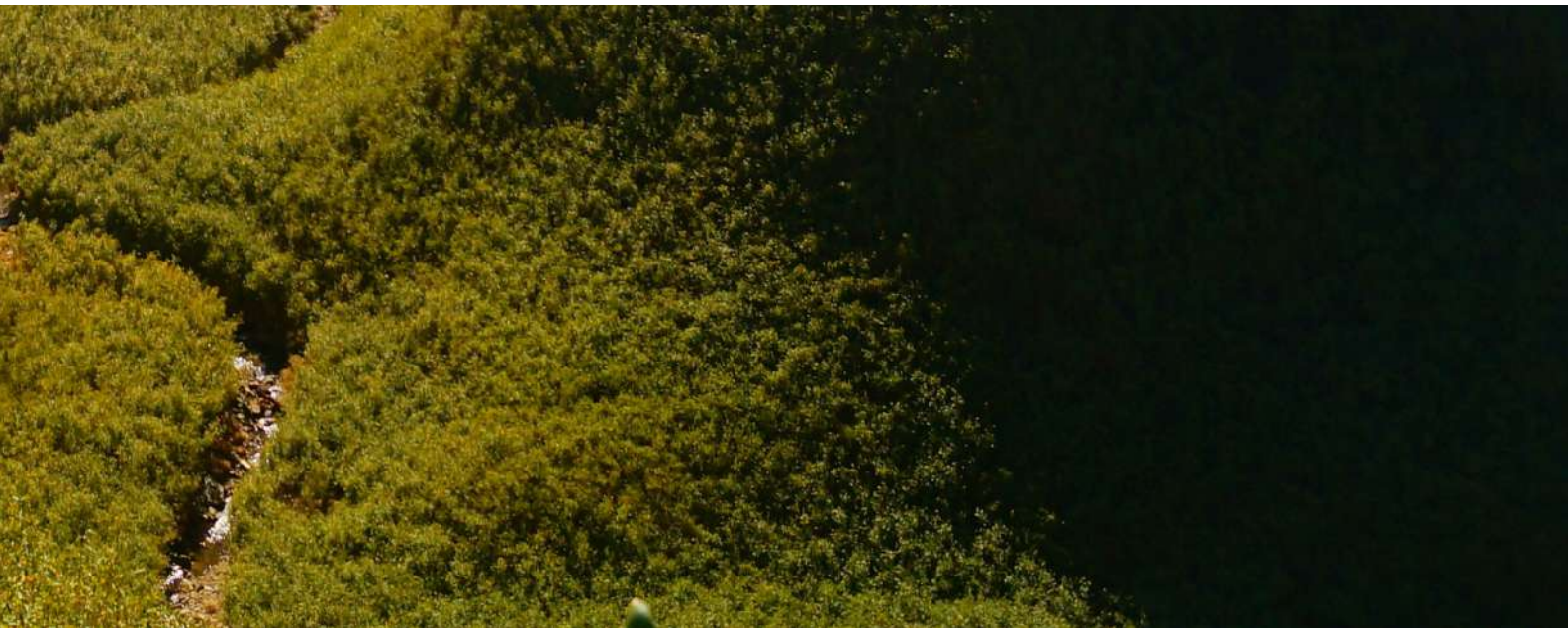
Key discussions have centred on the effective monitoring and reporting of India's achievements under the Bonn Challenge, as well as the country's forestry policies, programmes, and schemes that have significantly contributed to meeting these commitments.

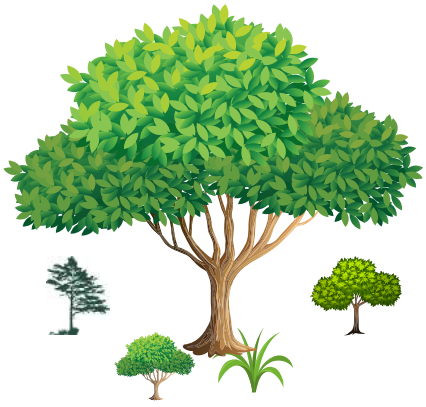
The importance of having an adaptable protocol, such as the Restoration Barometer, has also been emphasised during these discussions. Recognised as an effective tool, the Restoration Barometer supports the recording and reporting of FLR initiatives while fostering a shared understanding and coordinated approaches for FLR implementation in India.

This section outlines the two primary indicator categories of the Restoration Barometer at the national level in India: "Success Factors" and "Results and Benefits". It provides a comprehensive overview of Bonn Challenge progress by integrating data collected from States and UTs. Detailed assessments for each State and UT are presented in Section 4 of this report.

A summary of information from States and UTs on four key parameters of the Restoration Barometer-land area restored, financial flows, total jobs generated, and estimated carbon sequestration is depicted in the figure below.

Additionally, the assessment of three parameters, calculated as a 10-year average per hectare (2011–2020), is also graphically represented in the figure 10a and 10b.





Total area brought under restoration

21.76 million ha *(based on 35 states and UTs data + DoLR data of 26 states)*

Total financial flow 702,335.29 million *(based on 27 states and 7 UTs data)*

Total jobs created 1,224.51 million man-days *(based on 27 states and 5 UTs data)*

Total carbon sequestered

461.14 million tC *(without mortality rate)*

343.66 million tC *(with mortality rate)*

1,692.39 million tCO_2e *(without mortality rate)*

1,261.23 million tCO_2e *(with mortality rate)*

Figure 10a: Total area brought under restoration, financial flow, jobs created, and carbon sequestered from 2011-2020

On an average 21.19 tC/ha & 15.79 tC/ha

(without and with mortality) is estimated to be sequestered

On an average 77.76.62 tCO_2e/ha & 57.95 tCO_2e/ha

(without and with mortality) is estimated to be sequestered

On an average 0.032 *million INR spent per ha*

On an average 56.26 *man-days of jobs generated per ha*

Figure 10b: Per-hectare carbon sequestered, expenditure, and jobs generated through FLR

3.0 RESULTS, BENEFITS, AND SUCCESS FACTORS

3.1 Results and benefits

3.1.1 Hectares brought under restoration

India has prioritised Forest Landscape Restoration (FLR) to deliver ecological benefits and improve the livelihoods of local communities that depend on these landscapes. Data were collected from various States and Union Territories over the period 2011 to 2020. Figure 11 presents the achievements of States and UTs in terms of the total area restored.

Over the past ten years, 21.76 million hectares of land have been restored. Telangana has recorded the maximum area restored, followed by Andhra Pradesh, Gujarat, Madhya Pradesh, and Odisha. Further details are provided in the respective chapters on the States and UTs.

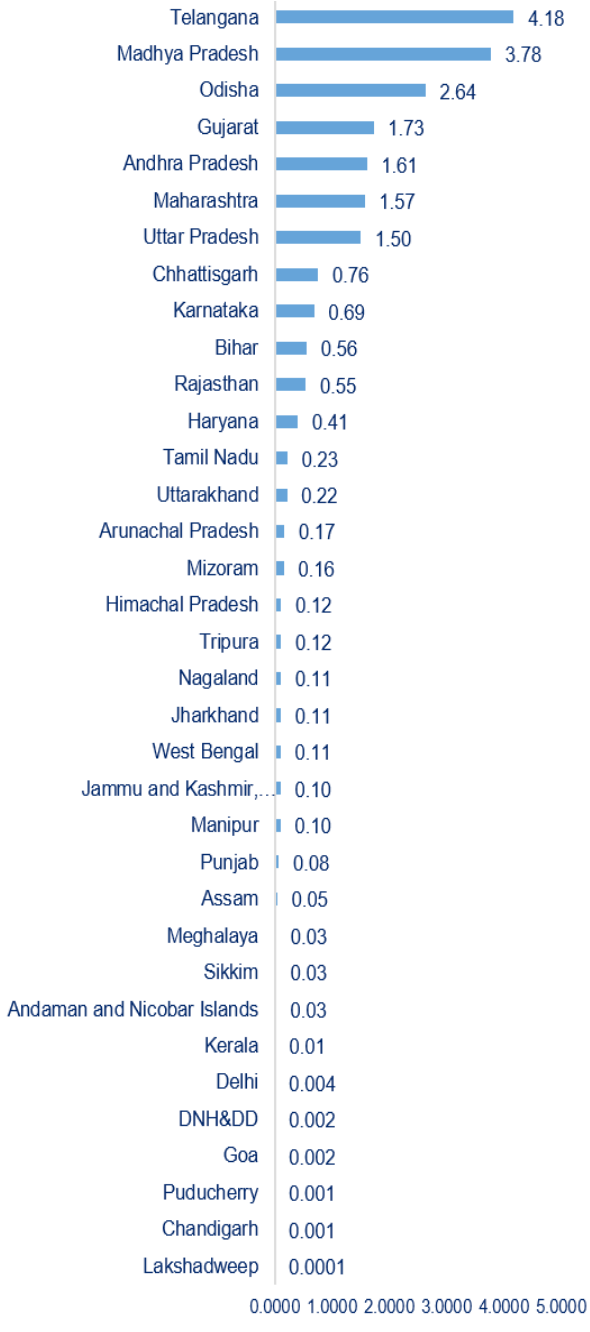


Figure 11: Total area brought under restoration (million ha) for all states and UTs

3.1.2 Climate impacts

To evaluate the climate impact of the land brought under restoration over the past decade, the IPCC's Good Practice Guidance for LULUCF 2003 was utilised.[19] Carbon sequestration in plantations was calculated based on the average annual Aboveground Biomass increment data for plantations at the Tier-1 level. Over the past decade, 21.76 million hectares of land have been restored, leading to the sequestration of 461.14 million tonnes of carbon (tC), excluding mortality factors, and 343.66 million tC when accounting for mortality. This corresponds to 1,692.39 million tonnes of carbon dioxide (tCO2e) without considering plantation mortality, and 1,261.23 million tCO2e when mortality is factored in.[20]

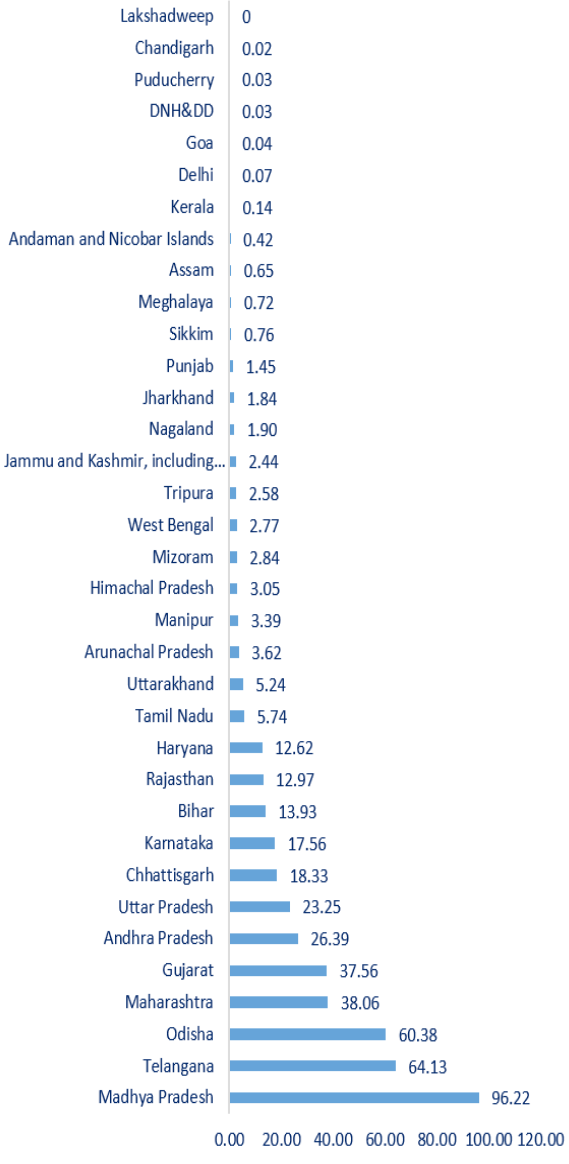


Figure 12a: Carbon sequestration (tC) without mortality, for all States and UTs

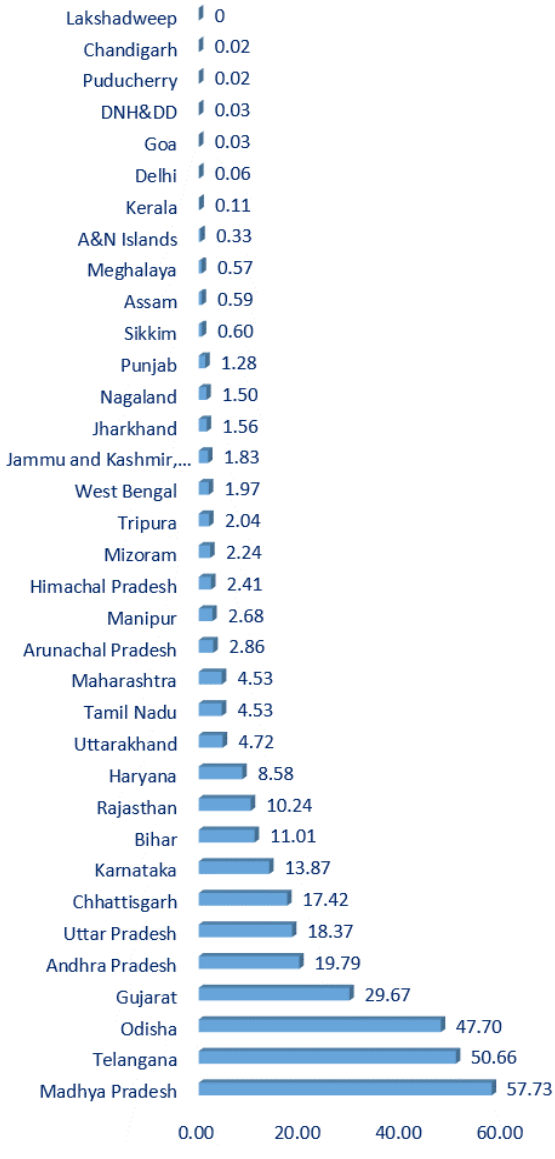


Figure 12b: Carbon sequestration (tC) with mortality, for all States and UTs

[19] Good Practice Guidance for Land Use, Land-Use Change and Forestry, https://www.ipcc-nggip.iges.or.jp/public/gpglulucf/gpglulucf_files/GPG_LULUCF_FULL.pdf

[20] Mortality rates were not available for 22 states/UT at the time of publication of this report. In cases where this data was not available, law of averages was applied assigning average mortality rates to states for which mortality rates were not available. In cases, where states/UT reported mortality rates of plantation, the same was used.

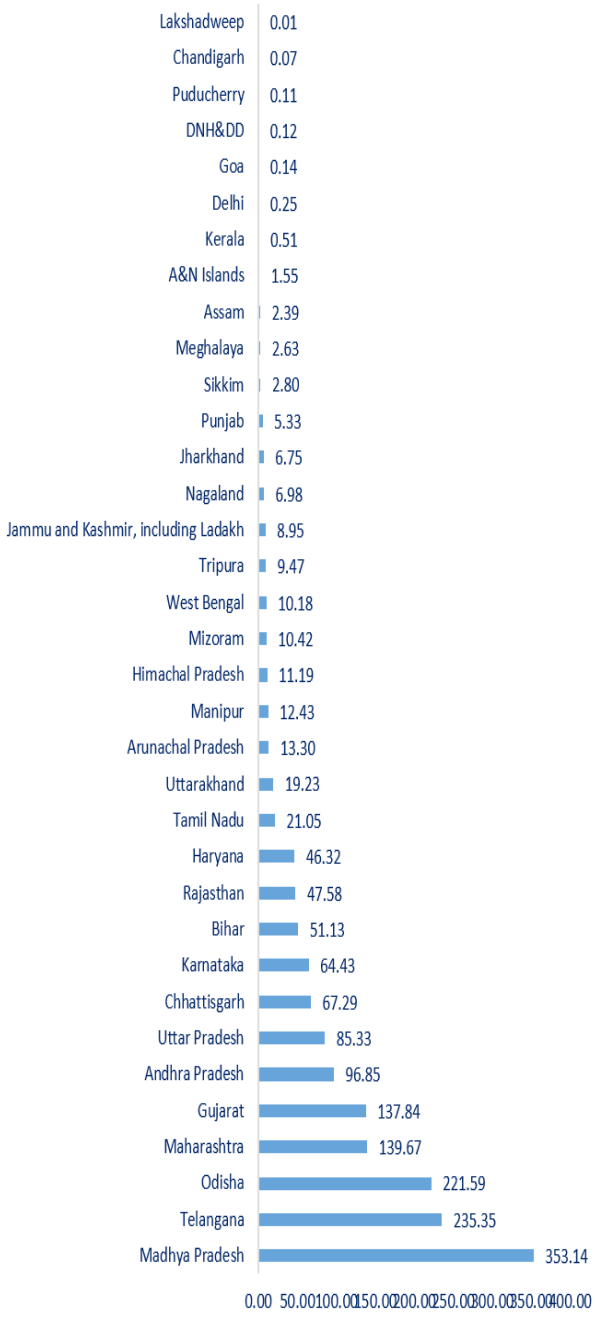


Figure 13a: Carbon sequestration (tCO_2e) without mortality, for all States and UTs

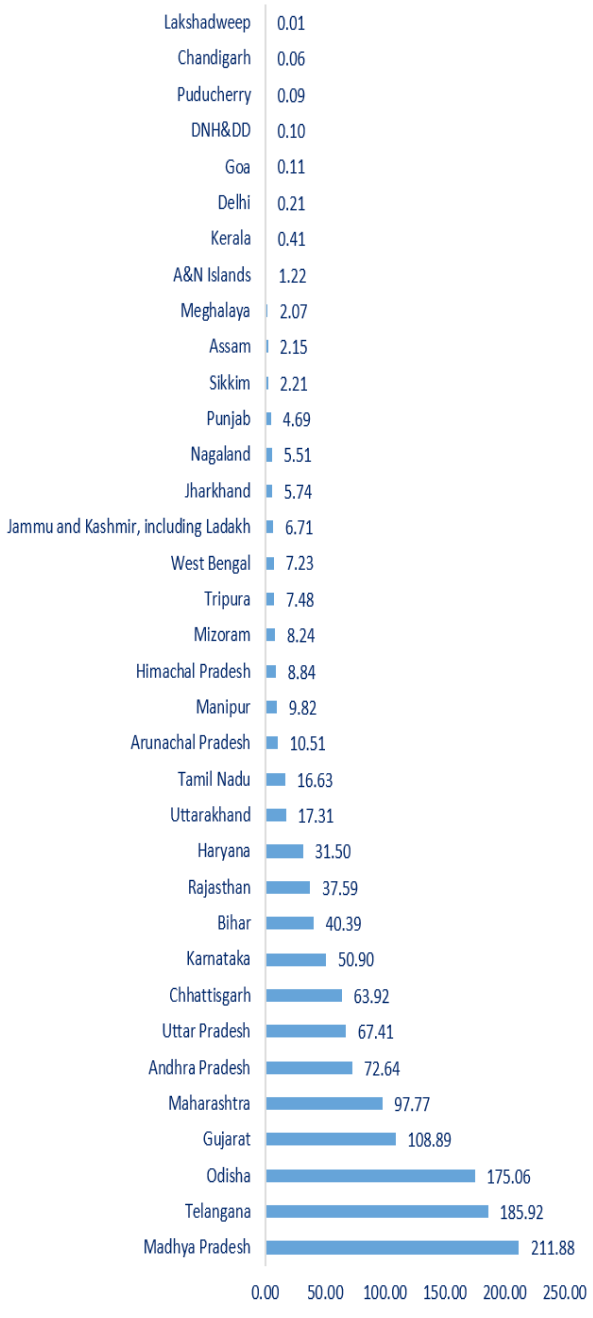


Figure 13b: Carbon sequestration (tCO_2e) with mortality, for all States and UTs

The analysis reveals that the average tC per hectare (Aboveground Biomass + Belowground Biomass (AGB + BGB)) of the restored area in the country is 21.19. This value is lower than the ISFR 2021 figure, which reports 42.57 as the average tC per hectare (AGB + BGB) value for the country's forest area.[21] Similarly, the average tCO_2 per hectare (AGB + BGB) of the area brought under restoration in the country is 77.76.

This discrepancy arises from the conservative approach employed throughout the estimation process. The carbon estimates are based on Tier-2 and Tier-1 data. Although this approach results in a conservative estimate of net carbon stock change, it helps to avoid overestimating the net removal of carbon from the atmosphere, given the lack of valid and verified data to calculate carbon stock change over the ten years of the reporting period.

3.1.3 Socio-economic impacts

An important indicator under 'Results and Benefits' is the socio-economic impact, which details the number of jobs created as a benefit flowing from FLR. This directly contributes to long-term improvements in people's lives and economic revival. The socio-economic impacts, measured through job creation, were based on data provided by the forest departments of the respective states and Union Territories.

From 2011 to 2020, the total socio-economic impact for the reported states and UTs is 1,224.51 million man-days of jobs generated. The highest number of man-days of jobs created was in Gujarat, followed by Telangana, Madhya Pradesh, Uttarakhand, and Odisha. This assessment considered the number of people involved in maintaining forest landscapes and implementing FLR activities. Out of the 35 States and UTs, 27 states and five UTs provided data on the number of jobs created from restoration work over the past decade. Detailed information is provided in the chapters on the States and UTs.

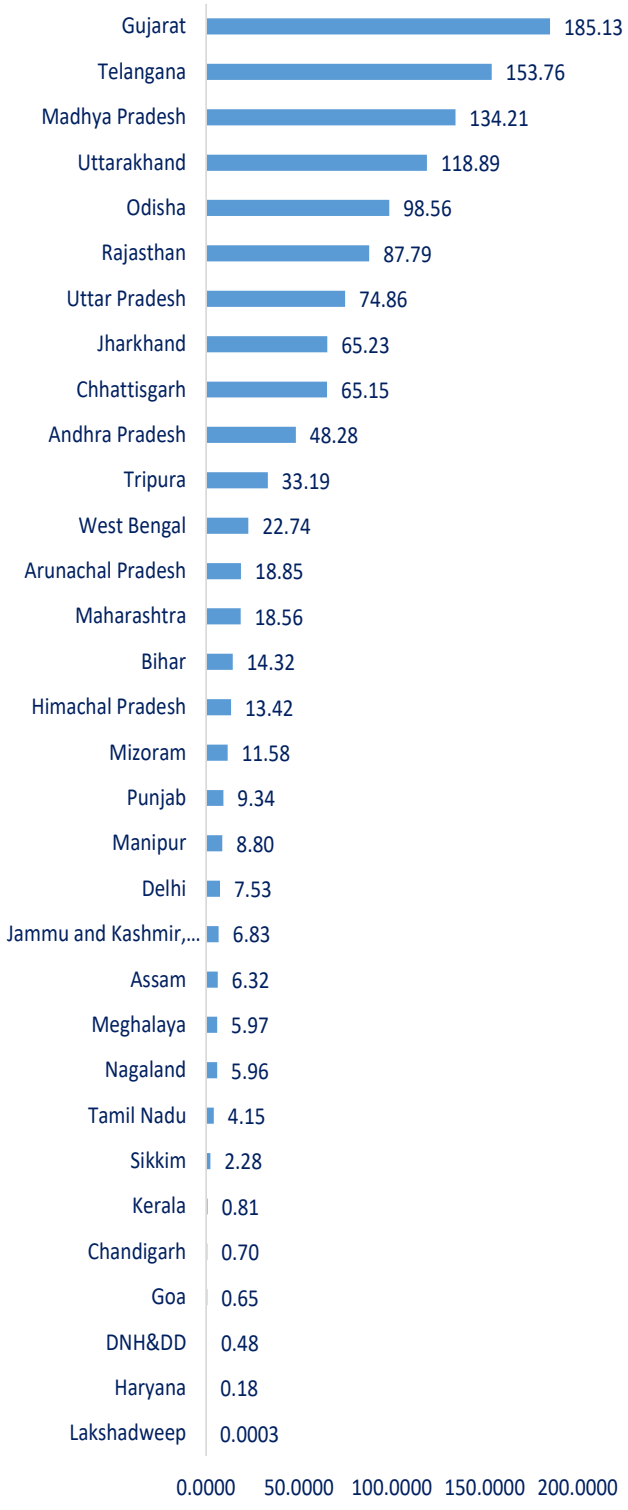


Figure 14: Total million man-days of jobs created for all States and UTs

[21] ISFR 2021, https://fsi.nic.in/isfr-2021/chapter-9.pdf

3.1.4 Biodiversity benefits

For this indicator, generic information based on a secondary literature review has been incorporated into this section. The analysis indicates that India ranks among the top 10 countries globally in terms of forest area, growing stock, and average annual net gain in forest area. Additionally, the Global Forest Resources Assessments (GFRA) 2020 reports that the area of forest managed by communities has increased significantly in India, primarily due to joint forest management. India ranks 8th in the world and 4th in Asia among mega-diverse countries.[22] In 2019, India submitted its Sixth National Report to the Convention on Biological Diversity (CBD), providing updates on the country's progress towards achieving the Aichi Biodiversity Targets (ABTs).[23] India developed 12 National Biodiversity Targets (NBTs) aligned with 20 global ABTs. India has largely achieved its NBTs by 2020.[24] At the 15th Conference of the Parties (COP) to the CBD, the "Kunming-Montreal Global Biodiversity Framework" (GBF) was adopted by several countries, including India. The COP reinforced the obligation to focus on the biodiversity crisis and concluded with a historic deal to preserve biodiversity and reverse ecosystem loss. The Kunming-Montreal GBF includes four goals and 23 targets, one of which (Target Two) is the effective restoration of at least 30% of degraded terrestrial, inland water, and coastal and marine ecosystems by 2030.[25]

The 6th National Report to the Convention on Biological Diversity (CBD) highlights India's concerted efforts to conserve and sustainably utilise its biodiversity. These efforts include the establishment of protected areas, the implementation of targeted conservation and management plans, and the integration of biodiversity considerations across multiple sectors. The report also highlights the challenges India faces in conserving biodiversity. These challenges include habitat loss, over-exploitation of natural resources, shrinking genetic diversity, the spread of invasive alien species, a declining forest resource base, climate change, desertification, pollution, and varying socio-cultural dynamics, as well as conflicting demands from diverse stakeholders. Furthermore, the report emphasises the critical need for enhanced resources, sustainable biodiversity management, the fair and equitable sharing of benefits arising from utilising genetic resources, and strengthened international cooperation to address these pressing issues effectively.

3.2 Success Factors

The following subsections outline the key enabling conditions, identified as 'Success Factors,' that have contributed to the results achieved over the past decade (2011–2020).

3.2.1 Financial flows

The funding for FLR across States and UTs has been recorded mainly from various sources. This indicator measured financial flows from domestic public expenditure, private investment, international donor support, and domestic philanthropic and non-profit support. However, all States and UTs, except Assam, Madhya Pradesh, Nagaland, and Uttar Pradesh, reported data only on financial flows from domestic public expenditure. Specific funding for FLR types was not received until the finalisation of this report.

The financial flow was observed to be highest in Gujarat, Madhya Pradesh, Telangana, Uttarakhand and Kerala. Out of the 35 States and UTs, 27 States and 7 UTs provided financial expenditure data towards FLR for the

[22] The 201 Most (& Least) Biodiverse Countries, https://theswiftest.com/biodiversity-index/

[23] Sixth National Report, https://chm.cbd.int/database/record?documentID=241351

[24] India submits Sixth National Report to the Convention of Biological Diversity (CBD), https://pib.gov.in/Pressreleaseshare.aspx?PRID=1557771

[25] COP 15: Final text of Kunming-Montreal Global Biodiversity Framework, https://www.cbd.int/article/cop15-final-text-kunming-montreal-gbf-221222

last decade. The total financial flow towards FLR for the reported States and UTs amounted to INR 702,335.29 million (USD 8,608.11 million). Comprehensive details are provided in the respective State and UT chapters.

3.2.2 Policies and institutional arrangements

This section provides a brief overview of the national and sub-national Acts, schemes, policies, and programmes in India that have been instrumental in the effective implementation of FLR. Based on data provided by the States and UTs, key forestry sector-related Acts, policies, missions, programmes, and schemes have been collated, which have been effective in the successful implementation of FLR in India.

National level: Several national-level actions contribute to India's Bonn Challenge Commitment, achieved mostly through the Compensatory Afforestation Fund Management and Planning Authority (CAMPA), the National Afforestation Programme (NAP), and the Green India Mission (GIM). Other important initiatives include the National Bamboo Mission and the Forest Conservation Act (FCA) of 1980.

Among the various Acts, schemes, policies, and programmes, the most pertinent ones (in multiple States) are listed in the table below.

The CAMPA not only compensates for forest diversion but also creates employment and livelihood opportunities for youth and marginalised communities. Similarly, with respect to the NAP and the GIM, in addition to afforestation programmes and the safeguarding of natural resources, the involvement of local communities (e.g., JFMCs) and their livelihoods is taken into account.

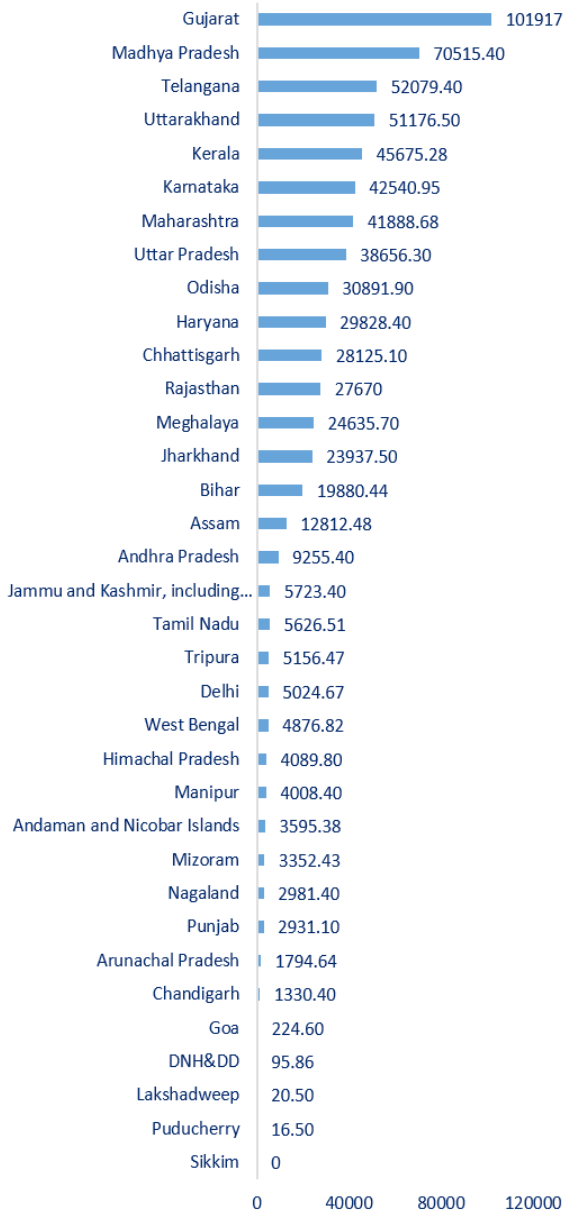


Figure 15: Total financial flow (million INR) for all States and UTs

Sub-national level: Sub-National Level: Several States have also indicated that their sub-national/State-level schemes have played a crucial role in expanding restoration efforts. Key sub-national level actions include Telangana's *Ku Haritha Haram* (TKHH), Krishi Aranya Protsaha Yojana (KAPY), Madhya Pradesh's Ecosystem Services Improvement Project (ESIP), Odisha's Ama Jangala Yojana, Uttar Pradesh's *Vanavaran Sanvardhan Yojana*, and West Bengal's *Jalatirtha*, among others.

Table 2: Key national Acts and schemes/policies/programmes driving FLR in Indian States and UTs, 2011–2020

S. No.	Relevant Acts, Missions, Programmes and Schemes
1	Green India Mission (GIM)
2	National Afforestation Programme (NAP)
3	Mahatma Gandhi National Rural Employment Guarantee Act (MGNREGA)
4	Compensatory Afforestation Fund Management and Planning Authority (CAMPA)
5	Sub-Mission on Agroforestry (SMAF)
6	Integrated Development of Wildlife Habitats (IDWH)
7	National Bamboo Mission
8	13th Finance Commission
9	Forest Fire Prevention and Management (FFPM)
10	Forest Conservation Act (FCA) 1980/Van (Sanrakshan Evam Samvardhan) Adhiniyam, 1980 (VSESA)
11	Scheduled Tribes and other Traditional Forest Dwellers (Recognition of Forest Rights) Act, 2006
12	The Indian Forest Act, 1927
13	National Forest Policy (NFP), 1988
14	Western Ghats Development Programme (WGDP)
15	Wildlife (Protection) Act, 1972
16	Namami Gange Programme

3.2.3. Technical planning and monitoring

In most States and UTs, monitoring is carried out by the Monitoring and Evaluation (M&E) wing of the respective forest departments. Some States have outsourced monitoring activities to reputable technical institutions. Evaluation reports are prepared, and data analyses are utilised for further planning of forestry and conservation activities. Most States and UTs rely on the Forest Survey of India's (FSI) biennial reporting to monitor and report changes in forest and tree cover within their jurisdictions.

Additionally, some States and UTs procure real-time monitoring data from FSI for forest fire monitoring. Monitoring and evaluation of CAMPA plantations and forest land diversion are specifically conducted through the portal developed by the Ministry of Environment, Forest and Climate Change (MoEFCC). Most States report that technical capacity for planning, implementing, and monitoring FLR activities exists and is generally sufficient and effective. However, there is a lack of State- and UT-specific information regarding technical planning and monitoring parameters.

4.0 STATE-WISE PROGRESS OF FLR IN INDIA

The individual State and UT-level assessments are presented in this section.

4.1 Andaman and Nicobar Islands

4.1.1 Restoration Barometer

The following table summarises the key components of the Restoration Barometer:

Table 3: Highlights of Restoration Barometer for Andaman and Nicobar Islands

Highlights	
Area brought under restoration (in ha)	26,058.42
Financial flow (in million INR)	3,595.38
Socio-economic impacts (man-days generated) (in million)	Not available
Climate impacts: Estimated carbon sequestered (in million tC)	0.42 (0% Mortality)
	0.33 (21% Mortality)
Climate impacts: Estimated carbon dioxide sequestered (in million tCO_2e)	1.55 (0% Mortality)
	1.22 (21% Mortality)

4.1.2 Background

The Andaman and Nicobar Islands, a Union Territory of India, is renowned for its marine ecosystem, rich biodiversity, and pristine beaches. The UT spans a Total Geographical Area (TGA) of 8,249 sq km, which constitutes 0.25% of the country's TGA.[26] The climate is humid tropical, with annual temperatures ranging from 24°C to 28°C and annual rainfall varying between 1,400 mm and 3,000 mm.[27] The UT has a population of 0.38 million, constituting 0.03% of India's population. The rural population comprises 37.70%, while the urban population represents 62.30% of the total. The average population density is 46 persons per sq km, significantly lower than the national average. According to the 19th Livestock Census of 2012, the total livestock population is 0.15 million.[28] The economy of Andaman and Nicobar is primarily driven by tourism within the tertiary sector, followed by the primary sector, where fishing and agriculture are significant contributors to the UT's economy.[29]

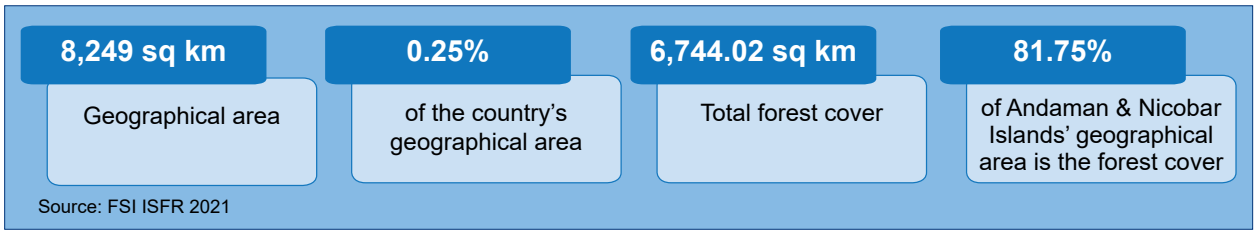


Figure 16: Geographical Area and Forest Cover of Andaman and Nicobar Islands

[26] ISFR 2021, https://fsi.nic.in/isfr-2021/chapter-13.pdf
[27] ISFR 2019, https://fsi.nic.in/isfr19/vol2/isfr-2019-vol-ii-andaman-nicobar-islands.pdf
[28] ISFR 2019, https://fsi.nic.in/isfr19/vol2/isfr-2019-vol-ii-andaman-nicobar-islands.pdf
[29] IBEF Infographics, https://www.ibef.org/states/andaman-and-nicobar-infographic

The total forest cover of the UT is 6,744.02 sq km, which forms 81.75% of its geographical area.[30]

As per India UT of Forest Report (ISFR) 2011[31] and ISFR 2021[32], the following observations were made:

- In the last 10 years, from 2011 to 2020, there is an increase of 20.02 sq km, or 2,002 ha, in the forest cover.
- The tree cover of Andaman & Nicobar Islands constituted 0.28% of the UT's TGA. In the last 10 years, there is a decrease of 16 sq km, or 1,600 ha, in the tree cover area of the UT.
- The average growing stock in Andaman & Nicobar Islands is 121.72 million cum in forest and 5.55 million cum in ToF. In the last 10 years, the average growing stock in the forest area and ToF has increased by 73.42 million cum.
- The total carbon stock of forest in the UT, including the TOF patches which are more than one ha in size, is 109.84 million tonnes (402.75 $MtCO_2e$), which is 1.52% of the total forest carbon in the country.

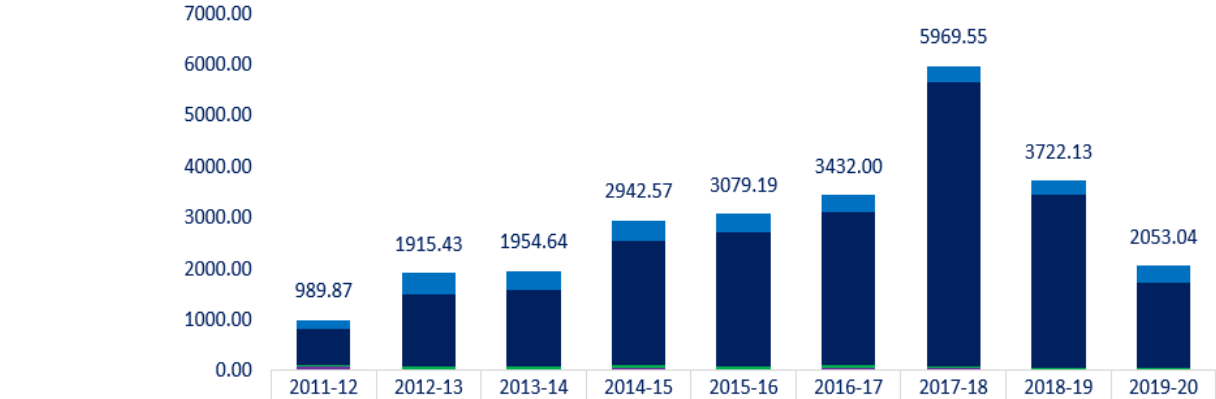
As per the 2021 DLD Atlas of India, negligible land degradation is observed in the Union Territory of Andaman and Nicobar Islands. Hence, the area of this UT is included in the No Apparent Degradation (NAD) class in the DLD Atlas of India.[33]

4.1.3 Restoration Barometer: UT Contribution

4.1.3.1 Area brought under restoration

As of 2020, a total of 26,058.42 ha of the UT area had been brought under restoration since 2011, according to data submitted by the Forest Department.

Note: Data for 2020 were unavailable at the time of publication.



	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20
Planted forest and woodlots	179.00	413.00	384.00	404.00	376.00	336.00	308.00	291.00	323.00
Natural regeneration	717.00	1436.00	1500.00	2438.00	2627.00	3003.00	5574.00	3372.00	1688.00
Mangrove restoration	27.00	56.00	51.00	43.00	50.00	41.00	34.00	32.00	28.00
Others	66.87	10.43	19.64	57.57	26.19	52.00	53.55	27.13	14.04
Total	989.87	1915.43	1954.64	2942.57	3079.19	3432.00	5969.55	3722.13	2053.04

Figure 17: Area brought under restoration from 2011–2020 as reported by the Forest Department of Andaman and Nicobar Islands

[30] ISFR 2021, https://fsi.nic.in/isfr-2021/chapter-13.pdf

[31] ISFR 2011, https://fsi.nic.in/forest-report-2011

[32] ISFR 2021, https://fsi.nic.in/forest-report-2021-details

[33] DLD Atlas of India, 2021, https://vedas.sac.gov.in/static/atlas/dsm/DLD_Atlas_SAC_2021.pdf

Table 4: Area brought under restoration based on FLR interventions by FD of Andaman and Nicobar Islands

FLR interventions implemented	Area brought under restoration (in ha)
Planted forest and woodlots	3,014
Natural regeneration	22,355
Mangrove restoration	362
Others	327.42

4.1.3.2 Climate Impact

The carbon sequestration for the Andaman and Nicobar Islands has been estimated for the restoration work carried out from 2011 to 2020 under different scenarios (A1 and A2) and assumptions (a1, a2, and a3). To estimate carbon sequestration, the IPCC GPG LULUCF 2003 methodology has been adopted. The Andaman and Nicobar Islands are classified under the Wet Season category, with an annual average rainfall of >2,000 mm. According to the IPCC GPG LULUCF 2003, the following cases of average annual increment are applicable for this level of rainfall – best case (8 tdm/ha/yr), base case (5.2 tdm/ha/yr), and worst case (2.4 tdm/ha/yr), for the estimation of carbon sequestration.[34]

The detailed methodology for estimating carbon sequestration is outlined in Section 1.4.1(B) and Annex I of the report. Based on this methodology, the total carbon sequestered and the per-hectare carbon sequestration are presented in the following graph and table, respectively.

To report on carbon sequestration while accounting for mortality rates, the Base Case (a2) assumption under the two scenarios has been applied, as it represents a balanced middle ground with neither too high nor too low values (refer to the detailed methodology in Section 1.4.1(B) and Annex I).

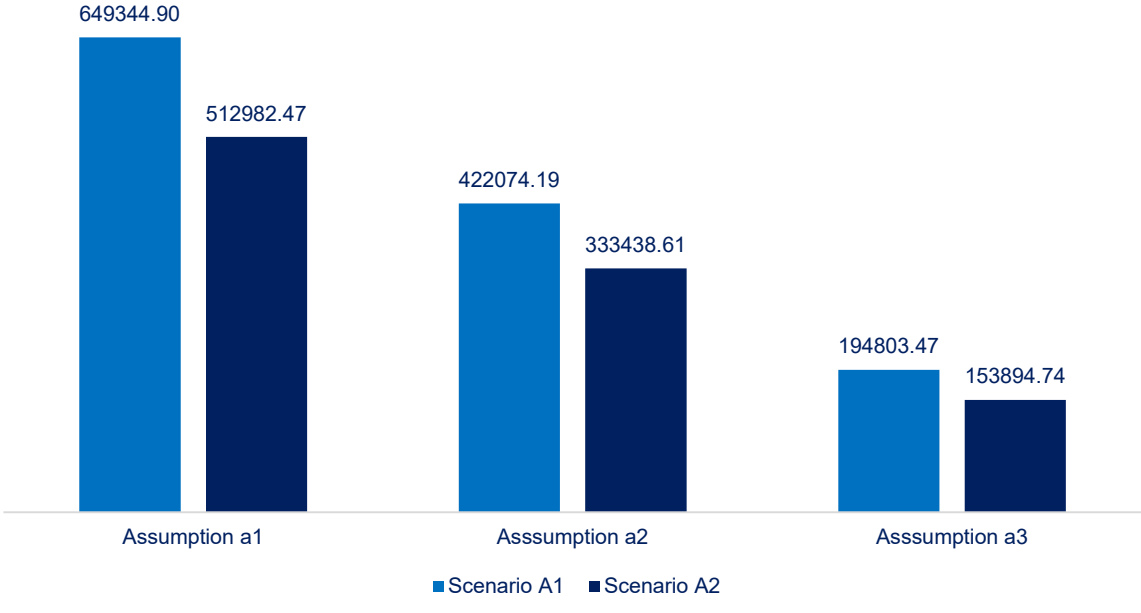


Figure 18: Total calculated tC sequestration in 10 years under two scenarios and three assumptions in Andaman and Nicobar Islands

[34] GPG LULUCF table 3A.1.6 - for AGB only https://www.ipcc-nggip.iges.or.jp/public/gpglulucf/gpglulucf_files/Chp3/Anx_3A_1_Data_Tables.pdff

From 2011 to 2020, expressed as carbon, this corresponds to 0.42 million tonnes of carbon (tC) without factoring in mortality and 0.33 million tC when a mortality rate of 21%, was considered. An estimated 1.55 million tonnes of carbon dioxide (tCO_2e) were sequestered, excluding plantation mortality. When accounting for mortality, the sequestration was 1.22 million tCO_2e.[35]

Table 5: Carbon stock tC (per ha) in AGB and BGB carbon pools in area brought under restoration for different assumptions and scenarios in Andaman and Nicobar Islands

Scenario	Assumption a1	Assumption a2	Assumption a3
Scenario A1	24.92	16.20	7.48
Scenario A2	19.69	12.80	5.91

4.1.3.3 Socio-economic impact

The socio-economic impact achieved in terms of man-days generated through the FLR work in the UT was not available at the time of publication.

Note: The data were not available at the time of publication.

4.1.3.4 Financial flow

The total financial flow towards FLR in the UT has been reported as INR 3,595.4 million (USD 44 million).[36] Domestic public expenditure is the primary source of funding, according to data provided by the FD for the period 2011 to 2020.

Table 6: Financial outflow from 2011–2020 in Andaman and Nicobar Islands

Financial outflow											
Year	**2011-12**	**2012-13**	**2013-14**	**2014-15**	**2015-16**	**2016-17**	**2017-18**	**2018-19**	**2019-20**	**2020-21**	**Total**
FLR funding in INR (million)	38.10	49.28	105.98	77.63	84.93	96.20	108.93	954.86	1016.08	1063.39	**3,595.38**

Table 7: Fund utilisation for bringing area under restoration in Andaman and Nicobar Islands

Description	**Fund utilisation** (2011-12 to 2020-21)
Total area brought under restoration (ha)	26,058.42
Total fund invested in FLR activities (million INR)	3,595.38
Funds invested per hectare (million INR/ha)	0.14
Area brought under restoration per million rupees (ha/million INR)	7.25

[35] Mortality rates was not available at the time of publication of this report. Hence, law of averages was applied assigning the average mortality rate derived from mortality rates provided by 13 other States and UTs.

[36] Exchange Rate - 81.59 as assessed on 01 October 2022

4.2 Andhra Pradesh

4.2.1 Restoration Barometer

The following table summarises the key components of the Restoration Barometer:

Table 8: Highlights of Restoration Barometer for Andhra Pradesh

Highlights	
Area brought under restoration (in ha)	1,613,589
Financial flow (in million INR)	9,255.40
Socio-economic impacts (man-days generated) (in million)	48.28
Climate impacts: Estimated carbon sequestered (in million tC)	26.39 (0% Mortality)
	19.79 (25% Mortality)
Climate impacts: Estimated carbon dioxide sequestered (in million tCO_2e)	96.85 (0% Mortality)
	72.64 (25% Mortality)

4.2.2 Background

Andhra Pradesh, located along the southeastern coast of India, is the country's eighth-largest state by geographical area. It spans a total geographical area of 162,968 sq km, representing 4.96% of India's total TGA.[37] The climate of Andhra Pradesh is humid, with average annual temperature ranging from 15°C to 45°C and annual rainfall between 1,100 mm and 1,250 mm.[38]

The state comprises 13 districts, including five tribal districts. According to the 2011 Census, Andhra Pradesh has a population of 49.39 million, representing 4.08% of India's population. The rural population accounts for 70.42%, while the urban population comprises 29.58%. The State's population density is 308 persons per sq km, which is below the national average. The 19th Livestock Census of 2012 reported a total livestock population of 56.10 million for the undivided Andhra Pradesh.[39] (The Andhra Pradesh Reorganisation Act, 2014, bifurcated the erstwhile State into Andhra Pradesh and Telangana).

Andhra Pradesh's economy is mainly driven by the tertiary sector, particularly Information Technology (IT) and services. Agriculture and allied activities in the primary sector also play a significant role, followed by the secondary sector, which includes pharmaceuticals, textiles, and automobiles.[40] The total forest cover of the State is 29,784.30 sq km, which constitutes 18.28% of its area.[41]

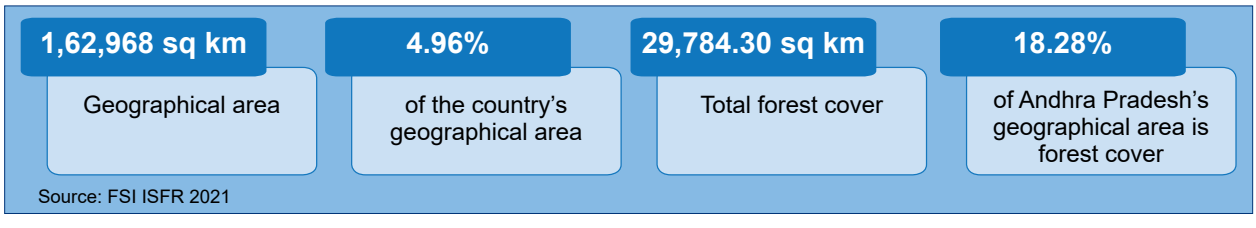


Figure 19: Geographical area and forest cover of Andhra Pradesh

[37] ISFR 2021, https://fsi.nic.in/isfr-2021/chapter-13.pdf
[38] ISFR 2019, https://fsi.nic.in/isfr19/vol2/isfr-2019-vol-ii-andhra-pradesh.pdf
[39] ISFR 2019, https://fsi.nic.in/isfr19/vol2/isfr-2019-vol-ii-andhra-pradesh.pdf
[40] IBEF Infographics, https://www.ibef.org/states/andhra-pradesh-infographic
[41] ISFR 2021, https://fsi.nic.in/isfr-2021/chapter-13.pdff

As per ISFR 2015[42 and 43] and ISFR 2021[44], the following observations were made:

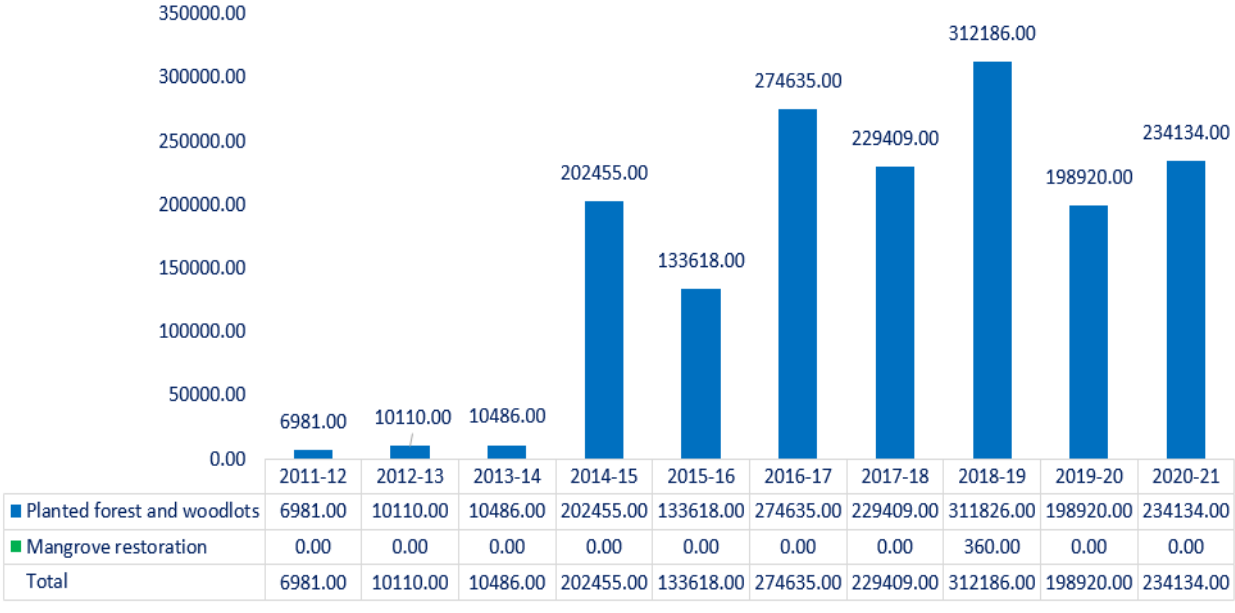
- In the five years from 2015 to 2020, there is an increase of 5,360.30 sq km, or 536,030 ha, in forest cover.
- The tree cover of Andhra Pradesh constituted 2.87% of the state's TGA. In the last five years, there is an increase of 714 sq km, or 71,400 ha, in the tree cover area of the state.
- The average growing stock in Andhra Pradesh is 115.71 million cum in forest and 73.16 million cum in ToF. In the last five years (2015-2020), the average growing stock in the forest area decreased by 32.40 million cum while increased for ToF by 8.88 million cum.
- The total carbon stock of forest in the State, including the TOF patches which are more than one ha in size, is 230.22 million tonnes (844.14 $MtCO_2e$), which is 3.20% of the total forest carbon in the country.

As per the 2021 DLD Atlas of India, 2,378,042 ha of land, representing 14.84% of the state's TGA, is affected by various forms of desertification and land degradation. There has been an increase of 79,283 ha (0.49%) of degraded land from 2011–13 to 2018–19. The primary driver of land degradation is vegetation degradation (7.30%), followed by water erosion (5%).[45]

Table 9: Status of desertification and land degradation from 2018–19 and 2011–13 (area in ha) in Andhra Pradesh

Year	Vegetation degradation	Water erosion	Wind erosion	Salinity	Water logging	Manmade	Barren/ rocky	Settlement
2018-19	1170184	801280	3986	119368	166341	30203	20521	66158
2011-13	1164257	789433	3986	117952	132334	20833	20521	49441

4.2.3 Restoration Barometer: State contribution



	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20	2020-21
Planted forest and woodlots	6981.00	10110.00	10486.00	202455.00	133618.00	274635.00	229409.00	311826.00	198920.00	234134.00
Mangrove restoration	0.00	0.00	0.00	0.00	0.00	0.00	0.00	360.00	0.00	0.00
Total	6981.00	10110.00	10486.00	202455.00	133618.00	274635.00	229409.00	312186.00	198920.00	234134.00

Figure 20: Area brought under restoration from 2011–2020 as reported by the State Forest Department of Andhra Pradesh

[42] ISFR 2015, https://fsi.nic.in/isfr-2015/isfr-2015-forest-and-tree-resources-in-states-and-union-territories.pdf

[43] Before 2015 Andhra Pradesh and Telangana were together. Segregated values of the states are not available before 2015. Hence, the ISFR analysis is done from 2015 onwards to avoid any inconsistencies. https://fsi.nic.in/isfr-2021/chapter-13.pdf

[44] ISFR 2021, https://fsi.nic.in/isfr-2021/chapter-13.pdf

[45] DLD Atlas of India, 2021, https://vedas.sac.gov.in/static/atlas/dsm/DLD_Atlas_SAC_2021.pdf

As of 2020, a total of 1,612,934 ha of the state's area had been brought under restoration since 2011, according to data submitted by the State Forest Department. Additionally, data from the Department of Land Resources (DoLR) indicate that 655 ha were restored between 2018 and 2020 by the DoLR.

Table 10: Area brought under restoration based on FLR interventions by State Forest Department of Andhra Pradesh

FLR interventions implemented	Area brought under restoration (in ha)
Planted forest and woodlots	1,612,574
Mangrove restoration	360

4.2.3.2 Climate impacts

The carbon sequestration for Andhra Pradesh has been estimated for the restoration work carried out from 2011 to 2020 under different scenarios (A1 and A2) and assumptions (a1, a2, and a3). To estimate carbon sequestration, the IPCC GPG LULUCF 2003 methodology has been adopted. Andhra Pradesh is classified under the Moist with Long Dry Season category, with an annual average rainfall ranging from 1,000 mm – 2,000 mm. According to the IPCC GPG LULUCF 2003, the following cases of average annual increment are applicable for this level of rainfall – best case (12.6 tdm/ha/yr), base case (7.1 tdm/ha/yr), and worst case (1.6 tdm/ha/yr), for the estimation of carbon sequestration.[46] The detailed methodology for estimating carbon sequestration is outlined in Section 1.4.1(B) and Annex I of the report. Based on this methodology, the total carbon sequestered and the per-hectare carbon sequestration are presented in the following graph and table, respectively.

To report on carbon sequestration while accounting for mortality rates, the Base Case (a2) assumption under the two scenarios has been applied, as it represents a balanced middle ground with neither too high nor too low values (refer to the detailed methodology in Section 1.4.1 (B) and Annex I).

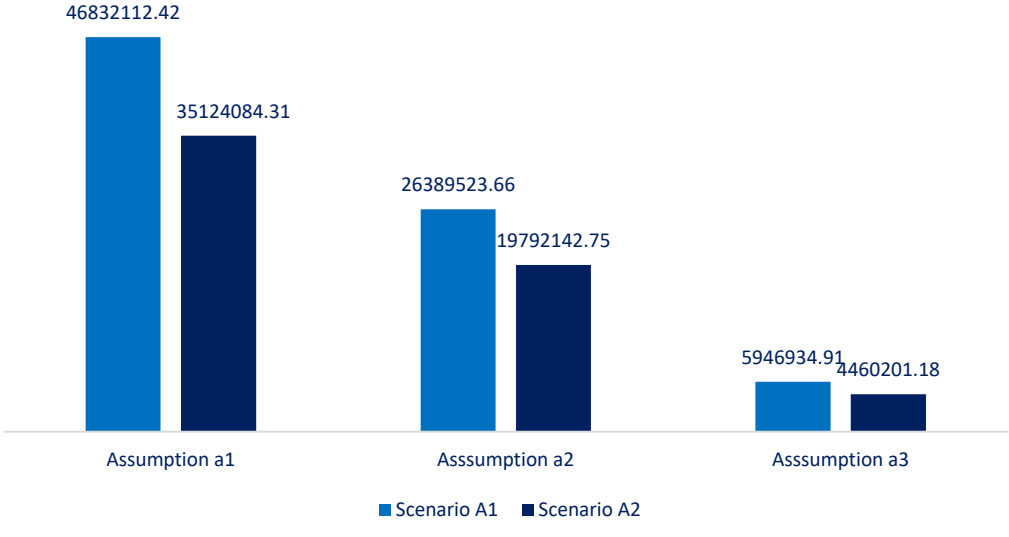


Figure 21: Total calculated tC sequestration in 10 years under two scenarios and three assumptions in Andhra Pradesh

[46] GPG LULUCF table 3A.1.6 - for AGB only https://www.ipcc-nggip.iges.or.jp/public/gpglulucf/gpglulucf_files/Chp3/Anx_3A_1_Data_Tables.pdf

From 2011 to 2020, expressed as carbon, this corresponds to 26.39 million tonnes of carbon (tC) without factoring in mortality and 19.79 million tC when a mortality rate of 25%, was considered. An estimated 96.85 million tonnes of carbon dioxide (tCO_2e) were sequestered, excluding plantation mortality. When accounting for mortality, the sequestration was 72.64 million tCO_2e. [47]

Table 11: Carbon stock tC (per ha) in AGB and BGB carbon pools in area brought under restoration for different assumptions and scenarios in Andhra Pradesh

Scenario	Assumption a1	Assumption a2	Assumption a3
Scenario A1	29.02	16.35	3.69
Scenario A2	21.77	12.27	2.76

4.2.3.3 Socio-economic impact

The socio-economic impact achieved has been measured in terms of man-days generated through FLR work in the state. According to SFD data for the period 2011 to 2020, a total of 48.28 million man-days of jobs were generated. This assessment accounts for the number of people involved in the implementation and maintenance of areas brought under restoration.

Table 12: Socio-economic impact (man-days generated) in Andhra Pradesh

Socio-economic impact											
Year	**2011-12**	**2012-13**	**2013-14**	**2014-15**	**2015-16**	**2016-17**	**2017-18**	**2018-19**	**2019-20**	**2020-21**	**Total**
Number of man-days generated (in million)	2.670	2.555	3.695	5.950	6.689	5.596	7.076	6.457	5.018	2.575	**48.28**

4.2.3.4 Financial flow

The total financial flow towards FLR in the state has been reported as INR 9,255.40 million (USD 113.43 million).[48] Domestic public expenditure is the primary source of funding, according to data provided by the SFD for the period 2011 to 2020.

Table 13: Financial outflow from 2011–2020 in Andhra Pradesh

Financial outflow											
Year	**2011-12**	**2012-13**	**2013-14**	**2014-15**	**2015-16**	**2016-17**	**2017-18**	**2018-19**	**2019-20**	**2020-21**	**Total**
FLR Funding in INR (million)	534	511.10	739	1189.10	1337.80	1119.30	1015.10	1291.50	1003.50	515	**9,255.40**

Table 14: Fund utilisation for bringing area under restoration in Andhra Pradesh

Description	**Fund utilisation** (2011-12 to 2020-21)
Total area brought under restoration (ha)	1,612,934
Total fund invested in FLR activities (million INR)	9,255.40
Funds invested per hectare (million INR/ha)	0.01
Area brought under restoration per million rupees (ha/million INR)	174.27

[47] Mortality rates was not available at the time of publication of this report. Hence, law of averages was applied assigning the average mortality rate derived from mortality rates provided by 13 other States and UTs.

[48] Exchange Rate - 81.59 as assessed on 01 October 2022

4.3 Arunachal Pradesh

4.3.1 Restoration Barometer

The following table summarises the key components of the Restoration Barometer:

Table 15: Highlights of Restoration Barometer for Arunachal Pradesh

Highlights	
Area brought under restoration (in ha)	174,347
Financial flow (in million INR)	1,794.64
Socio-economic impacts (man-days generated) (in million)	18.85
Climate impacts: Estimated carbon sequestered (in million tC)	3.62 (0% Mortality)
	2.86 (21% Mortality)
Climate impacts: Estimated carbon dioxide sequestered (in million tCO_2e)	13.30 (0% Mortality)
	10.51 (21% Mortality)

4.3.2 Background

Arunachal Pradesh, located in northeastern region of India, is often referred to as the 'Land of the Dawn-Lit Mountains.' The state has a TGA of 83,743 sq km, constituting 2.55% of the country's TGA.[49] The climate is dominated by the Himalayan system, with significant altitudinal variations. Average annual temperatures range from 0°C to 31°C, and annual rainfall varies between 2,000 mm and 8,000 mm.[50]

Arunachal Pradesh has a population of 1.38 million, making up 0.11% of India's population. Of this, 77.06% reside in rural areas, while 22.94% is urban. The tribal population comprises 68.79% of the state's total. The average population density is 17 persons per sq km, much lower than the national average. According to the 19th Livestock Census of 2012, the livestock population is 1.41 million.[51] Arunachal Pradesh's economy is primarily driven by tourism within the tertiary sector, followed by the primary sector, where forestry has seen significant growth in recent years. Agriculture also plays a crucial role in the state's economy.[52] The total forest cover of the state is 66,431 sq km, accounting for 79.33% of the state's geographical area.[53]

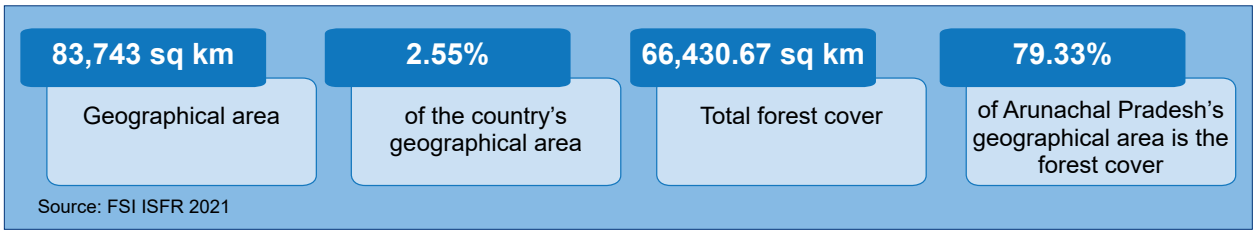


Figure 22: Geographical Area and Forest Cover of Arunachal Pradesh

[49] ISFR 2021, https://fsi.nic.in/isfr-2021/chapter-13.pdf
[50] ISFR 2019, https://fsi.nic.in/isfr19/vol2/isfr-2019-vol-ii-arunachal-pradesh.pdf
[51] ISFR 2019, https://fsi.nic.in/isfr19/vol2/isfr-2019-vol-ii-arunachal-pradesh.pdf
[52] IBEF Infographics, https://www.ibef.org/states/arunachal-pradesh-infographic
[53] ISFR 2021, https://fsi.nic.in/isfr-2021/chapter-13.pdf

As per ISFR 2011[54] and ISFR 2021[55], the following observations were made:

- In the last 10 years, from 2011 to 2020, there is an increase of 979.33 sq km, or 97,933 ha, in the forest cover.
- The tree cover of Arunachal Pradesh constituted 1.20% of the state's TGA. In the last 10 years, there is an increase of 452 sq km, or 45,200 ha, in the tree cover area of the state.
- The average growing stock in Arunachal Pradesh is 418.99 million cum in forest and 73.48 million cum in ToF. In the last 10 years, the average growing stock in the forest area and ToF has decreased by 74.74 million cum.
- The total carbon stock of forest in the State, including the TOF patches which are more than one ha in size, is 1,023.84 million tonnes (3,754.04 $MtCO_2e$), which is 14.21% of the total forest carbon in the country.

As per the 2021 DLD Atlas of India, 200,683 ha of land, representing 2.40% of the state's TGA, is affected by various forms of desertification and land degradation.[56] There has been an increase of 46,750 ha (0.56%) of degraded land from 2011–13 to 2018–19. The primary driver of land degradation is vegetation degradation (1.94%), followed by frost shattering (0.28%).[57]

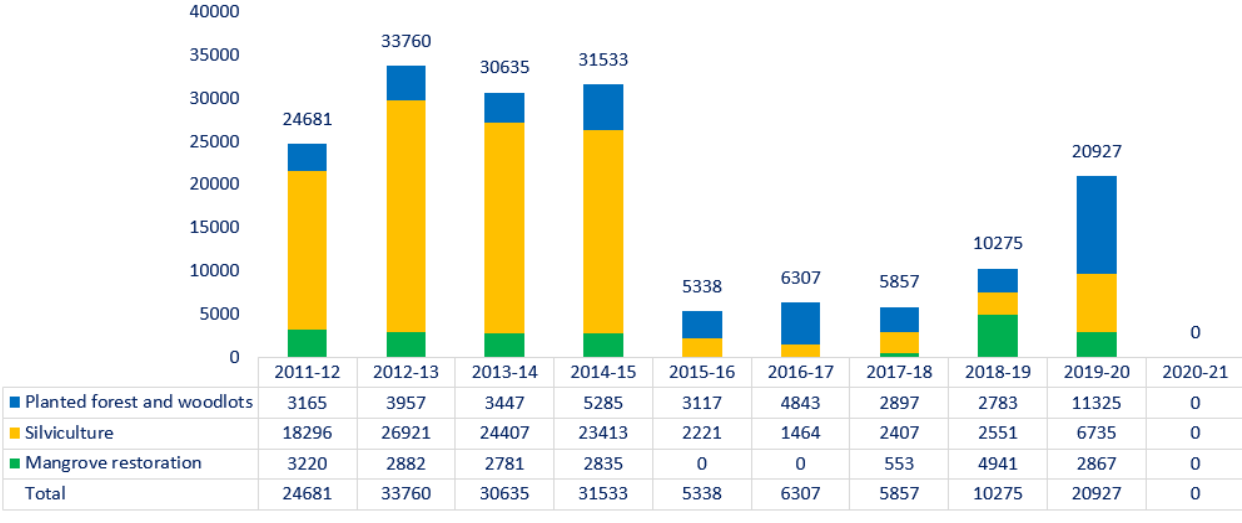
Table 16: Status of desertification and land degradation from 2018–19 and 2011–13 (area in ha) in Arunachal Pradesh

Year	Vegetation Degradation	Frost Shattering	Settlement
2018-19	1,62,560	23,726	14,398
2011-13	1,20,499	20,186	13,247

Source: ISRO 2021

4.3.3 Restoration Barometer: State contribution

4.3.3.1 Area brought under restoration



	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20	2020-21
Planted forest and woodlots	3165	3957	3447	5285	3117	4843	2897	2783	11325	0
Silviculture	18296	26921	24407	23413	2221	1464	2407	2551	6735	0
Mangrove restoration	3220	2882	2781	2835	0	0	553	4941	2867	0
Total	24681	33760	30635	31533	5338	6307	5857	10275	20927	0

Figure 23: Area brought under restoration from 2011–2020 as reported by SFD of Arunachal Pradesh

[54] ISFR 2011, https://fsi.nic.in/forest-report-2011

[55] ISFR 2021, https://fsi.nic.in/forest-report-2021-details

[56] Desertification and Land Degradation Atlas of India, 2021 https://vedas.sac.gov.in/static/atlas/dsm/DLD_Atlas_SAC_2021.pdf

[57] DLD Atlas of India, 2021, https://vedas.sac.gov.in/static/atlas/dsm/DLD_Atlas_SAC_2021.pdf

As of 2020, a total of 169,313 ha of the state's area had been brought under restoration since 2011, according to data submitted by the State Forest Department. Additionally, data from the Department of Land Resources (DoLR) indicate that 5,034 ha were restored between 2018 and 2020 by the DoLR.

Table 17: Area brought under restoration based on FLR interventions by SFD of Arunachal Pradesh

FLR interventions implemented	Area brought under restoration (in ha)
Planted forest and woodlots	40,819
Silviculture	108,415
Mangrove restoration	20,079

4.3.3.2 Climate impacts

The carbon sequestration for Arunachal Pradesh has been estimated for the restoration work carried out from 2011 to 2020 under different scenarios (A1 and A2) and assumptions (a1, a2, and a3). To estimate carbon sequestration, the IPCC GPG LULUCF 2003 methodology has been adopted. Arunachal Pradesh is classified under the Wet Season category, with an annual average of >2,000 mm. According to the IPCC GPG LULUCF 2003, the following cases of average annual increment are applicable for this level of rainfall – best case (8 tdm/ha/yr), base case (5.2 tdm/ha/yr), and worst case (2.4 tdm/ha/yr), for the estimation of carbon sequestration.[58] The detailed methodology for estimating carbon sequestration is outlined in Section 1.4.1(B) and Annex I of the report. Based on this methodology, the total carbon sequestered and the per-hectare carbon sequestration are presented in the following graph and table, respectively.

To report on carbon sequestration while accounting for mortality rates, the Base Case (a2) assumption under the two scenarios has been applied, as it represents a balanced middle ground with neither too high nor too low values (refer to the detailed methodology in Section 1.4.1 (B) and Annex I).

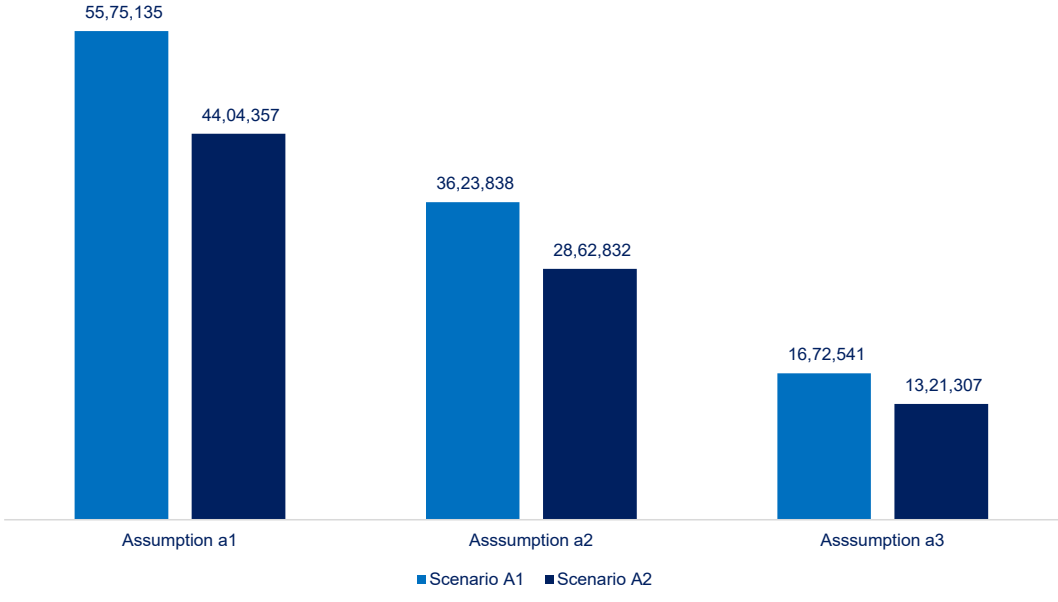


Figure 24: Total calculated tC sequestration in 10 years under two scenarios and three assumptions in Arunachal Pradesh

[58] GPG LULUCF table 3A.1.6 - for AGB only https://www.ipcc-nggip.iges.or.jp/public/gpglulucf/gpglulucf_files/Chp3/Anx_3A_1_Data_Tables.pdf

From 2011 to 2020, expressed as carbon, this corresponds to 3.62 million tonnes of carbon (tC) without factoring in mortality and 2.86 million tC when a mortality rate of 21%, was considered. An estimated 13.30 million tonnes of carbon dioxide (tCO_2e) were sequestered, excluding plantation mortality. When accounting for mortality, the sequestration was 10.51 million tCO_2e.[59]

Table 18: Carbon stock tC (per ha) in AGB and BGB carbon pools in area brought under restoration for different assumptions and scenarios in Arunachal Pradesh

Scenario	Assumption a1	Assumption a2	Assumption a3
Scenario A1	31.98	20.79	9.59
Scenario A2	25.26	16.42	7.58

4.3.3.3 Socio-economic impact

The socio-economic impact achieved has been measured in terms of man-days generated through FLR work in the state. According to SFD data for the period 2011 to 2020, a total of 18.85 million man-days of jobs were generated. This assessment accounts for the number of people involved in the implementation and maintenance of areas brought under restoration.

Table 19: Socio-economic impact (man-days generated) in Arunachal Pradesh

Socio-economic impact											
Year	**2011-12**	**2012-13**	**2013-14**	**2014-15**	**2015-16**	**2016-17**	**2017-18**	**2018-19**	**2019-20**	**2020-21**	**Total**
Number of man-days generated (in million)	1.54	4.93	4.72	4.68	0.33	0.47	0.34	0.48	1.35	0	**18.85**

4.3.3.4 Financial flow

The total financial flow towards FLR in the state has been reported as INR 1,794.64 million (USD 157.03 million).[60] Domestic public expenditure is the primary source of funding, according to data provided by the SFD for the period 2011 to 2020.

Table 20: Financial outflow from 2011–2020 in Arunachal Pradesh

Financial outflow											
Year	**2011-12**	**2012-13**	**2013-14**	**2014-15**	**2015-16**	**2016-17**	**2017-18**	**2018-19**	**2019-20**	**2020-21**	**Total**
FLR Funding in INR (million)	199.38	263.46	232.25	254.88	68.87	69.97	152.29	156.85	396.69	0	**1,794.64**

Table 21: Fund utilisation for bringing area under restoration in Arunachal Pradesh

Description	**Fund utilisation** (2011-12 to 2020-21)
Total area brought under restoration (ha)	169,313
Total fund invested in FLR activities (million INR)	1,794.64
Funds invested per hectare (million INR/ha)	0.01
Area brought under restoration per million rupees (ha/million INR)	94.34

[59] Mortality rates was not available at the time of publication of this report. Hence, law of averages was applied assigning the average mortality rate derived from mortality rates provided by 13 other States and UTs.

[60] Exchange Rate - 81.59 as assessed on 01 October 2022

4.4 Assam

4.4.1 Restoration Barometer

The following table summarises the key components of the Restoration Barometer:

Table 22: Highlights of Restoration Barometer for Assam

Highlights	
Area brought under restoration (in ha)	48,937.73
Financial flow (in million INR)	12,812.48
Socio-economic impacts (man-days generated) (in million)	6.31
Climate impacts: Estimated carbon sequestered (in million tC)	0.67 (0% Mortality)
	0.60 (10% Mortality)
Climate impacts: Estimated carbon dioxide sequestered (in million tCO_2e)	2.39 (0% Mortality)
	2.15 (10% Mortality)

4.4.2 Background

Assam, located in the northeastern region of India, shares borders with West Bengal, six northeastern states, and the countries of Bangladesh and Bhutan. The state covers a TGA of 78,438 sq km, which represents 2.39% of India's total TGA.[61] Assam experiences a subtropical climate, with annual temperatures ranging between 5°C and 32°C and annual rainfall between 1,500 mm and 3,800 mm.[62]

The state has a population of 31.21 million, representing 2.58% of India's total population. The rural population constitutes 85.90%, while the urban population comprises 14.10%. The state's population density is 398 persons per sq km, below the national average. According to the 19th Livestock Census 2012, the total livestock population is 19.08 million.[63]

Assam's economy is primarily driven by the tertiary sector, with tourism playing a major role. The secondary sector, led by food processing, contributes significantly to the state's industrial output. The primary sector, including tea, coal, and agriculture, also makes key contributions to the economy.[64] The total forest cover of Assam is 28,311.51 sq km, which constitutes 36.09% of its geographical area.[65]

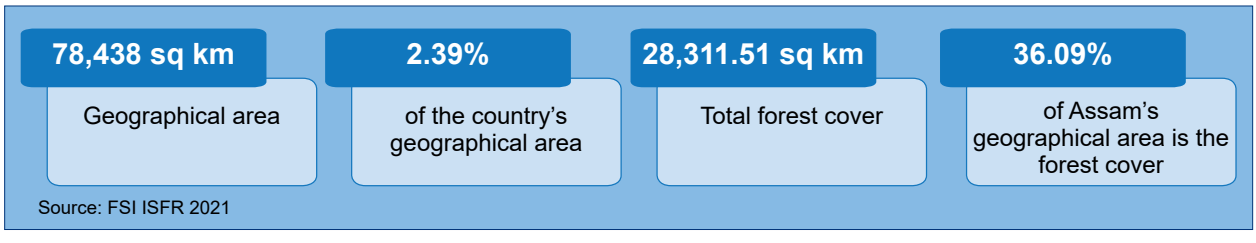


Figure 25: Geographical Area and Forest Cover of Assam

[61] ISFR 2021, https://fsi.nic.in/isfr-2021/chapter-13.pdf
[62] ISFR 2019, https://fsi.nic.in/isfr19/vol2/isfr-2019-vol-ii-assam.pdf
[63] ISFR 2019, https://fsi.nic.in/isfr19/vol2/isfr-2019-vol-ii-assam.pdf
[64] IBEF Infographics, https://www.ibef.org/states/assam-infographic
[65] ISFR 2021, https://fsi.nic.in/isfr-2021/chapter-13.pdf

As per ISFR 2011[66] and ISFR 2021[67], the following observations were made:

- In the last 10 years, from 2011 to 2020, there is an increase of 638.51 sq km, or 63,851 ha, in the forest cover.
- The tree cover of Assam constituted 2.08% of the state's TGA. In the last 10 years, there is an increase of 66 sq km, or 6,600 ha, in the tree cover area of the state.
- The average growing stock in Assam is 112.68 million cum in forest and 23.94 million cum in ToF. In the last 10 years, the average growing stock in the forest area and ToF has increased by 78.21 million cum.
- The total carbon stock of forest in the State, including the TOF patches which are more than one ha in size, is 271.37 million tonnes (995.02 $MtCO_2e$), which is 3.77% of the total forest carbon in the country.

As per the 2021 DLD Atlas of India, 834,530 ha of land, representing 10.64% of the state's TGA, is affected by various forms of desertification and land degradation. There has been an increase of 117,934 ha (1.5%) of degraded land from 2011–13 to 2018–19. The primary driver of land degradation is vegetation degradation (6.79%), followed by waterlogging (2.93%).[68]

Table 23: Status of desertification and land degradation from 2018–19 and 2011–13 (area in ha) in Assam

Year	Vegetation Degradation	Water Erosion	Water Logging	Manmade	Settlement
2018-19	532652	31827	229584	427	40040
2011-13	471958	31424	186667	-	26548

Source: ISRO 2021

4.4.3 Restoration Barometer: State Contribution

4.4.3.1 Area brought under restoration

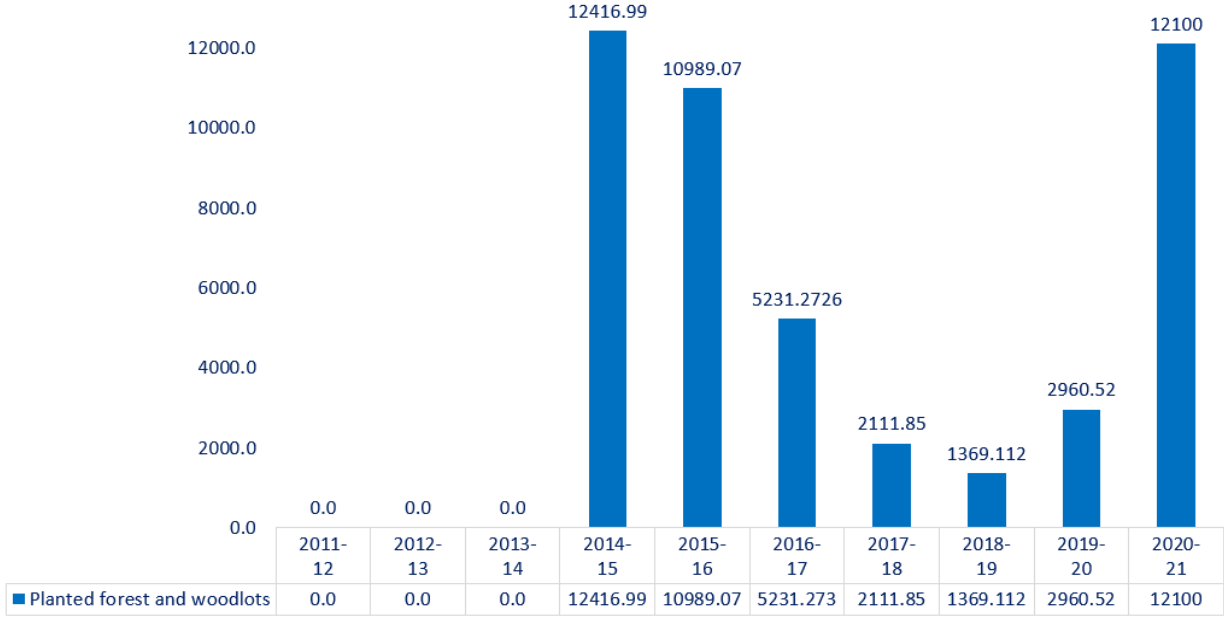


Figure 26: Area brought under restoration from 2011–2020 as reported by SFD of Assam

[66] ISFR 2011, https://fsi.nic.in/forest-report-2011

[67] ISFR 2021, https://fsi.nic.in/forest-report-2021-details

[68] DLD Atlas of India, 2021, https://vedas.sac.gov.in/static/atlas/dsm/DLD_Atlas_SAC_2021.pdf

As of 2020, a total of 47,178.81 ha of the state's area had been brought under restoration since 2011, according to data submitted by the State Forest Department. Additionally, data from the Department of Land Resources (DoLR) indicate that 1,758.92 ha were restored between 2018 and 2020 by the DoLR.

Table 24: Area brought under restoration based on FLR interventions by SFD of Assam

FLR interventions implemented	Area brought under restoration (in ha)
Planted forest and woodlots	47,178.81

4.4.3.2 Climate impacts

The carbon sequestration for Assam has been estimated for the restoration work carried out from 2011 to 2020 under different scenarios (A1 and A2) and assumptions (a1, a2, and a3). To estimate carbon sequestration, the IPCC GPG LULUCF 2003 methodology has been adopted. Assam is classified under the Wet Season category, with an annual average rainfall of >2,000 mm. According to the IPCC GPG LULUCF 2003, the following cases of average annual increment are applicable for this level of rainfall – best case (8 tdm/ha/yr), base case (5.2 tdm/ha/yr), and worst case (2.4 tdm/ha/yr), for the estimation of carbon sequestration.[69] The detailed methodology for estimating carbon sequestration is outlined in Section 1.4.1(B) and Annex I of the report. Based on this methodology, the total carbon sequestered and the per-hectare carbon sequestration are presented in the following graph and table, respectively.

To report on carbon sequestration while accounting for mortality rates, the Base Case (a2) assumption under the two scenarios has been applied, as it represents a balanced middle ground with neither too high nor too low values (refer to the detailed methodology in Section 1.4.1 (B) and Annex I).

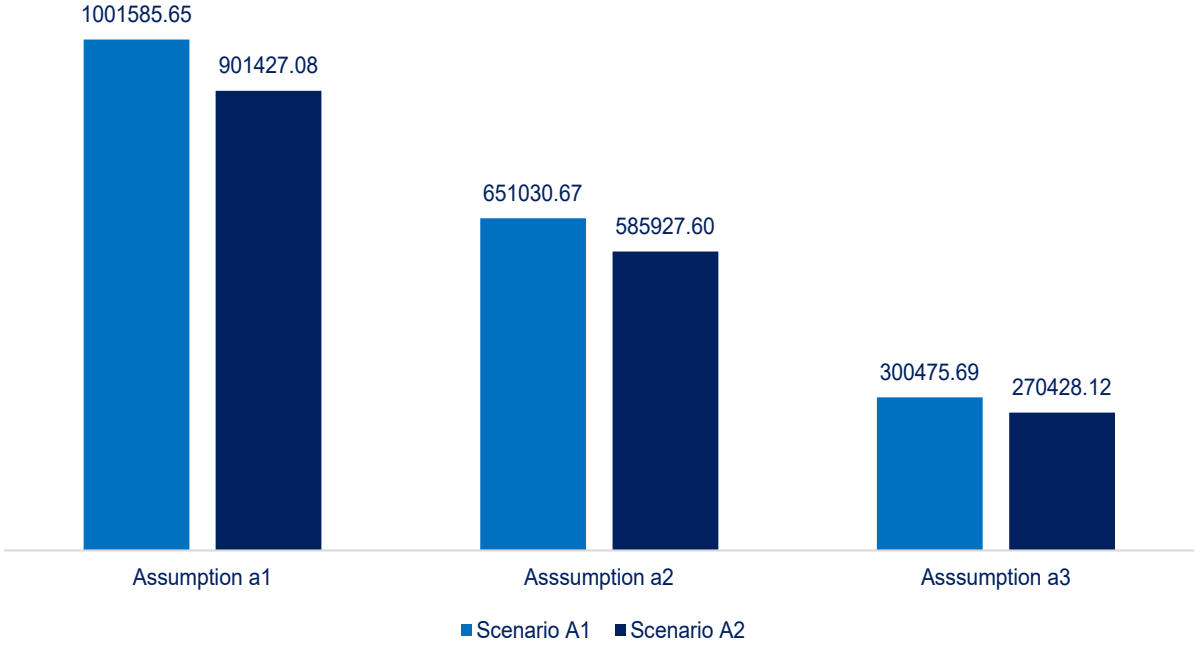


Figure 27: Total calculated tC sequestration in 10 years under two scenarios and three assumptions in Assam

[69] GPG LULUCF table 3A.1.6 - for AGB only https://www.ipcc-nggip.iges.or.jp/public/gpglulucf/gpglulucf_files/Chp3/Anx_3A_1_Data_Tables.pdf

From 2011 to 2020, expressed as carbon, this corresponds to 0.65 million tonnes of carbon (tC) without factoring in mortality and 0.59 million tC when a mortality rate of 10%, was considered. An estimated 2.39 million tonnes of carbon dioxide (tCO_2e) were sequestered, excluding plantation mortality. When accounting for mortality, the sequestration was 2.15 million tCO_2e.[70]

Table 25: Carbon stock tC (per ha) in AGB and BGB carbon pools in area brought under restoration for different assumptions and scenarios in Assam

Scenario	Assumption a1	Assumption a2	Assumption a3
Scenario A1	20.47	13.30	6.14
Scenario A2	18.42	11.97	5.53

4.4.3.3 Socio-economic impact

The socio-economic impact achieved has been measured in terms of man-days generated through FLR work in the state. According to SFD data for the period 2011 to 2020, a total of 6.31 million man-days of jobs were generated. This assessment accounts for the number of people involved in the implementation and maintenance of areas brought under restoration.

Table 26: Socio-economic impact (man-days generated) in Assam

Socio-economic impact											
Year	**2011-12**	**2012-13**	**2013-14**	**2014-15**	**2015-16**	**2016-17**	**2017-18**	**2018-19**	**2019-20**	**2020-21**	**Total**
Number of man-days generated (in million)	0	0	0	1.66	1.47	0.70	0.28	0.18	0.40	1.62	**6.31**

4.4.3.4 Financial flow

The total financial flow towards FLR in the state has been reported as INR 12,812.5 million (USD 157.03 million).[71] Domestic public expenditure is the primary source of funding, according to data provided by the SFD for the period 2011 to 2020.

Table 27: Financial outflow from 2011–2020 in Assam

Financial outflow											
Year	**2011-12**	**2012-13**	**2013-14**	**2014-15**	**2015-16**	**2016-17**	**2017-18**	**2018-19**	**2019-20**	**2020-21**	**Total**
FLR Funding in INR (million)	1334.66	1574.16	1357.40	334.17	191.11	1440.64	1178.03	375.94	3386.95	1639.42	**12,812.48**

Table 28: Fund utilisation for bringing area under restoration in Assam

Description	**Fund utilisation** (2011-12 to 2020-21)
Total area brought under restoration (ha)	47,178.81
Total fund invested in FLR activities (million INR)	12,812.48
Funds invested per hectare (million INR/ha)	0.27
Area brought under restoration per million rupees (ha/million INR)	3.68

[70] Mortality rates was not available at the time of publication of this report. Hence, law of averages was applied assigning the average mortality rate derived from mortality rates provided by 13 other States and UTs.

[71] Exchange Rate - 81.59 as assessed on 01 October 2022

4.5 Bihar

4.5.1 Restoration Barometer

The following table summarises the key components of the Restoration Barometer:

Table 29: Highlights of Restoration Barometer for Bihar

Highlights	
Area brought under restoration (in ha)	562,095.42
Financial flow (in million INR)	19,880.44
Socio-economic impacts (man-days generated) (in million)	14.32
Climate impacts: Estimated carbon sequestered (in million tC)	13.93 (0% Mortality)
	11.01 (21% Mortality)
Climate impacts: Estimated carbon dioxide sequestered (in million tCO_2e)	51.13 (0% Mortality)
	40.39 (21% Mortality)

4.5.2 Background

Bihar, a landlocked state in eastern India, spans a TGA of 94,163 sq km, representing 2.86% of India's total TGA. The state's current boundaries were established following its partition from Bengal and later from Jharkhand in 2000.[72] Bihar experiences a predominantly subtropical climate, with average annual temperatures ranging from 20°C to 28°C and annual rainfall between 1,000 mm and 2,000 mm.[73]

The state has a population of 104.10 million, accounting for 8.60% of India's total population, with 88.71% residing in rural areas and 11.29% in urban centres. The tribal population constitutes 1.28% of the total. With a population density of 1,106 persons per sq km, Bihar significantly exceeds the national average of 382 persons per sq km. The 19th Livestock Census of 2012 recorded a total livestock population of 32.93 million.[74] Services in the tertiary sector constitute the primary engine of Bihar's economy, followed by the primary sector. Agriculture dominates the primary sector, with significant contributions from forestry and fishing.[75] The total forest cover of Bihar is 7,380.79 sq km, constituting 7.84% of the state's geographical area.[76]

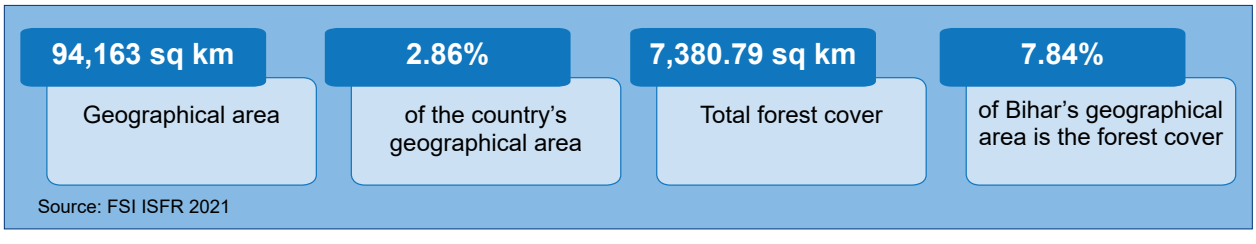


Figure 28: Geographical Area and Forest Cover of Bihar

[72] ISFR 2021, https://fsi.nic.in/isfr-2021/chapter-13.pdf
[73] ISFR 2019, https://fsi.nic.in/isfr19/vol2/isfr-2019-vol-ii-bihar.pdf
[74] ISFR 2019, https://fsi.nic.in/isfr19/vol2/isfr-2019-vol-ii-bihar.pdf
[75] IBEF Infographics, https://www.ibef.org/states/bihar-infographic
[76] ISFR 2021, https://fsi.nic.in/isfr-2021/chapter-13.pdf

As per ISFR 2011[77] and ISFR i2021[78], the following observations were made:

- In the last 10 years, from 2011 to 2020, there is an increase of 535.79 sq km, or 53,579 ha, in the forest cover.
- The tree cover of Bihar constituted 2.49% of the state's TGA. In the last 10 years, there is a decrease of 28 sq km, or 2,800 ha, in the tree cover area of the state.
- The average growing stock in Bihar is 30.52 million cum in forest and 41.04 million cum in ToF. In the last 10 years, the average growing stock in the forest area and ToF has increased by 10.82 million cum.
- The total carbon stock of forest in the State, including the TOF patches which are more than one ha in size, is 56.88 million tonnes (208.56 $MtCO_2e$), which is 0.79% of the total forest carbon in the country.

As per the 2021 DLD Atlas of India, 746,586 ha of land, representing 7.93% of the state's TGA, is affected by various forms of desertification and land degradation. There has been an increase of 51,777 ha (0.55%) of degraded land from 2011–13 to 2018–19. The primary driver of land degradation is water erosion (3.47%), followed by vegetation degradation 2.82%).[79]

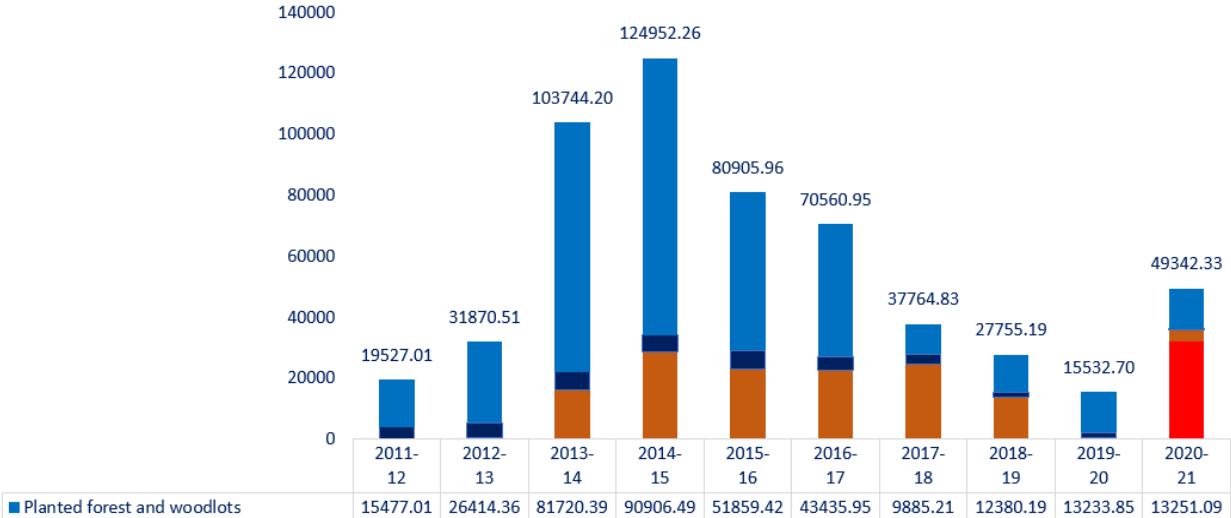
Table 30: Status of desertification and land degradation from 2018–19 and 2011–13 (area in ha) in Bihar

Year	Vegetation Degradation	Water Erosion	Water Logging	Manmade	Settlement
2018-19	265244	327004	125187	984	28168
2011-13	242525	321175	106628	984	23496

Source: ISRO 2021

4.5.3 Restoration Barometer: State contribution

4.5.3.1 Area brought under restoration



	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20	2020-21
Planted forest and woodlots	15477.01	26414.36	81720.39	90906.49	51859.42	43435.95	9885.21	12380.19	13233.85	13251.09
Natural Regeneration	4050	4750	5900	5555	5905	4455	3155	1435	1685	160
Agroforestry	0	706.15	16123.81	28490.77	23141.54	22670	24724.62	13940	613.85	4000.18
Watershed protection and erosion control	0	0	0	0	0	0	0	0	0	31931.06
Total	19527.01	31870.51	103744.20	124952.26	80905.96	70560.95	37764.83	27755.19	15532.70	49342.33

Figure 29: Area brought under restoration from 2011–2020 as reported by SFD of Bihar

[77] ISFR 2011, https://fsi.nic.in/forest-report-2011

[78] ISFR 2021, https://fsi.nic.in/forest-report-2021-details

[79] DLD Atlas of India, 2021, https://vedas.sac.gov.in/static/atlas/dsm/DLD_Atlas_SAC_2021.pdf

As of 2020, a total of 561,955.92 ha of the state's area had been brought under restoration since 2011, according to data submitted by the State Forest Department. Additionally, data from the Department of Land Resources (DoLR) indicate that 139.50 ha were restored between 2018 and 2020 by the DoLR.

Table 31: Area brought under restoration based on FLR interventions by SFD of Bihar

FLR interventions implemented	Area brought under restoration (in ha)
Planted forest and woodlots	358,563.96
Natural regeneration	37,050
Agroforestry	134,410.91
Watershed protection and erosion control	31,931.06

4.4.3.2 Climate impacts

The carbon sequestration for Bihar has been estimated for the restoration work carried out from 2011 to 2020 under different scenarios (A1 and A2) and assumptions (a1, a2, and a3). To estimate carbon sequestration, the IPCC GPG LULUCF 2003 methodology has been adopted. Bihar is classified under the Moist with Long Dry Season category, with an annual average rainfall ranging from 1,000 mm – 2,000 mm. According to the IPCC GPG LULUCF 2003, the following cases of average annual increment are applicable for this level of rainfall – best case (12.6 tdm/ha/yr), base case (7.1 tdm/ha/yr), and worst case (1.6 tdm/ha/yr), for the estimation of carbon sequestration.[80] The detailed methodology for estimating carbon sequestration is outlined in Section 1.4.1(B) and Annex I of the report. Based on this methodology, the total carbon sequestered and the per-hectare carbon sequestration are presented in the following graph and table, respectively.

To report on carbon sequestration while accounting for mortality rates, the Base Case (a2) assumption under the two scenarios has been applied, as it represents a balanced middle ground with neither too high nor too low values (refer to the detailed methodology in Section 1.4.1 (B) and Annex I).

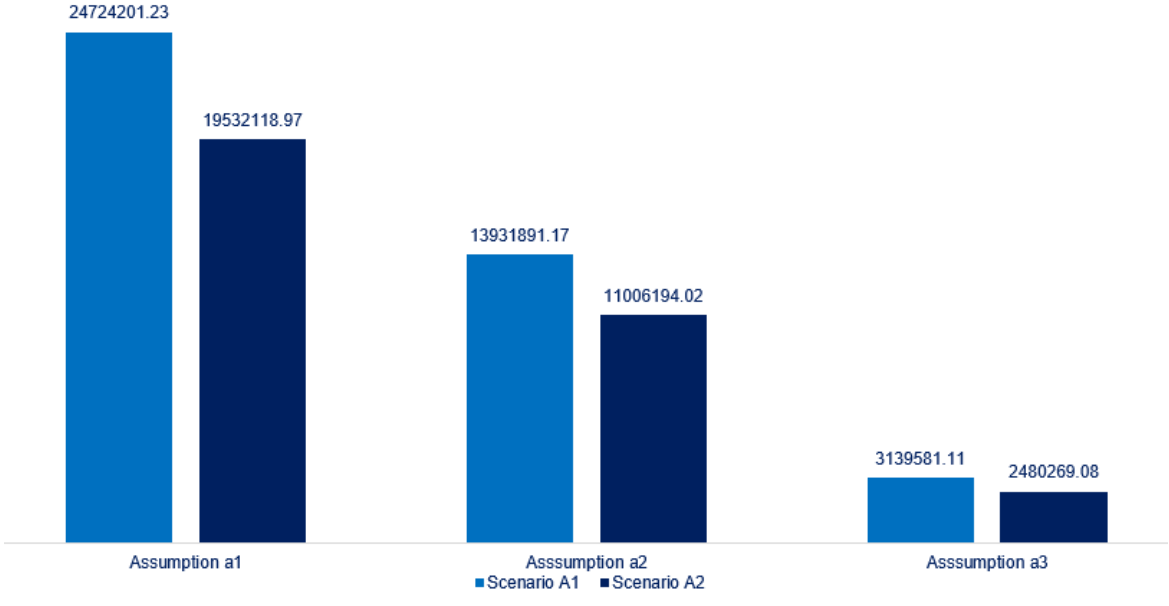


Figure 30: Total calculated tC sequestration in 10 years under two scenarios and three assumptions in Bihar

[80] GPG LULUCF table 3A.1.6 - for AGB only https://www.ipcc-nggip.iges.or.jp/public/gpglulucf/gpglulucf_files/Chp3/Anx_3A_1_Data_Tables.pdf

From 2011 to 2020, expressed as carbon, this corresponds to 13.93 million tonnes of carbon (tC) without factoring in mortality and 11.01 million tC when a mortality rate of 21%, was considered. An estimated 51.13 million tonnes of carbon dioxide (tCO_2e) were sequestered, excluding plantation mortality. When accounting for mortality, the sequestration was 40.39 million tCO_2e.[81]

Table 32: Carbon stock tC (per ha) in AGB and BGB carbon pools in area brought under restoration for different assumptions and scenarios in Bihar

Scenario	Assumption a1	Assumption a2	Assumption a3
Scenario A1	43.99	24.79	5.59
Scenario A2	34.75	19.58	4.41

4.5.3.3 Socio-economic impact

The socio-economic impact achieved has been measured in terms of man-days generated through FLR work in the state. According to SFD data for the period 2011 to 2020, a total of 14.32 million man-days of jobs were generated. This assessment accounts for the number of people involved in the implementation and maintenance of areas brought under restoration.

Table 33: Socio-economic impact (man-days generated) in Bihar

Socio-economic impact											
Year	**2011-12**	**2012-13**	**2013-14**	**2014-15**	**2015-16**	**2016-17**	**2017-18**	**2018-19**	**2019-20**	**2020-21**	**Total**
Number of man-days generated (in million)	0.16	0.58	0.97	2.87	1.21	1.34	1.56	1.69	0.82	3.13	**14.32**

4.5.3.4 Financial flow

The total financial flow towards FLR in the state has been reported as INR 19,880.4 million (USD 243.6 million).[82] Domestic public expenditure is the primary source of funding, according to data provided by the SFD for the period 2011 to 2020.

Table 34: Financial outflow from 2011–2020 in Bihar

Financial outflow											
Year	**2011-12**	**2012-13**	**2013-14**	**2014-15**	**2015-16**	**2016-17**	**2017-18**	**2018-19**	**2019-20**	**2020-21**	**Total**
FLR Funding in INR (million)	280.11	1034.99	1733.73	3718.36	2152.82	2934.22	2788.75	2188.84	1462.27	1586.35	**19,880.44**

Table 35: Fund utilisation for bringing area under restoration in Bihar

Description	**Fund utilisation** (2011-12 to 2020-21)
Total area brought under restoration (ha)	561,955.92
Total fund invested in FLR activities (million INR)	19,880.44
Funds invested per hectare (million INR/ha)	0.04
Area brought under restoration per million rupees (ha/million INR)	28.27

[81] Mortality rates was not available at the time of publication of this report. Hence, law of averages was applied assigning the average mortality rate derived from mortality rates provided by 13 other States and UTs

[82] Exchange Rate - 81.59 as assessed on 01 October 2022

4.6 Chandigarh

4.6.1 Restoration Barometer

The following table summarises the key components of the Restoration Barometer:

Table 36: Highlights of Restoration Barometer for Chandigarh

Highlights	
Area brought under restoration (in ha)	1,085.28
Financial flow (in million INR)	1,330.40
Socio-economic impacts (man-days generated) (in million)	0.70
Climate impacts: Estimated carbon sequestered (in million tC)	0.02 (0% Mortality)
	0.02 (10% Mortality)
Climate impacts: Estimated carbon dioxide sequestered (in million tCO_2e)	0.07(0% Mortality)
	0.06 (10% Mortality)

4.6.2 Background

Chandigarh, India's first planned city, is located at the foothills of the Shivalik Range in northern India. It spans an area of 114 sq km, representing 0.003% of India's TGA. Chandigarh serves as the capital for both Punjab and Haryana and is a Union Territory directly governed by the central government.[83] Chandigarh experiences a humid subtropical climate, with average temperatures ranging from 1°C to 45°C annually. Average annual rainfall varies between 400 mm and 600 mm.[84]

The city has a population of 1.06 million, constituting 0.09% of India's total population. Of this, 97.25% of the population resides in urban areas, while the remaining 2.75% live in rural zones. The Tribal population is 30.62%. The population density is 9,298 persons per sq km, making it one of the most densely populated UTs in India. The 19th Livestock Census of 2012 reported a livestock population of 24,197.[85] Chandigarh's economy is primarily driven by the tertiary sector, particularly in the fields of education, and health services. The secondary sector, including pharmaceuticals and engineering, also plays a significant role in driving the local economy.[86] Chandigarh's total forest cover is 22.88 sq km, constituting 20.07% of its geographical area.[87]

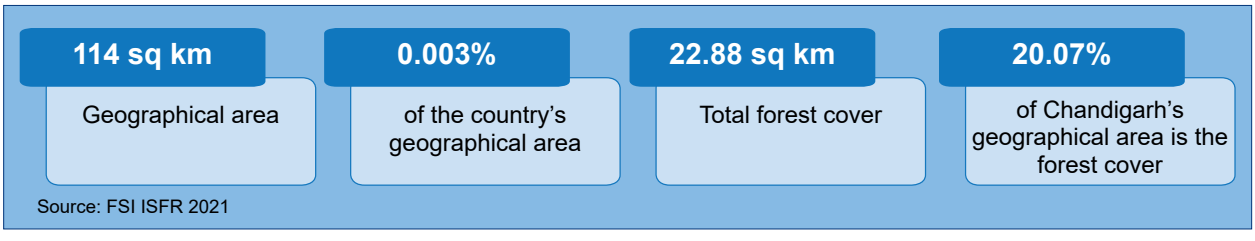


Figure 31: Geographical Area and Forest Cover of Chandigarh

[83] ISFR 2021, https://fsi.nic.in/isfr-2021/chapter-13.pdf
[84] ISFR 2019, https://fsi.nic.in/isfr19/vol2/isfr-2019-vol-ii-chandigarh.pdf
[85] ISFR 2019, https://fsi.nic.in/isfr19/vol2/isfr-2019-vol-ii-chandigarh.pdf
[86] IBEF Infographics, https://www.ibef.org/states/chandigarh-infographic
[87] ISFR 2021, https://fsi.nic.in/isfr-2021/chapter-13.pdf

As per ISFR 2011[88] and ISFR 2021[89], the following observations were made:

- In the last 10 years, from 2011 to 2020, there is an increase of 5.88 sq km, or 588 ha, in the forest cover.
- The tree cover of Chandigarh constituted 13.16% of the UT's TGA. In the last 10 years, there is an increase of five sq km, or 500 ha, in the tree cover area of the UT.
- The average growing stock in Chandigarh is 0.21 million cum in forest and 0.29 million cum in ToF. In the last 10 years, the average growing stock in the forest area decreased by 0.08 million cum while increased for ToF by 0.21 million cum.
- The total carbon stock of forest in the UT, including the TOF patches which are more than one ha in size, is 0.18 million tonnes (0.66 $MtCO_2e$), which is 0.002% of the total forest carbon in the country.

As per the 2021 DLD Atlas of India, negligible land degradation is observed in the Union Territory of Chandigarh. Hence, the area of this UT is included in the No Apparent Degradation (NAD) class in the DLD Atlas of India.[90]

4.6.3 Restoration Barometer: UT Contribution

4.6.3.1 Area brought under restoration

As of 2020, a total of 1,085.28 ha of the UT's area had been brought under restoration since 2011, according to data submitted by the Forest Department.

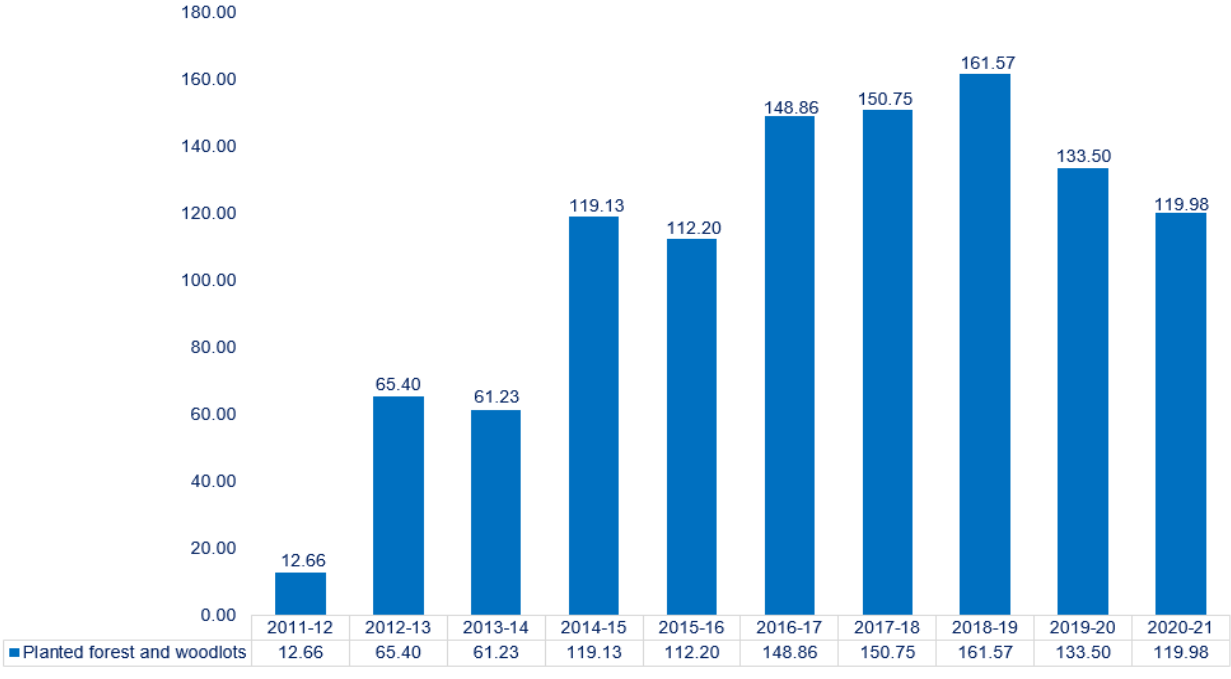


Figure 32: Area brought under restoration from 2011–2020 as reported by FD of Chandigarh

[88] ISFR 2011, https://fsi.nic.in/forest-report-2011

[89] ISFR 2021, https://fsi.nic.in/forest-report-2021-details

[90] DLD Atlas of India, 2021, https://vedas.sac.gov.in/static/atlas/dsm/DLD_Atlas_SAC_2021.pdf

Table 37: Area brought under restoration based on FLR interventions by FD of Chandigarh

FLR interventions implemented	Area brought under restoration (in ha)
Planted forest and woodlots	1,085.28

4.6.3.2 Climate impacts

The carbon sequestration for Chandigarh has been estimated for the restoration work carried out from 2011 to 2020 under different scenarios (A1 and A2) and assumptions (a1, a2, and a3). To estimate carbon sequestration, the IPCC GPG LULUCF 2003 methodology is adopted. Chandigarh is classified under the Dry Season category, with an annual average rainfall of <1,000 mm. According to the IPCC GPG LULUCF 2003, the following cases of average annual increment are applicable for this level of rainfall – best case (11.7 tdm/ha/yr), base case (6.45 tdm/ha/yr), and worst case (1.2 tdm/ha/yr), for the estimation of carbon sequestration.[91]

The detailed methodology for estimating carbon sequestration is outlined in Section 1.4.1(B) and Annex I of the report. Based on this methodology, the total carbon sequestered and the per-hectare carbon sequestration are presented in the following graph and table, respectively.

To report on carbon sequestration while accounting for mortality rates, the Base Case (a2) assumption under the two scenarios has been applied, as it represents a balanced middle ground with neither too high nor too low values (refer to the detailed methodology in Section 1.4.1(B) and Annex I).

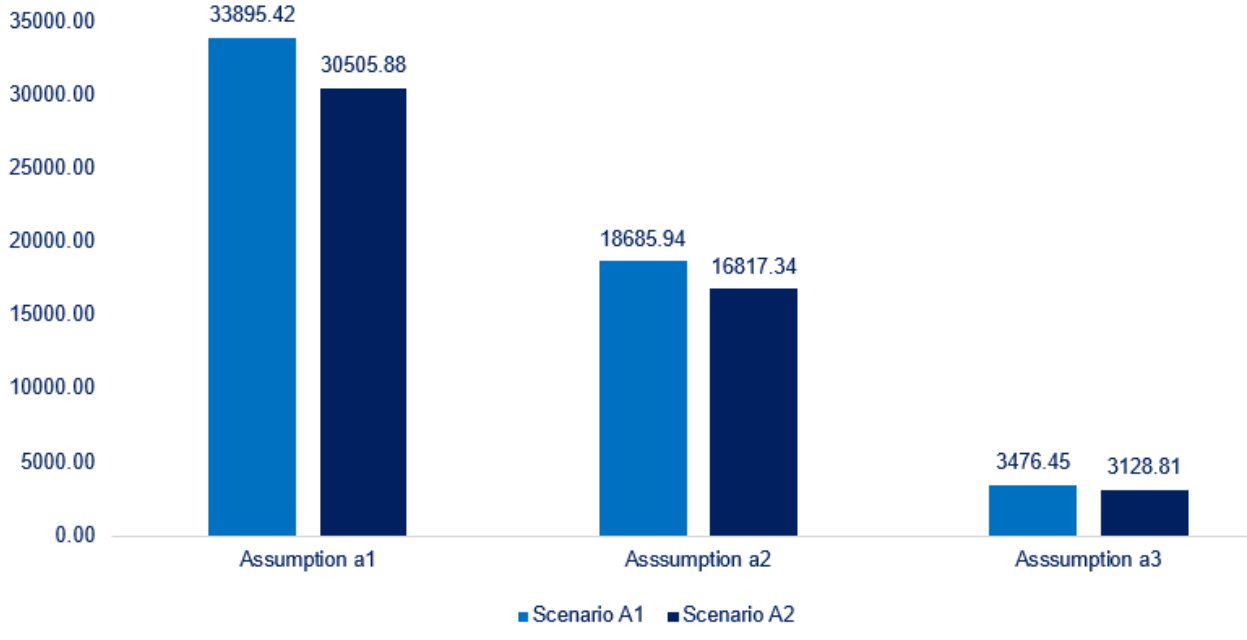


Figure 33: Total calculated tC sequestration in 10 years under two scenarios and three assumptions in Chandigarh

[91] GPG LULUCF table 3A.1.6 - for AGB only https://www.ipcc-nggip.iges.or.jp/public/gpglulucf/gpglulucf_files/Chp3/Anx_3A_1_Data_Tables.pdf

From 2011 to 2020, expressed as carbon, this corresponds to 0.02 million tonnes of carbon (tC) without factoring in mortality and 0.02 million tC when a mortality rate of 10%, was considered. An estimated 0.07 million tonnes of carbon dioxide (tCO_2e) were sequestered, excluding plantation mortality. When accounting for mortality, the sequestration was 0.06 million tCO_2e.[92]

Table 38: Carbon stock tC (per ha) in AGB and BGB carbon pools in area brought under restoration for different assumptions and scenarios in Chandigarh

Scenario	Assumption a1	Assumption a2	Assumption a3
Scenario A1	31.23	17.22	3.20
Scenario A2	28.11	15.50	2.88

4.6.3.3 Socio-economic impact

The socio-economic impact achieved has been measured in terms of man-days generated through FLR work in the UT. According to FD data for the period 2011 to 2020, a total of 0.70 million man-days of jobs were generated. This assessment accounts for the number of people involved in the implementation and maintenance of areas brought under restoration.

Table 39: Socio-economic impact (man-days generated) in Chandigarh

Socio-economic impact											
Year	**2011-12**	**2012-13**	**2013-14**	**2014-15**	**2015-16**	**2016-17**	**2017-18**	**2018-19**	**2019-20**	**2020-21**	**Total**
Number of man-days generated (in million)	0.06	0.06	0.06	0.06	0.07	0.07	0.07	0.07	0.13	0.04	**0.70**

4.6.3.4 Financial flow

The total financial flow towards FLR in the UT has been reported as INR 1,330.40 million (USD 16.31 million).[93] Domestic public expenditure is the primary source of funding, according to data provided by the FD for the period 2011 to 2020.

Table 40: Financial outflow from 2011–2020 in Chandigarh

Financial outflow											
Year	**2011-12**	**2012-13**	**2013-14**	**2014-15**	**2015-16**	**2016-17**	**2017-18**	**2018-19**	**2019-20**	**2020-21**	**Total**
FLR Funding in INR (million)	58.50	73.80	83.50	92	115.20	113.30	117.80	181.80	234.50	260	**1,330.40**

Table 41: Fund utilisation for bringing area under restoration in Chandigarh

Description	**Fund utilisation** (2011-12 to 2020-21)
Total area brought under restoration (ha)	1,085.28
Total fund invested in FLR activities (million INR)	1,330.40
Funds invested per hectare (million INR/ha)	1.23
Area brought under restoration per million rupees (ha/million INR)	0.82

[92] Mortality rates was not available at the time of publication of this report. Hence, law of averages was applied assigning the average mortality rate derived from mortality rates provided by 13 other States and UTs

[93] Exchange Rate - 81.59 as assessed on 01 October 2022

4.7 Chhattisgarh

4.7.1 Restoration Barometer

The following table summarises the key components of the Restoration Barometer:

Table 42: Highlights of Restoration Barometer for Chhattisgarh

Highlights	
Area brought under restoration (in ha)	762,705.53
Financial flow (in million INR)	28,125.10
Socio-economic impacts (man-days generated) (in million)	65.15
Climate impacts: Estimated carbon sequestered (in million tC)	18.33 (0% Mortality)
	17.42 (5% Mortality)
Climate impacts: Estimated carbon dioxide sequestered (in million tCO_2e)	67.29 (0% Mortality)
	63.92 (5% Mortality)

4.7.2 Background

Chhattisgarh, also known as the 'Rice Bowl of Central India', is a landlocked state bordered by Bihar, Jharkhand, and Uttar Pradesh to the north, Andhra Pradesh to the south, Odisha to the east, and Madhya Pradesh to the west. The state covers an area of 135,192 sq km, which constitutes 4.11% of the TGA of the country. The state was formed on 1 November 2000, following its separation from Madhya Pradesh.[94] Chhattisgarh has a tropical climate, characterised by hot and humid conditions due to its proximity to the Tropic of Cancer and reliance on monsoon rains. Average annual temperatures range from 11°C to 47°C, with rainfall varying between 1,100 mm and 1,700 mm.[95]

The state's population is 25.55 million, constituting 2.11% of India's total population. Of this, 76.76% reside in rural areas, while the remaining 23.24% live in urban areas. The population density is 189 persons per sq km, much lower than the national average of 382 persons per sq km. According to the 19th Livestock Census of 2012, the state has a livestock population of 15.04 million.[96] The economy of Chhattisgarh is largely driven by the tertiary sector, with significant contributions from services and commerce. The secondary sector, particularly mining and power generation, also plays a vital role, with the state being rich in natural resources like coal and iron ore. The primary sector, including agriculture, remains an important contributor, with rice being the major crop.[97] The total forest cover of Chhattisgarh is 55,716.60 sq km, which constitutes 41.21% of its geographical area.[98]

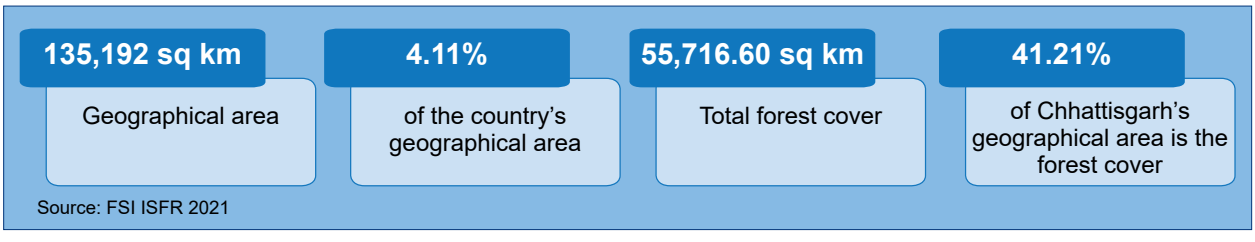


Figure 34: Geographical Area and Forest Cover of Chhattisgarh

[94] ISFR 2021, https://fsi.nic.in/isfr-2021/chapter-13.pdf
[95] ISFR 2019, https://fsi.nic.in/isfr19/vol2/isfr-2019-vol-ii-chhattisgarh.pdf
[96] ISFR 2019, https://fsi.nic.in/isfr19/vol2/isfr-2019-vol-ii-chhattisgarh.pdf
[97] IBEF Infographics, https://www.ibef.org/states/chhattisgarh-infographic
[98] ISFR 2021, https://fsi.nic.in/isfr-2021/chapter-13.pdf

As per ISFR 2011[99] and ISFR 2021[100], the following observations were made:

- In the last 10 years, from 2011 to 2020, there is an increase of 42.60 sq km, or 4,260 ha, in the forest cover.
- The tree cover of Chhattisgarh constituted 3.96% of the state's TGA. In the last 10 years, there is an increase of 1,489 sq km, or 148,900 ha, in the tree cover area of the state.
- The average growing stock in Chhattisgarh is 389.64 million cum in forest and 117.30 million cum in ToF. In the last 10 years, the average growing stock in the forest area and ToF has increased by 102.49 million cum.
- The total carbon stock of forest in the State, including the TOF patches which are more than one ha in size, is 496.44 million tonnes (1,820.28 $MtCO_2e$), which is 6.89% of the total forest carbon in the country.

As per the 2021 DLD Atlas of India, 2,306,531 ha of land, representing 17.06% of the state's TGA, is affected by various forms of desertification and land degradation. There has been an increase of 95,377 ha (0.70%) of degraded land from 2011–13 to 2018–19. The primary driver of land degradation is vegetation degradation (10.03%), followed by water erosion (6.32%).[101]

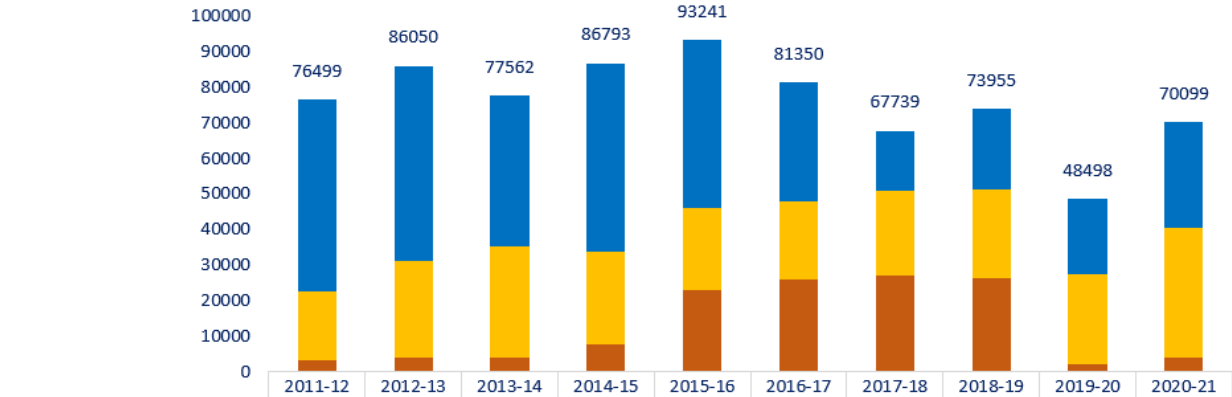
Table 43: Status of desertification and land degradation from 2018–19 and 2011–13 (area in ha) in Chhattisgarh

Year	Vegetation Degradation	Water Erosion	Manmade	Barren/Rocky	Settlement
2018-19	1356314	854393	52756	7222	35845
2011-13	1348089	783645	40541	7222	31656

Source: ISRO 2021

4.7.3 Restoration Barometer: State contribution

4.7.3.1 Area brought under restoration



	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20	2020-21
Planted forests and woodlots	53811	55028	42393	53170	47104	33543	16949	22667	21191	29494
Silviculture	19635	27184	31281	25833	23231	21743	23960	25140	25198	36884
Agroforestry	3053	3838	3888	7790	22906	26064	26830	26148	2109	3721
Total	76499	86050	77562	86793	93241	81350	67739	73955	48498	70099

Figure 35: Area brought under restoration from 2011–2020 as reported by SFD of Chhattisgarh

[99] ISFR 2011, https://fsi.nic.in/forest-report-2011

[100] ISFR 2021, https://fsi.nic.in/forest-report-2021-details

[101] DLD Atlas of India, 2021, https://vedas.sac.gov.in/static/atlas/dsm/DLD_Atlas_SAC_2021.pdf

As of 2020, a total of 761,786 ha of the state's area had been brought under restoration since 2011, according to data submitted by the State Forest Department. Additionally, data from the Department of Land Resources (DoLR) indicate that 919.53 ha were restored between 2018 and 2020 by the DoLR.

Table 44: Area brought under restoration based on FLR interventions by SFD of Chhattisgarh

FLR interventions implemented	Area brought under restoration (in ha)
Planted forest and woodlots	375,350
Silviculture	260,089
Agroforestry	126,347

4.7.3.2 Climate impacts

The carbon sequestration for Chhattisgarh has been estimated for the restoration work carried out from 2011 to 2020 under different scenarios (A1 and A2) and assumptions (a1, a2, and a3). To estimate carbon sequestration, the IPCC GPG LULUCF 2003 methodology has been adopted. Chhattisgarh is classified under the Moist with Long Dry Season category, with an annual average rainfall ranging from 1,000 mm – 2,000 mm. According to the IPCC GPG LULUCF 2003, the following cases of average annual increment are applicable for this level of rainfall – best case (12.6 tdm/ha/yr), base case (7.1 tdm/ha/yr), and worst case (1.6 tdm/ha/yr), for the estimation of carbon sequestration.[102] The detailed methodology for estimating carbon sequestration is outlined in Section 1.4.1(B) and Annex I of the report. Based on this methodology, the total carbon sequestered and the per-hectare carbon sequestration are presented in the following graph and table, respectively.

To report on carbon sequestration while accounting for mortality rates, the Base Case (a2) assumption under the two scenarios has been applied, as it represents a balanced middle ground with neither too high nor too low values (refer to the detailed methodology in Section 1.4.1 (B) and Annex I).

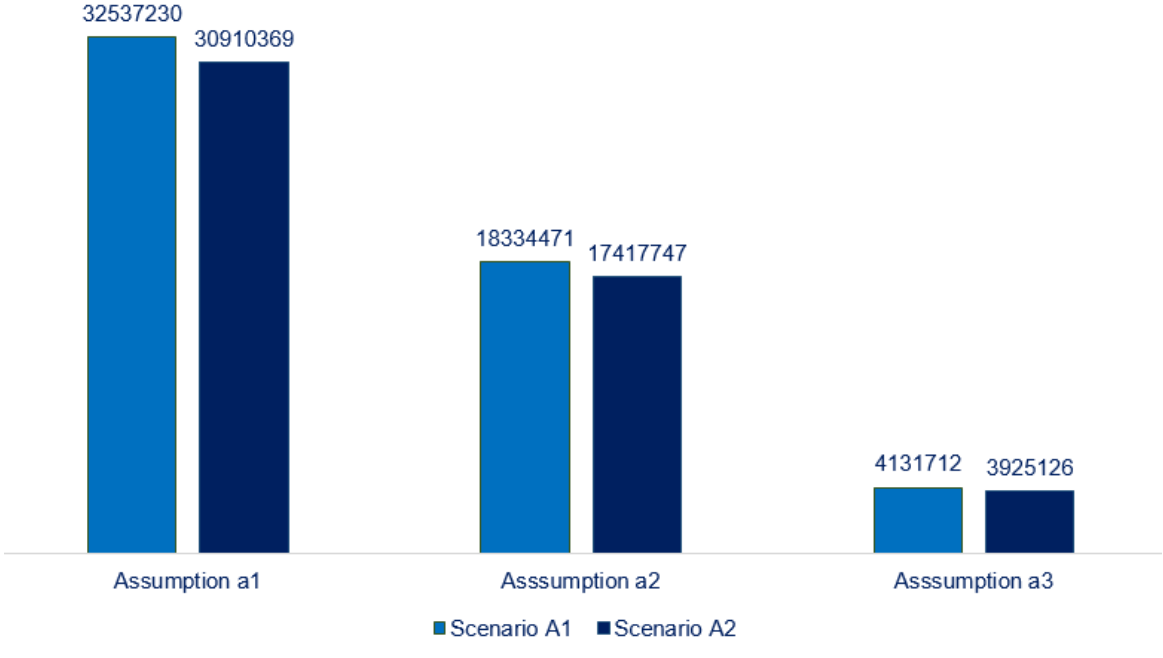


Figure 36: Total calculated tC sequestration in 10 years under two scenarios and three assumptions in Chhattisgarh

[102] GPG LULUCF table 3A.1.6 - for AGB only https://www.ipcc-nggip.iges.or.jp/public/gpglulucf/gpglulucf_files/Chp3/Anx_3A_1_Data_Tables.pdf

From 2011 to 2020, expressed as carbon, this corresponds to 18.33 million tonnes of carbon (tC) without factoring in mortality and 17.42 million tC when a mortality rate of 5%, was considered. An estimated 67.29 million tonnes of carbon dioxide (tCO_2e) were sequestered, excluding plantation mortality. When accounting for mortality, the sequestration was 63.92 million tCO_2e.[103]

Table 45: Carbon stock tC (per ha) in AGB and BGB carbon pools in area brought under restoration for different assumptions and scenarios in Chhattisgarh

Scenario	Assumption a1	Assumption a2	Assumption a3
Scenario A1	42.66	24.04	5.42
Scenario A2	40.53	22.84	5.15

4.7.3.3 Socio-economic impact

The socio-economic impact achieved has been measured in terms of man-days generated through FLR work in the state. According to SFD data for the period 2011 to 2020, a total of 65.15 million man-days of jobs were generated. This assessment accounts for the number of people involved in the implementation and maintenance of areas brought under restoration.

Table 46: Socio-economic impact (man-days generated) in Chhattisgarh

Socio-economic impact											
Year	**2011-12**	**2012-13**	**2013-14**	**2014-15**	**2015-16**	**2016-17**	**2017-18**	**2018-19**	**2019-20**	**2020-21**	**Total**
Number of man-days generated (in million)	6.85	6.86	6.78	7.44	8.05	5.27	5.96	6.57	5.59	5.77	**65.15**

4.7.3.4 Financial flow

The total financial flow towards FLR in the state has been reported as INR 28,125.10 million (USD 344.71 million).[104] Domestic public expenditure is the primary source of funding, according to data provided by the SFD for the period 2011 to 2020.

Table 47: Financial outflow from 2011–2020 in Chhattisgarh

Financial outflow											
Year	**2011-12**	**2012-13**	**2013-14**	**2014-15**	**2015-16**	**2016-17**	**2017-18**	**2018-19**	**2019-20**	**2020-21**	**Total**
FLR Funding in INR (million)	2283.3	2513.8	2713.1	3101.3	3487.9	2373.5	2781	3176.5	2706.5	2988.2	**28,125.10**

Table 48: Fund utilisation for bringing area under restoration in Chhattisgarh

Description	**Fund utilisation** (2011-12 to 2020-21)
Total area brought under restoration (ha)	761,786
Total fund invested in FLR activities (million INR)	28,125.10
Funds invested per hectare (million INR/ha)	0.04
Area brought under restoration per million rupees (ha/million INR)	27.09

[103] Mortality rates was not available at the time of publication of this report. Hence, law of averages was applied assigning the average mortality rate derived from mortality rates provided by 13 other States and UTs

[104] Exchange Rate - 81.59 as assessed on 01 October 2022

4.8 Dadra & Nagar Haveli and Daman & Diu

4.8.1 Restoration Barometer

The following table summarises the key components of the Restoration Barometer:

Table 49: Highlights of Restoration Barometer for Dadra & Nagar Haveli and Daman & Diu

Highlights	
Area brought under restoration (in ha)	2185.17
Financial flow (in million INR)	95.86
Socio-economic impacts (man-days generated) (in million)	0.48
Climate impacts: Estimated carbon sequestered (in million tC)	0.03 (0% Mortality)
	0.03 (21% Mortality)
Climate impacts: Estimated carbon dioxide sequestered (in million tCO_2e)	0.12 (0% Mortality)
	0.10 (21% Mortality)

4.8.2 Background

Dadra & Nagar Haveli and Daman & Diu, located on the western coast of India, are situated on the western side of the foothills of the Western Ghats. The Union Territory was formed through the merger of two separate UTs in 2020. The total geographical area of the UT is 602 sq km, which is equal to 0.02% of the TGA of the country.[105] The climate of Dadra & Nagar Haveli and Daman & Diu is tropical. In Dadra and Nagar Haveli, the average annual temperature ranges from 25°C to 27.5°C, with average annual rainfall between 2,000 mm and 2,500 mm. In Daman and Diu, the mean annual temperature ranges from 25°C to 28°C, and the average annual rainfall varies between 2,300 mm and 4,800 mm.[106]

The UT has a population of 0.58 million, constituting 0.05% of India's total population. The rural and urban populations account for 41.49% and 58.51%, respectively, of the UT's total population. The average population density is 963 persons per sq km, nearly double the national average. According to the 19th Livestock Census 2012, the total livestock population is 0.05 million.[107] The economy of Dadra & Nagar Haveli and Daman & Diu is primarily driven by the secondary sector, particularly manufacturing. Key industries include pharmaceuticals, yarn production, and plastic manufacturing. The tertiary sector, encompassing services and tourism, also makes a significant contribution. The primary sector, which includes agriculture and forestry, supports the region's economy but plays a less dominant role compared to other sectors.[108]

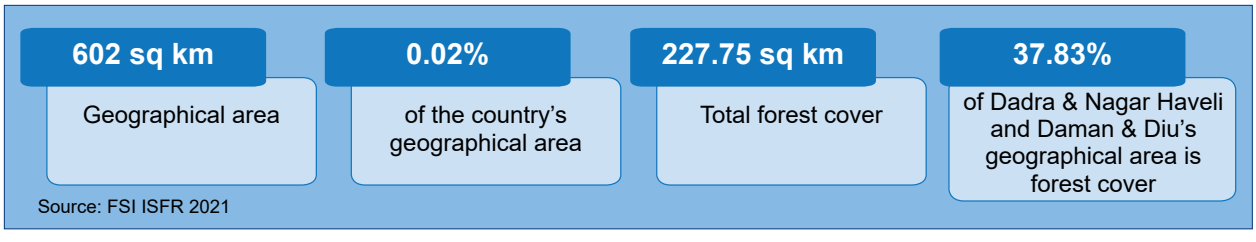


Figure 37: Geographical Area and Forest Cover of Dadra & Nagar Haveli and Daman & Diu

[105] ISFR 2021, https://fsi.nic.in/isfr-2021/chapter-13.pdf

[106] ISFR 2019, https://fsi.nic.in/isfr19/vol2/isfr-2019-vol-ii-dadra-nagar-haveli.pdf and https://fsi.nic.in/isfr19/vol2/isfr-2019-vol-ii-daman-diu.pdf

[107] ISFR 2021, https://fsi.nic.in/isfr-2021/chapter-13.pdf

[108] IBEF Infographics, https://www.ibef.org/states/dadra-nagar-haveli-and-daman-diu-infographic

The total forest cover of the Union Territory is 227.75 sq km, constituting 37.83% of the UT's total area.[109]

As per ISFR 2011[110] and ISFR 2021[111], the following observations were made:

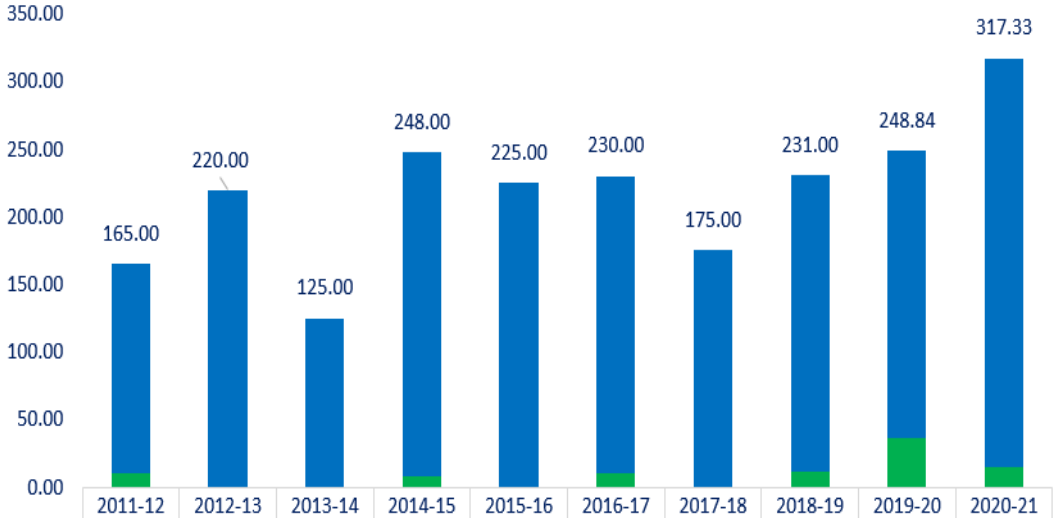
- In the last 10 years, from 2011 to 2020, there is an increase of 10.75 sq km, or 1,075 ha, in the forest cover.
- The tree cover of Dadra & Nagar Haveli and Daman & Diu constituted 5.48% of the UT's TGA. In the last 10 years, there is an increase of six sq km, or 600 ha, in the tree cover area of the UT.
- The average growing stock in Dadra & Nagar Haveli and Daman & Diu is 0.45 million cum in forest and 0.67 million cum in ToF. In the last 10 years, the average growing stock in the forest area and ToF has increased by 3.71 million cum.
- The total carbon stock of forest in the UT, including the TOF patches which are more than one ha in size, is 1.98 million tonnes (7.26 $MtCO_2e$), which is 0.03% of the total forest carbon in the country.

As per the 2021 DLD Atlas of India, negligible land degradation is observed in the Union Territory of the Dadra & Nagar Haveli and Daman & Diu. Hence, the area of this UT is included in the No Apparent Degradation (NAD) class in the DLD Atlas of India.[112]

4.8.3 Restoration Barometer: UT Contribution

4.8.3.1 Area brought under restoration

As of 2020, a total of 2,185.17 ha the UT area had been brought under restoration since 2011, according to data submitted by the Forest Department.



	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20	2020-21
Planted forest and woodlots	155.00	220.00	125.00	240.00	225.00	220.00	175.00	220.00	212.00	303.00
Mangrove restoration	10.00	0.00	0.00	8.00	0.00	10.00	0.00	11.00	36.84	14.33
Total	165.00	220.00	125.00	248.00	225.00	230.00	175.00	231.00	248.84	317.33

Figure 38: Area brought under restoration from 2011–2020 as reported by FD of Dadra & Nagar Haveli and Daman & Diu

[109] ISFR 2021, https://fsi.nic.in/isfr-2021/chapter-13.pdf

[110] ISFR 2011, https://fsi.nic.in/forest-report-2011

[111] ISFR 2021, https://fsi.nic.in/forest-report-2021-details

[112] DLD Atlas of India, 2021, https://vedas.sac.gov.in/static/atlas/dsm/DLD_Atlas_SAC_2021.pdf

Table 50: Area brought under restoration based on FLR interventions by FD of Dadra & Nagar Haveli and Daman & Diu

FLR interventions implemented	Area brought under restoration (in ha)
Planted forest and woodlots	2,095
Mangrove restoration	90.17

4.8.3.2 Climate impact

The carbon sequestration of Dadra & Nagar Haveli and Daman & Diu has been estimated for the restoration work carried out from 2011 to 2020 under different scenarios (A1 and A2) and assumptions (a1, a2, and a3). To estimate carbon sequestration, the IPCC GPG LULUCF 2003 methodology has been adopted. Dadra & Nagar Haveli and Daman & Diu are classified under the Wet Season category, with an annual average rainfall of >2,000 mm. According to the IPCC GPG LULUCF 2003, the following cases of average annual increment are applicable for this level of rainfall – best case, (8 tdm/ha/yr), base case (5.2 tdm/ha/yr), and worst case (2.4 tdm/ha/yr), for the estimation of carbon sequestration.[113] The detailed methodology for estimating carbon sequestration is outlined in Section 1.4.1(B) and Annex I of the report. Based on this methodology, the total carbon sequestered and the per-hectare carbon sequestration are presented in the following graph and table, respectively.

To report on carbon sequestration while accounting for mortality rates, the Base Case (a2) assumption under the two scenarios has been applied, as it represents a balanced middle ground with neither too high nor too low values (refer to the detailed methodology in Section 1.4.1(B) and Annex I).

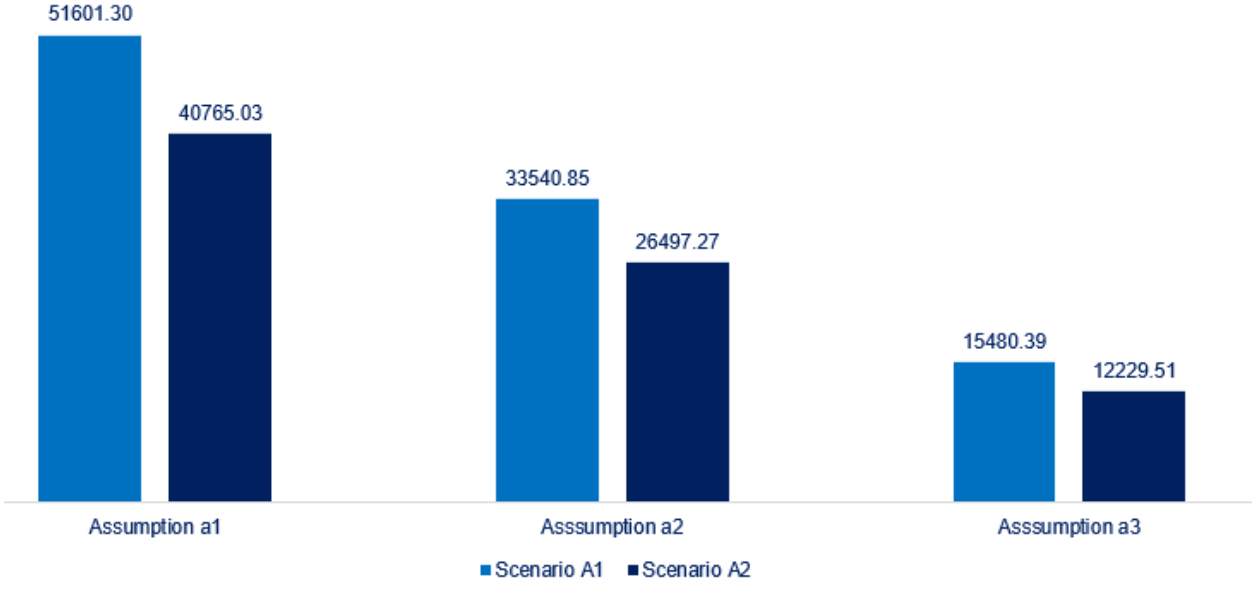


Figure 39: Total calculated tC sequestration in 10 years under two scenarios and three assumptions in Dadra & Nagar Haveli and Daman & Diu

[113] GPG LULUCF table 3A.1.6 - for AGB only https://www.ipcc-nggip.iges.or.jp/public/gpglulucf/gpglulucf_files/Chp3/Anx_3A_1_Data_Tables.pdf

From 2011 to 2020, expressed as carbon, this corresponds to 0.03 million tonnes of carbon (tC) without factoring in mortality and 0.03 million tC when a mortality rate of 21%, was considered. An estimated 0.12 million tonnes of carbon dioxide (tCO_2e) were sequestered, excluding plantation mortality. When accounting for mortality, the sequestration was 0.10 million tCO_2e.[114]

Table 51: Carbon stock tC (per ha) in AGB and BGB carbon pools in area brought under restoration for different assumptions and scenarios in Dadra & Nagar Haveli and Daman & Diu

Scenario	Assumption a1	Assumption a2	Assumption a3
Scenario A1	27.62	17.96	8.29
Scenario A2	21.82	14.18	6.55

4.8.3.3 Socio-economic impact

The socio-economic impact achieved has been measured in terms of man-days generated through FLR work in the UT. According to FD data for the period 2011 to 2020, a total of 0.48 million man-days of jobs were generated. This assessment accounts for the number of people involved in the implementation and maintenance of areas brought under restoration.

Table 52: Socio-economic impact (man-days generated) in Dadra & Nagar Haveli and Daman & Diu

Socio-economic impact											
Year	**2011-12**	**2012-13**	**2013-14**	**2014-15**	**2015-16**	**2016-17**	**2017-18**	**2018-19**	**2019-20**	**2020-21**	**Total**
Number of man-days generated (in million)	0.003	0.004	0.002	0.004	0.450	0.004	0.003	0.004	0.004	0.006	**0.48**

4.8.3.4 Financial flow

The total financial flow towards FLR in the UT has been reported as INR 95.86 million (USD 0.88 million).[115] Domestic public expenditure is the primary source of funding, according to data provided by the FD for the period 2011 to 2020.

Table 53: Financial outflow from 2011–2020 in Dadra & Nagar Haveli and Daman & Diu

Financial outflow											
Year	**2011-12**	**2012-13**	**2013-14**	**2014-15**	**2015-16**	**2016-17**	**2017-18**	**2018-19**	**2019-20**	**2020-21**	**Total**
FLR Funding in INR (million)	4.59	5.80	4.10	8.48	11.20	11.69	7.10	12	13	17.90	**95.86**

Table 54: Fund utilisation for bringing area under restoration in Dadra & Nagar Haveli and Daman & Diu

Description	**Fund utilisation** (2011-12 to 2020-21)
Total area brought under restoration (ha)	2,185.17
Total fund invested in FLR activities (million INR)	95.86
Funds invested per hectare (million INR/ha)	0.04
Area brought under restoration per million rupees (ha/million INR)	22.80

[114] Mortality rates was not available at the time of publication of this report. Hence, law of averages was applied assigning the average mortality rate derived from mortality rates provided by 13 other States and UTs

[115] Exchange Rate - 81.59 as assessed on 01 October 2022

4.9 Delhi

4.9.1 Restoration Barometer

The following table summarises the key components of the Restoration Barometer:

Table 55: Highlights of Restoration Barometer for NCT of Delhi

Highlights	
Area brought under restoration (in ha)	3,550.38
Financial flow (in million INR)	5,024.67
Socio-economic impacts (man-days generated) (in million)	7.53
Climate impacts: Estimated carbon sequestered (in million tC)	0.07 (0% Mortality)
	0.06 (15% Mortality)
Climate impacts: Estimated carbon dioxide sequestered (in million tCO_2e)	0.25 (0% Mortality)
	0.21 (15% Mortality)

4.9.2 Background

The National Capital Territory (NCT) of Delhi is a Union Territory with special status under the Indian Constitution. Located in northern India, it serves as a major political, cultural, and economic hub. Delhi is bordered by Haryana on all sides except to the east, where it shares a boundary with Uttar Pradesh. Delhi covers a total area of 1,483 sq km, constituting 0.05% of the country's total geographical area.[116] One of the country's largest urban agglomerations, Delhi is situated primarily on the western bank of the Yamuna River, a tributary of the Ganges (Ganga) River, approximately 160 km south of the Himalayas.[117]

Delhi experiences an extreme climate, characterised by very hot summers (April to July) and cold winters (December to January). The annual temperature varies between 3°C and 45°C, with annual rainfall ranging from 400 mm to 600 mm.[118] The population of Delhi is 16.79 million, representing 1.38% of India's total population. The urban population accounts for 97.25%, while the rural population makes up 2.50%. With a population density of 11,320 persons per sq km, Delhi is one of the most densely populated UTs in India. According to the 19th Livestock Census 2012, the total livestock population is 0.36 million.[119] The economy of Delhi is driven primarily by the tertiary sector, particularly in areas such as trade, commerce, IT services, finance, and tourism. The secondary sector, including manufacturing and construction, also contributes significantly. The primary sector, with agriculture, plays a minimal role in Delhi's economy due to its urban character.[120]

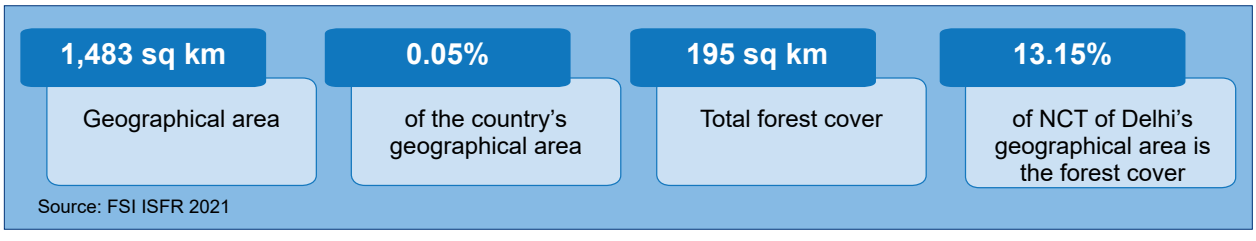


Figure 40: Geographical Area and Forest Cover of Delhi

[116] ISFR 2021, https://fsi.nic.in/isfr-2021/chapter-13.pdf
[117] Delhi Britannica, https://www.britannica.com/place/Delhi
[118] ISFR 2019, https://fsi.nic.in/isfr19/vol2/isfr-2019-vol-ii-delhi.pdf
[119] ISFR 2019, https://fsi.nic.in/isfr19/vol2/isfr-2019-vol-ii-delhi.pdf
[120] IBEF Infographics, https://www.ibef.org/states/delhi-infographic

The total forest cover of Delhi is 195 sq km, forming 13.15% of its geographical area.[121]

As per ISFR 2011[122] and ISFR 2021[123], the following observations were made:

- In the last 10 years, from 2011 to 2020, there is an increase of 19 sq km, or 1,900 ha, in the forest cover.
- The tree cover of NCT of Delhi constituted 9.91% of the UT's TGA. In the last 10 years, there is an increase of 27 sq km, or 2,700 ha, in the tree cover area of the UT.
- The average growing stock in NCT of Delhi is 0.51 million cum in forest and 1.75 million cum in ToF. In the last 10 years, the average growing stock in the forest area decreased by 1.20 million cum while increased for ToF by 0.71 million cum.
- The total carbon stock of forest in the UT, including the TOF patches which are more than one ha in size, is 1.20 million tonnes (4.40 $MtCO_2e$), which is 0.02% of the total forest carbon in the country.

As per the 2021 DLD Atlas of India, 91,543 ha of land, representing 61.73% of the UT's TGA, is affected by various forms of desertification and land degradation. There has been an increase of 1,674 ha (1.13%) of degraded land from 2011–13 to 2018–19. The primary driver of land degradation is settlement (54.76%), followed by vegetation degradation (6.73%).[124]

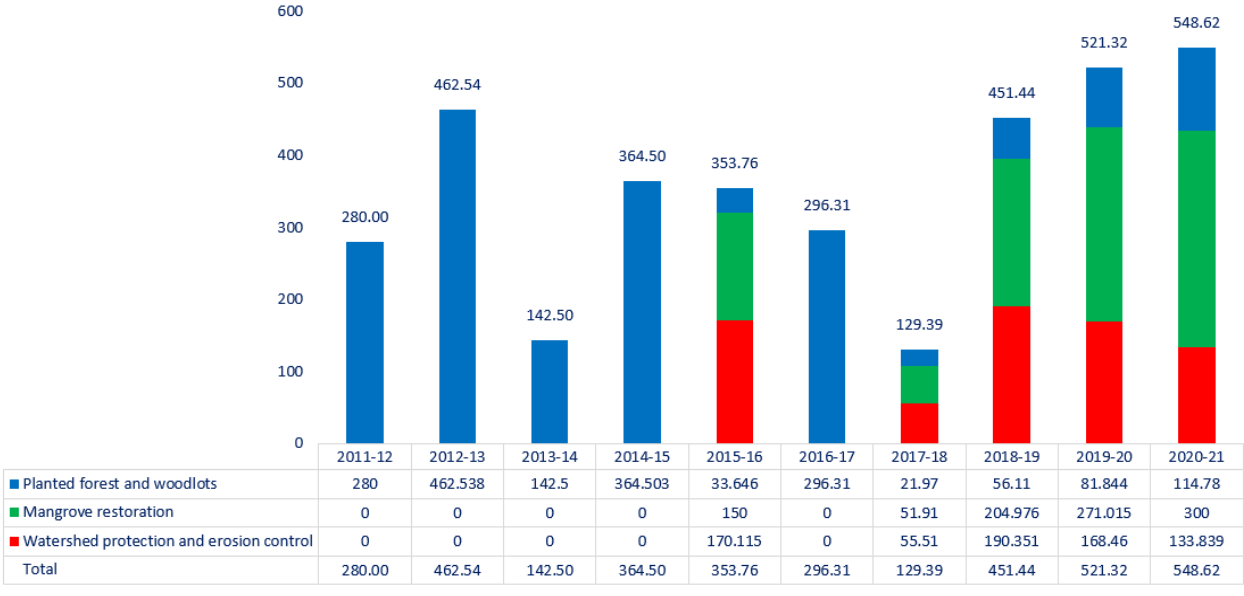
Table 56: Status of desertification and land degradation from 2018–19 and 2011–13 (area in ha) in NCT of Delhi

Year	Vegetation Degradation	Water Logging	Settlement
2018-19	9980	347	81216
2011-13	9980	347	79541

Source: ISRO 2021

4.9.3 Restoration Barometer: UT Contribution

4.9.3.1 Area brought under restoration



	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20	2020-21
Planted forest and woodlots	280	462.538	142.5	364.503	33.646	296.31	21.97	56.11	81.844	114.78
Mangrove restoration	0	0	0	0	150	0	51.91	204.976	271.015	300
Watershed protection and erosion control	0	0	0	0	170.115	0	55.51	190.351	168.46	133.839
Total	280.00	462.54	142.50	364.50	353.76	296.31	129.39	451.44	521.32	548.62

Figure 41: Area brought under restoration from 2011–2020 as reported by the State Forest Department of NCT of Delhi

[121] ISFR 2021, https://fsi.nic.in/isfr-2021/chapter-13.pdf

[122] ISFR 2011, https://fsi.nic.in/forest-report-2011

[123] ISFR 2021, https://fsi.nic.in/forest-report-2021-details

[124] DLD Atlas of India, 2021, https://vedas.sac.gov.in/static/atlas/dsm/DLD_Atlas_SAC_2021.pdf

As of 2020, a total of 3,550.38 ha of the UT's area had been brought under restoration since 2011, according to data submitted by the Forest Department.

Table 57: Area brought under restoration based on FLR interventions by FD of NCT of Delhi

FLR interventions implemented	Area brought under restoration (in ha)
Planted forest and woodlots	1,854.20
Natural regeneration	977.90
Watershed protection and erosion control	718.28

4.9.3.2 Climate impacts

The carbon sequestration for NCT of Delhi has been estimated for the restoration work carried out from 2011 to 2020 under different scenarios (A1 and A2) and assumptions (a1, a2, and a3). To estimate carbon sequestration, the IPCC GPG LULUCF 2003 methodology has been adopted. NCT of Delhi is classified under the Dry Season category, with an annual average rainfall of <1,000 mm. According to the IPCC GPG LULUCF 2003, the following cases of average annual increment are applicable for this level of rainfall – best case (11.7 tdm/ha/yr), base case (6.45 tdm/ha/yr), and worst case (1.2 tdm/ha/yr), for the estimation of carbon sequestration.[125] The detailed methodology for estimating carbon sequestration is outlined in Section 1.4.1(B) and Annex I of the report. Based on this methodology, the total carbon sequestered and the per-hectare carbon sequestration are presented in the following graph and table, respectively.

To report on carbon sequestration while accounting for mortality rates, the Base Case (a2) assumption under the two scenarios has been applied, as it represents a balanced middle ground with neither too high nor too low values (refer to the detailed methodology in Section 1.4.1(B) and Annex I).

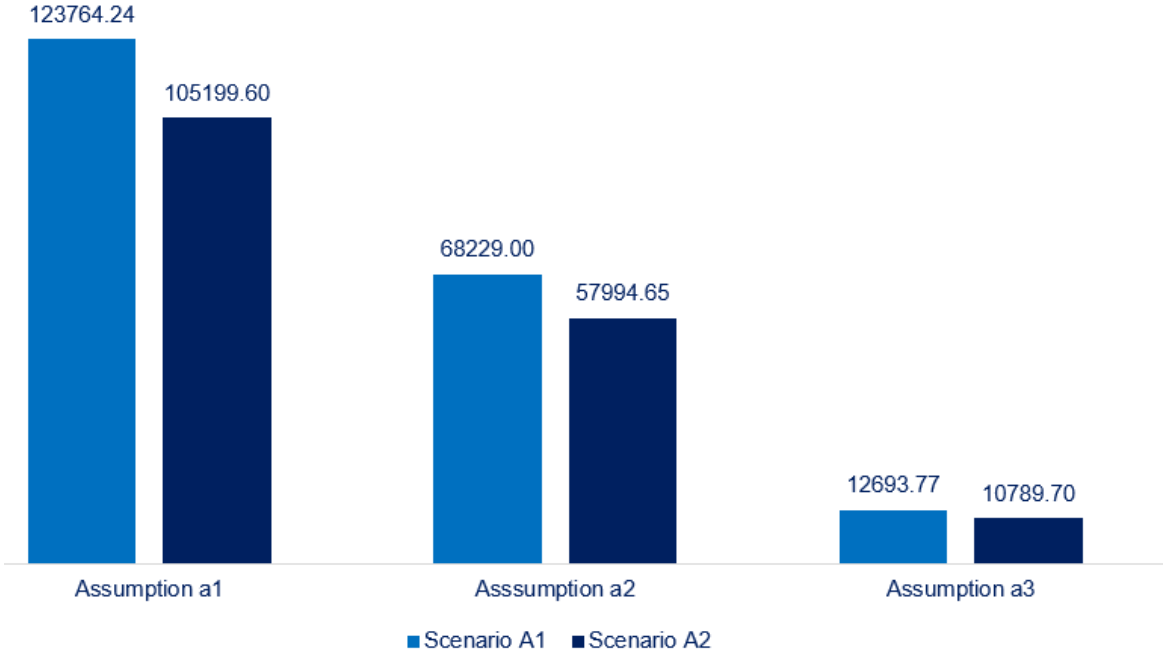


Figure 42: Total calculated tC sequestration in 10 years under two scenarios and three assumptions in NCT of Delhi

[125] GPG LULUCF table 3A.1.6 - for AGB only https://www.ipcc-nggip.iges.or.jp/public/gpglulucf/gpglulucf_files/Chp3/Anx_3A_1_Data_Tables.pdf

From 2011 to 2020, expressed as carbon, this corresponds to 0.07 million tonnes of carbon (tC) without factoring in mortality and 0.06 million tC when a mortality rate of 15%, was considered. An Estimated 0.25 million tonnes of carbon dioxide (tCO_2e) were sequestered, excluding plantation mortality. When accounting for mortality, the sequestration was 0.21 million tCO_2e.[126]

Table 58: Carbon stock tC (per ha) in AGB and BGB carbon pools in area brought under restoration for different assumptions and scenarios in NCT of Delhi

Scenario	Assumption a1	Assumption a2	Assumption a3
Scenario A1	34.86	19.22	3.58
Scenario A2	29.63	16.33	3.04

4.9.3.3 Socio-economic impact

The socio-economic impact achieved has been measured in terms of man-days generated through FLR work in the UT. According to FD data for the period 2011 to 2020, a total of 7.53 million man-days of jobs were generated. This assessment accounts for the number of people involved in the implementation and maintenance of areas brought under restoration.

Table 59: Socio-economic impact (man-days generated) in NCT of Delhi

Socio-economic impact											
Year	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20	2020-21	Total
Number of man-days generated (in million)	1.08	1.22	0.85	0.77	0.70	0.69	0.26	0.42	0.41	1.13	**7.53**

4.9.3.4 Financial flow

The total financial flow towards FLR in the UT has been reported as INR 5,024.67 million (USD 61.58 million).[127] Domestic public expenditure is the primary source of funding, according to data provided by the FD for the period 2011 to 2020.

Table 60: Financial outflow from 2011–2020 in NCT of Delhi

Financial outflow											
Year	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20	2020-21	Total
FLR Funding in INR (million)	467.35	566.65	423.42	450.51	464.43	514.36	234.10	387.71	386.12	1130.02	**5,024.67**

Table 61: Fund utilisation for bringing area under restoration in NCT of Delhi

Description	**Fund utilisation** (2011-12 to 2020-21)
Total area brought under restoration (ha)	3,550.38
Total fund invested in FLR activities (million INR)	5,024.67
Funds invested per hectare (million INR/ha)	1.42
Area brought under restoration per million rupees (ha/million INR)	0.71

[126] Mortality rates was not available at the time of publication of this report. Hence, law of averages was applied assigning the average mortality rate derived from mortality rates provided by 13 other States and UTs

[127] Exchange Rate - 81.59 as assessed on 01 October 2022

4.10 Goa

4.10.1 Restoration Barometer

The following table summarises the key components of the Restoration Barometer:

Table 62: Highlights of Restoration Barometer for Goa

Highlights	
Area brought under restoration (in ha)	1,987
Financial flow (in million INR)	224.60
Socio-economic impacts (man-days generated) (in million)	0.65
Climate impacts: Estimated carbon sequestered (in million tC)	0.04 (0% Mortality)
	0.03 (21% Mortality)
Climate impacts: Estimated carbon dioxide sequestered (in million tCO_2e)	0.14 (0% Mortality)
	0.11 (21% Mortality)

4.10.2 Background

Goa, located on the western coast of India, is known for its beaches, tourism, and vibrant culture. It spans a total geographical area of 3,702 sq km, which constitutes 0.11% of India's total TGA.[128] Goa experiences a tropical monsoon climate. Average annual temperatures range from 16°C to 37°C, with annual rainfall averaging 3,800 mm.[129]

The population of Goa is 1.46 million, accounting for 0.91% of India's total population. The rural population makes up 37.83% of the total, with the remaining 62.17% residing in urban areas. The tribal population constitutes 10.23% of the total. The state's average population density is 394 persons per sq km, which is slightly higher than the national average. According to the 19th Livestock Census 2012, the total livestock population is 0.14 million.[130] Goa's economy is primarily driven by the tertiary sector, with tourism, and services playing dominant roles. The secondary sector, including mining and manufacturing (such as pharmaceuticals and food processing), also contributes significantly. Agriculture, particularly the cultivation of rice, cashew nuts, and coconut, forms the primary sector but is less dominant compared to other sectors.[131] The total forest cover of Goa is 2244.21 sq km, constituting 60.62% of its geographical area.[132]

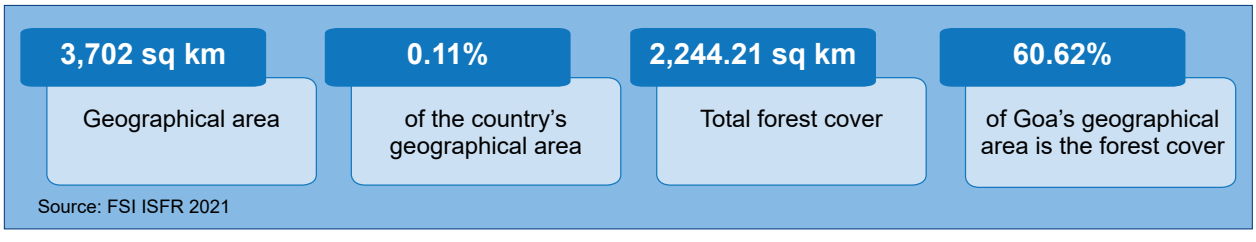


Figure 43: Geographical Area and Forest Cover of Goa

[128] ISFR 2021, https://fsi.nic.in/isfr-2021/chapter-13.pdf
[129] ISFR 2019, https://fsi.nic.in/isfr19/vol2/isfr-2019-vol-ii-goa.pdf
[130] ISFR 2019, https://fsi.nic.in/isfr19/vol2/isfr-2019-vol-ii-goa.pdf
[131] IBEF Infographics, https://www.ibef.org/states/goa-infographic
[132] ISFR 2021, https://fsi.nic.in/isfr-2021/chapter-13.pdf

As per ISFR 2011[133] and ISFR 2021[134], the following observations were made:

- In the last 10 years, from 2011 to 2020, there is an increase of 25.21 sq km, or 2,521 ha, in the forest cover.
- The tree cover of Goa constituted 6.59% of the state's TGA. In the last 10 years, there is a decrease of 42 sq km, or 4,200 ha, in the tree cover area of the state.
- The average growing stock in Goa is 12.87 million cum in forest and 4.15 million cum in ToF. In the last 10 years, the average growing stock in the forest area and ToF has increased by 5.41 million cum.
- The total carbon stock of forest in the State, including the TOF patches which are more than one ha in size, is 25.24 million tonnes (92.55 $MtCO_2e$), which is 0.35% of the total forest carbon in the country.

As per the 2021 DLD Atlas of India, 194,877 ha of land, representing 52.64% of the state's TGA, is affected by various forms of desertification and land degradation. There has been an increase of 1,905 ha (0.51%) of degraded land from 2011–13 to 2018–19. The primary driver of land degradation is vegetation degradation (37.75%), followed by water erosion (8.19%).[135]

Table 63: Status of desertification and land degradation from 2018–19 and 2011–13 (area in ha) in Goa

Year	Vegetation Degradation	Water Erosion	Water Logging	Manmade	Settlement
2018-19	139,765	30,328	9,551	3,374	11,860
2011-13	138,172	33,889	9,005	3,374	8,533

Source: ISRO 2021

4.10.3 Restoration Barometer: State Contribution

4.10.3.1 Area brought under restoration

As of 2020, a total of 1,987 ha of the state's area had been brought under restoration since 2011, according to data submitted by the State Forest Department.

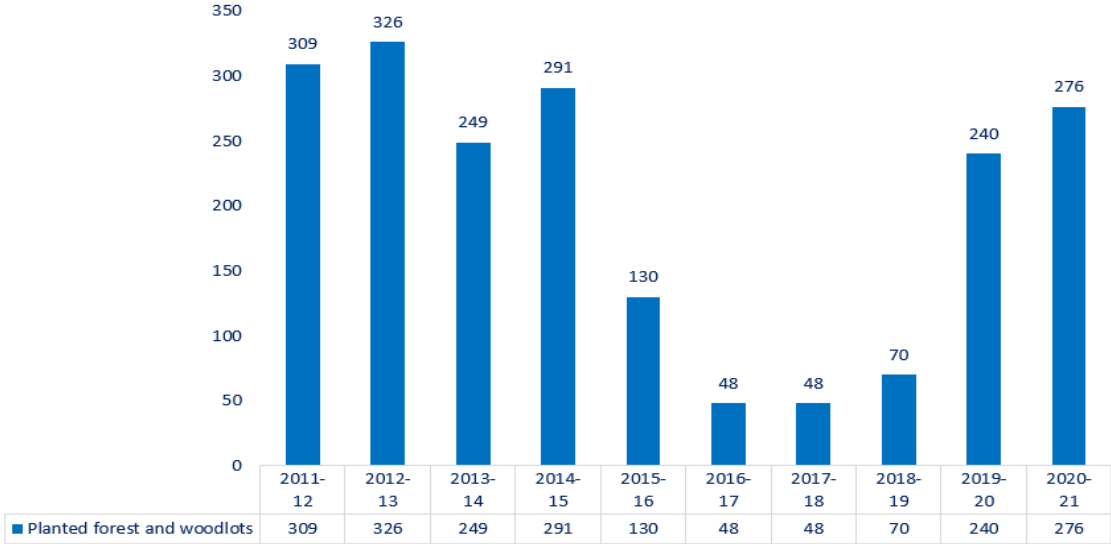


Figure 44: Area brought under restoration from 2011–2020 as reported by State Forest Department of Goa

[133] ISFR 2011, https://fsi.nic.in/forest-report-2011

[134] ISFR 2021, https://fsi.nic.in/forest-report-2021-details

[135] DLD Atlas of India, 2021, https://vedas.sac.gov.in/static/atlas/dsm/DLD_Atlas_SAC_2021.pdf

Table 64: Area brought under restoration based on FLR interventions by State Forest Department of Goa

FLR interventions implemented	Area brought under restoration (in ha)
Planted forest and woodlots	1,987

4.10.3.2 Climate impacts

The carbon sequestration for Goa has been estimated for the restoration work carried out from 2011 to 2020 under different scenarios (A1 and A2) and assumptions (a1, a2, and a3). To estimate carbon sequestration, the IPCC GPG LULUCF 2003 methodology has been adopted. Goa is classified under the Wet Season category, with an annual average rainfall of >2,000 mm. According to the IPCC GPG LULUCF 2003, the following cases of average annual increment are applicable for this level of rainfall – best case (8 tdm/ha/yr), base case (5.2 tdm/ha/yr), and worst case (2.4 tdm/ha/yr), for the estimation of carbon sequestration.[136]

The detailed methodology for estimating carbon sequestration is outlined in Section 1.4.1(B) and Annex I of the report. Based on this methodology, the total carbon sequestered and the per-hectare carbon sequestration are presented in the following graph and table, respectively.

To report on carbon sequestration while accounting for mortality rates, the Base Case (a2) assumption under the two scenarios has been applied, as it represents a balanced middle ground with neither too high nor too low values (refer to the detailed methodology in Section 1.4.1(B) and Annex I).

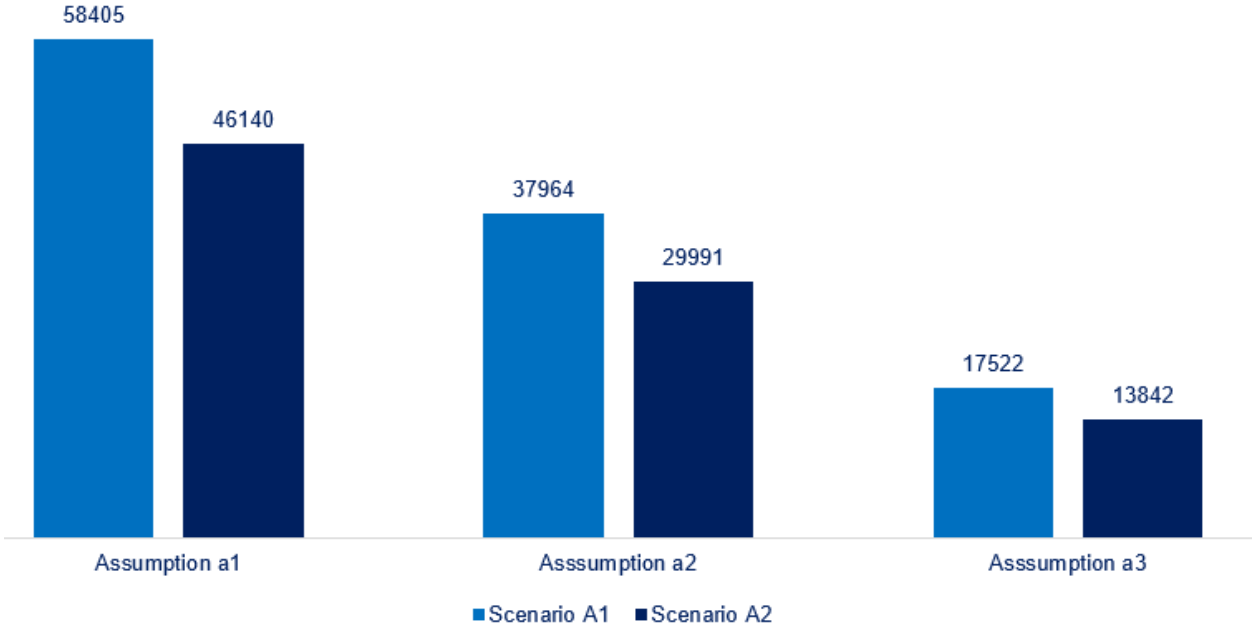


Figure 45: Total calculated tC sequestration in 10 years under two scenarios and three assumptions in Goa

[136] GPG LULUCF table 3A.1.6 - for AGB only https://www.ipcc-nggip.iges.or.jp/public/gpglulucf/gpglulucf_files/Chp3/Anx_3A_1_Data_Tables.pdf

From 2011 to 2020, expressed as carbon, this corresponds to 0.04 million tonnes of carbon (tC) without factoring in mortality and 0.03 million tC when a mortality rate of 21%, was considered. An estimated 0.14 million tonnes of carbon dioxide (tCO_2e) were sequestered, excluding plantation mortality. When accounting for mortality, the sequestration was 0.11 million tCO_2e.[137]

Table 65: Carbon stock tC (per ha) in AGB and BGB carbon pools in area brought under restoration for different assumptions and scenarios in Goa

Scenario	Assumption a1	Assumption a2	Assumption a3
Scenario A1	29.39	19.11	8.82
Scenario A2	23.22	15.09	6.97

4.10.3.3 Socio-economic impact

The socio-economic impact achieved has been measured in terms of man-days generated through FLR work in the state. According to SFD data for the period 2011 to 2020, a total of 0.65 million man-days of jobs were generated. This assessment accounts for the number of people involved in the implementation and maintenance of areas brought under restoration.

Table 66: Socio-economic impact (man-days generated) in Goa

Socio-economic impact											
Year	**2011-12**	**2012-13**	**2013-14**	**2014-15**	**2015-16**	**2016-17**	**2017-18**	**2018-19**	**2019-20**	**2020-21**	**Total**
Number of man-days generated (in million)	0.12	0.12	0.10	0.06	0.04	0.03	0.02	0.03	0.06	0.07	**0.65**

4.10.3.4 Financial flow

The total financial flow towards FLR in the state has been reported as INR 224.60 million (USD 2.75 million).[138] Domestic public expenditure is the primary source of funding, according to data provided by the SFD for the period 2011 to 2020.

Table 67: Financial outflow from 2011–2020 in Goa

Financial outflow											
Year	**2011-12**	**2012-13**	**2013-14**	**2014-15**	**2015-16**	**2016-17**	**2017-18**	**2018-19**	**2019-20**	**2020-21**	**Total**
FLR Funding in INR (million)	25.40	42.80	27.20	38.70	10.30	6.60	8.10	10.20	28.20	27.10	**224.60**

Table 68: Fund utilisation for bringing area under restoration in Goa

Description	**Fund utilisation** (2011-12 to 2020-21)
Total area brought under restoration (ha)	1,987
Total fund invested in FLR activities (million INR)	224.60
Funds invested per hectare (million INR/ha)	0.11
Area brought under restoration per million rupees (ha/million INR)	8.85

[137] Mortality rates was not available at the time of publication of this report. Hence, law of averages was applied assigning the average mortality rate derived from mortality rates provided by 13 other States and UTs

[138] Exchange Rate - 81.59 as assessed on 01 October 2022

4.11 Gujarat

4.11.1 Restoration Barometer

The following table summarises the key components of the Restoration Barometer:

Table 69: Highlights of Restoration Barometer for Gujarat

Highlights	
Area brought under restoration (in ha)	1,729,073.85
Financial flow (in million INR)	101,917
Socio-economic impacts (man-days generated) (in million)	185.13
Climate impacts: Estimated carbon sequestered (in million tC)	37.56 (0% Mortality)
	29.67 (21% Mortality)
Climate impacts: Estimated carbon dioxide sequestered (in million tCO_2e)	137.84 (0% Mortality)
	108.89 (21% Mortality)

4.11.2 Background

Gujarat, located on the western coast of India, is the country's fifth-largest state by geographical area. The state shares borders with Rajasthan to the northeast, Madhya Pradesh to the east, Maharashtra to the southeast, and Pakistan to the northwest. It has a coastline of 1,600 km along the Arabian Sea, the longest among Indian states. It covers a total geographical area of 196,244 sq km, constituting 5.97% of India's total TGA.[139] The climate of the state is moderate. The average annual temperature ranges from 25°C to 28°C, with annual rainfall varying between 800 mm and 1,000 mm.[140]

The state has a population of 60.44 million, accounting for 4.99% of India's total population. The rural and urban populations constitute 42.60% and 57.40%, respectively. The tribal population makes up 14.75% of the state's total population. The population density is 308 persons per sq km, which is lower than the national average. According to the 19th Livestock Census 2012, the total livestock population in the state is 27.12 million.[141]

Gujarat is one of the most industrially developed states in India and contributes approximately a quarter of the country's goods exports. Gujarat's economy is primarily driven by the secondary sector, particularly manufacturing and industrial activities. The tertiary sector contributes substantially through trade, transportation, and financial services, leveraging the state's strategic location and extensive port infrastructure. The primary sector is also significant, with agriculture focusing on cotton, groundnuts, and sugarcane.[142] The total forest cover of Gujarat is 14,925.87 sq km, constituting 7.60% of its geographical area.[143]

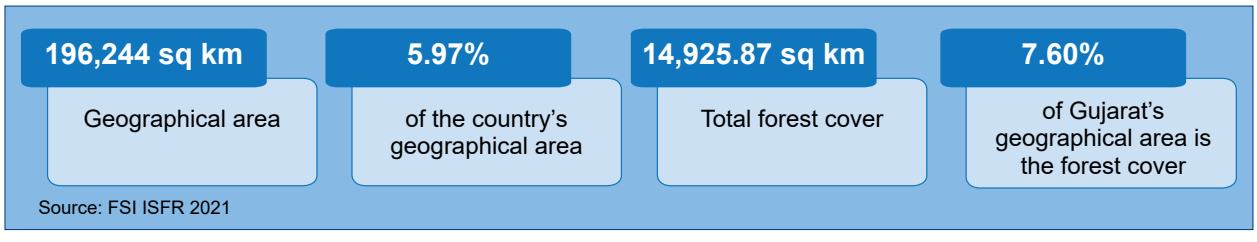


Figure 46: Geographical Area and Forest Cover of Gujarat

[139] ISFR 2021, https://fsi.nic.in/isfr-2021/chapter-13.pdf
[140] ISFR 2019, https://fsi.nic.in/isfr19/vol2/isfr-2019-vol-ii-gujarat.pdf
[141] ISFR 2019, https://fsi.nic.in/isfr19/vol2/isfr-2019-vol-ii-gujarat.pdf
[142] IBEF Infographics, https://www.ibef.org/states/gujarat-infographic
[143] ISFR 2021, https://fsi.nic.in/isfr-2021/chapter-13.pdf

As per ISFR 2011[144] and ISFR 2021[145], the following observations were made:

- In the last 10 years, from 2011 to 2020, there is an increase of 306.87 sq km, or 30,687 ha, in the forest cover.
- The tree cover of Gujarat constituted 2.80% of the state's TGA. In the last 10 years, there is a decrease of 2,348 sq km, or 234,800 ha, in the tree cover area of the state.
- The average growing stock in Gujarat is 51.22 million cum in forest and 78.24 million cum in ToF. In the last 10 years, the average growing stock in the forest area increased by 2.96 million cum while decreased for ToF by 39.25 million cum.
- The total carbon stock of forest in the State, including the TOF patches which are more than one ha in size, is 107.77 million tonnes (395.16 $MtCO_2e$), which is 1.50% of the total forest carbon in the country.

As per the 2021 DLD Atlas of India, 10,248,057 ha of land, representing 52.22% of the state's TGA, is affected by various forms of desertification and land degradation.[146] There has been a decrease of 13,584 ha (0.07%) of degraded land from 2011–13 to 2018–19. The primary driver of land degradation is water erosion (19.53%), followed by salinity (13.24%).[147]

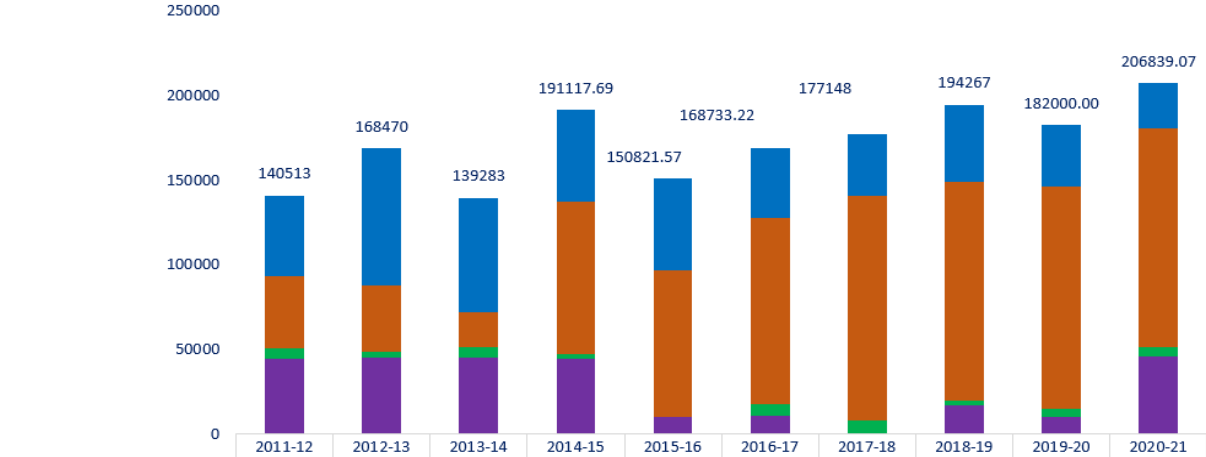
Table 70: Status of desertification and land degradation from 2018–19 and 2011–13 (area in ha) in Gujarat

Year	Vegetation Degradation	Water Erosion	Wind Erosion	Salinity	Manmade	Water Logging	Barren/ Rocky	Settlement
2018-19	2,322,802	3,833,330	1,174,936	2,598,828	68,649	3,375	33,484	212,653
2011-13	2,319,826	3,859,497	1,177,105	2,645,405	51,637	3,375	39,218	165,578

Source: ISRO 2021

4.11.3 Restoration Barometer: State Contribution

4.11.3.1 Area brought under restoration



	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20	2020-21
Planted forests and woodlots	47440	80534	67193	53947	54393	41341	36676	45626.5	36241.42	26657
Agroforestry	42491	39294	20674	90133.2	86178.07	109456.3	132622	128889.5	130554.13	129093.4
Mangrove restoration	6365	3500	6587	2850	0	7000	7850	2650	4999.00	5250
Others	44217	45142	44829	44188	10251	10936	0	17101	10205.45	45839
Total	140513	168470	139283	191117.69	150821.57	168733.22	177148	194267	182000.00	206839.07

Figure 47: Area brought under restoration from 2011–2020 as reported by State Forest Department of Gujarat

[144] ISFR 2011, https://fsi.nic.in/forest-report-2011

[145] ISFR 2021, https://fsi.nic.in/forest-report-2021-details

[146] Desertification and Land Degradation Atlas of India, 2021 https://vedas.sac.gov.in/static/atlas/dsm/DLD_Atlas_SAC_2021.pdf

[147] DLD Atlas of India, 2021, https://vedas.sac.gov.in/static/atlas/dsm/DLD_Atlas_SAC_2021.pdf

As of 2020, a total of 1,719,192.55 ha of the state's area had been brought under restoration since 2011, according to data submitted by the State Forest Department. Additionally, data from the Department of Land Resources (DoLR) indicate that 9,881.30 ha were restored between 2018 and 2020 by the DoLR.

Table 71: Area brought under restoration based on FLR interventions by State Forest Department of Gujarat

FLR interventions implemented	Area brought under restoration (in ha)
Planted forest and woodlots	490,048.92
Agroforestry	909,385.59
Mangrove restoration	47,051
Others	272,707.04

4.11.3.2 Climate impacts

The carbon sequestration for Gujarat has been estimated for the restoration work carried out from 2011 to 2020 under different scenarios (A1 and A2) and assumptions (a1, a2, and a3). To estimate carbon sequestration, the IPCC GPG LULUCF 2003 methodology has been adopted. Gujarat is classified under the Moist with Long Dry Season category, with an annual average rainfall ranging from 1,000 mm – 2,000 mm. According to the IPCC GPG LULUCF 2003, the following cases of average annual increment are applicable for this level of rainfall – best case (12.6 tdm/ha/yr), base case (7.1 tdm/ha/yr), and worst case (1.6 tdm/ha/yr), for the estimation of carbon sequestration.[148] The detailed methodology for estimating carbon sequestration is outlined in Section 1.4.1(B) and Annex I of the report. Based on this methodology, the total carbon sequestered and the per-hectare carbon sequestration are presented in the following graph and table, respectively.

To report on carbon sequestration while accounting for mortality rates, the Base Case (a2) assumption under the two scenarios has been applied, as it represents a balanced middle ground with neither too high nor too low values (refer to the detailed methodology in Section 1.4.1(B) and Annex I).

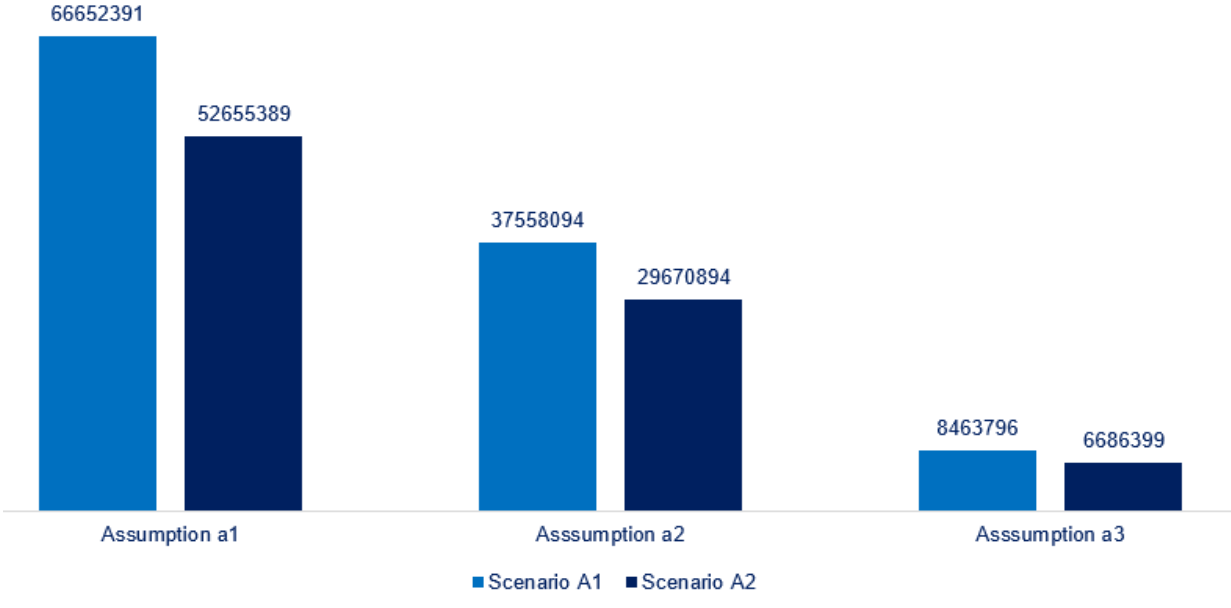


Figure 48: Total calculated tC sequestration in 10 years under two scenarios and three assumptions in Gujarat

[148] GPG LULUCF table 3A.1.6 - for AGB only https://www.ipcc-nggip.iges.or.jp/public/gpglulucf/gpglulucf_files/Chp3/Anx_3A_1_Data_Tables.pdf

From 2011 to 2020, expressed as carbon, this corresponds to 37.56 million tonnes of carbon (tC) without factoring in mortality and 29.67 million tC when a mortality rate of 21%, was considered. An estimated 137.84 million tonnes of carbon dioxide (tCO_2e) were sequestered, excluding plantation mortality. When accounting for mortality, the sequestration was 108.89 million tCO_2e.[149]

Table 72: Carbon stock tC (per ha) in AGB and BGB carbon pools in area brought under restoration for different assumptions and scenarios in Gujarat

Scenario	Assumption a1	Assumption a2	Assumption a3
Scenario A1	38.55	21.72	4.89
Scenario A2	30.45	17.16	3.87

4.11.3.3 Socio-economic impact

The socio-economic impact achieved has been measured in terms of man-days generated through FLR work in the state. According to SFD data for the period 2011 to 2020, a total of 185.13 million man-days of jobs were generated. This assessment accounts for the number of people involved in the implementation and maintenance of areas brought under restoration.

Table 73: Socio-economic impact (man-days generated) in Gujarat

Socio-economic impact											
Year	**2011-12**	**2012-13**	**2013-14**	**2014-15**	**2015-16**	**2016-17**	**2017-18**	**2018-19**	**2019-20**	**2020-21**	**Total**
Number of man-days generated (in million)	17.79	13.13	17.36	10.09	12.19	17.66	23.22	24.41	25.01	24.27	**185.13**

4.11.3.4 Financial flow

The total financial flow towards FLR in the state has been reported as INR 101,917 million (USD 1249.13 million).[150] Domestic public expenditure is the primary source of funding, according to data provided by the SFD for the period 2011 to 2020.

Table 74: Financial outflow from 2011–2020 in Gujarat

Financial outflow											
Year	**2011-12**	**2012-13**	**2013-14**	**2014-15**	**2015-16**	**2016-17**	**2017-18**	**2018-19**	**2019-20**	**2020-21**	**Total**
FLR Funding in INR (million)	7225.3	7805.5	8844.7	10256.7	7875.8	10696.7	10772.4	12373.8	12937.5	13128.6	**101,917**

Table 75: Fund utilisation for bringing area under restoration in Gujarat

Description	**Fund utilisation** (2011-12 to 2020-21)
Total area brought under restoration (ha)	1,719,192.55
Total fund invested in FLR activities (million INR)	101,917
Funds invested per hectare (million INR/ha)	0.06
Area brought under restoration per million rupees (ha/million INR)	16.87

[149] Mortality rates was not available at the time of publication of this report. Hence, law of averages was applied assigning the average mortality rate derived from mortality rates provided by 13 other States and UTs

[150] Exchange Rate - 81.59 as assessed on 01 October 2022

4.12 Haryana

4.12.1 Restoration Barometer

The following table summarises the key components of the Restoration Barometer:

Table 76: Highlights of Restoration Barometer for Haryana

Highlights	
Area brought under restoration (in ha)	406,468.19
Financial flow (in million INR)	29,828.40
Socio-economic impacts (man-days generated) (in million)	0.18
Climate impacts: Estimated carbon sequestered (in million tC)	12.62 (0% Mortality)
	8.52 (32% Mortality)
Climate impacts: Estimated carbon dioxide sequestered (in million tCO_2e)	46.32 (0% Mortality)
	31.50 (32% Mortality)

4.12.2 Background

Haryana, located in the northern part of India, is a landlocked state. It covers a total geographical area of 44,212 sq km, representing 1.34% of India's total TGA. The state shares its boundaries with the Shivalik Hills to the north, the Yamuna River to the east, the Aravalli Hills to the southwest, and the Ghaggar River to the west, contributing to the state's unique natural landscape.[151] The climate is humid tropical, with average annual temperatures ranging from 1°C to 45°C. The average annual rainfall varies between 200 mm and 1,400 mm.[152]

Haryana has a population of approximately 25.35 million, accounting for 2.01% of India's total population. The rural population constitutes 65.13%, while the urban population accounts for 34.87%.

The population density is 573 persons per sq km, which is significantly higher than the national average. According to the 19th Livestock Census 2012, the total livestock population is 8.82 million.[153] Haryana's economy is primarily driven by the secondary and tertiary sectors. The industrial sector, especially automobile manufacturing, IT, and electronics, is a major contributor to the state's economy. Agriculture, though less dominant in terms of GDP contribution, remains significant, with crops such as wheat, rice, and sugarcane being key agricultural products. The services sector, particularly trade, education, and healthcare, also plays a vital role in the state's economic landscape.[154] Haryana has a total forest cover of 1,603.48 sq km, constituting 3.63% of its total geographical area.[155]

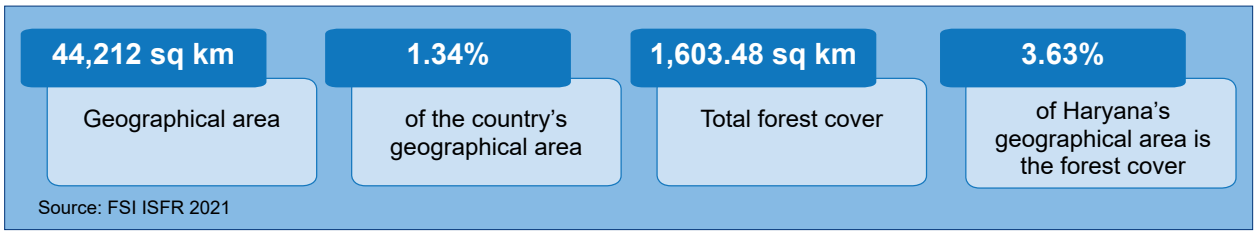


Figure 49: Geographical Area and Forest Cover of Haryana

[151] ISFR 2021, https://fsi.nic.in/isfr-2021/chapter-13.pdf
[152] ISFR 2019, https://fsi.nic.in/isfr19/vol2/isfr-2019-vol-ii-haryana.pdf
[153] ISFR 2019, https://fsi.nic.in/isfr19/vol2/isfr-2019-vol-ii-haryana.pdf
[154] IBEF Infographics, https://www.ibef.org/states/haryana-infographic
[155] ISFR 2021, https://fsi.nic.in/isfr-2021/chapter-13.pdf

As per ISFR 2011[156] and ISFR 2021[157], the following observations were made:

- In the last 10 years, from 2011 to 2020, there is an increase of 4.52 sq km, or 452 ha, in the forest cover.
- The tree cover of Haryana constituted 3.22% of the state's TGA. In the last 10 years, there is an increase of 30 sq km, or 3,000 ha, in the tree cover area of the state.
- The average growing stock in Haryana is 4.31 million cum in forest and 19.26 million cum in ToF. In the last 10 years, the average growing stock in the forest area decreased by 0.58 million cum while increased for ToF by 3.99 million cum.
- The total carbon stock of forest in the State, including the TOF patches which are more than one ha in size, is 10.23 million tonnes (37.51 $MtCO_2e$), which is 0.14% of the total forest carbon in the country.

As per the 2021 DLD Atlas of India, 364,154 ha of land, representing 8.24% of the state's TGA, is affected by various forms of desertification and land degradation. There has been an increase of 25,190 ha (0.57 %) of degraded land from 2011–13 to 2018–19. The primary driver of land degradation is wind erosion (3.42%), followed by settlement (2.27%).[158]

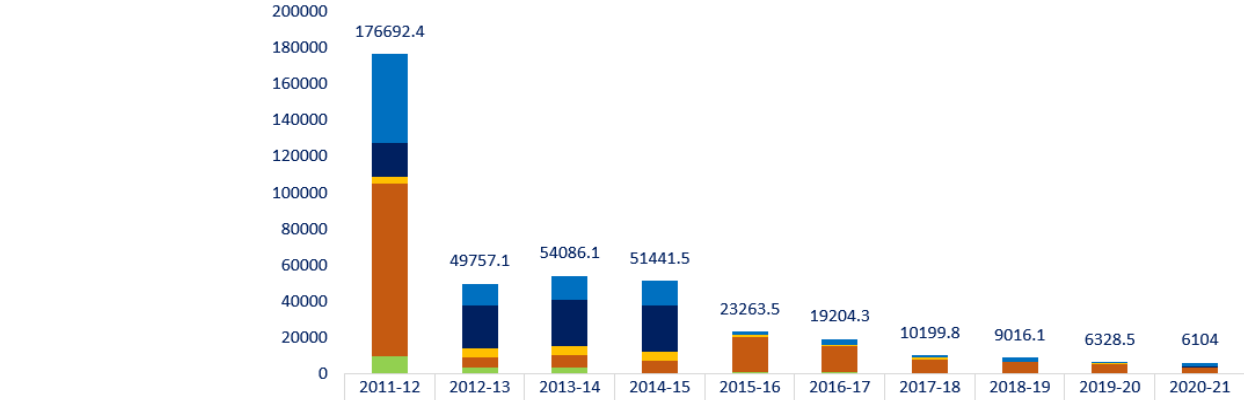
Table 77: Status of desertification and land degradation from 2018–19 and 2011–13 (area in ha) in Haryana

Year	Vegetation Degradation	Water Erosion	Wind Erosion	Salinity	Water Logging	Manmade	Settlement
2018-19	44226	13568	151224	33640	15293	5962	100241
2011-13	41411	13568	151797	27841	12530	5962	85855

Source: ISRO 2021

4.12.3 Restoration Barometer: State Contribution

4.12.3.1 Area brought under restoration



	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20	2020-21
Planted forests and woodlots	49281.58	12363.54	13439.05	13569	1615.14	3635.05	940.82	2295.3	611.47	2400
Natural regeneration	18581.34	23537.08	25584.58	25833.54	0	0	0	0	0	210
Silviculture	3680.1	4661.03	5067.12	5116.42	1513.36	134	1383.45	168.8	157	0
Agroforestry	95372.63	5988.56	6509.53	6562.85	19350	14705	7830	6440	5060	2932
Improved Fallow	9776.71	3206.88	3485.85	359.66	785	730.25	45.5	112	500	132
Watershed protection and erosion control	0	0	0	0	0	0	0	0	0	430
Total	176692.4	49757.1	54086.1	51441.5	23263.5	19204.3	10199.8	9016.1	6328.5	6104

Figure 50: Area brought under restoration from 2011–2020 as reported by State Forest Department of Haryana

[156] ISFR 2011, https://fsi.nic.in/forest-report-2011

[157] ISFR 2021, https://fsi.nic.in/forest-report-2021-details

[158] DLD Atlas of India, 2021, https://vedas.sac.gov.in/static/atlas/dsm/DLD_Atlas_SAC_2021.pdf

As of 2020, a total of 406,093.19 ha of the state's area had been brought under restoration since 2011, according to data submitted by the State Forest Department. Additionally, data from the Department of Land Resources (DoLR) indicate that 375 ha were restored between 2018 and 2020 by the DoLR.

Table 78: Area brought under restoration based on FLR interventions by State Forest Department of Haryana

FLR interventions implemented	Area brought under restoration (in ha)
Planted forest and woodlots	100,150.95
Natural regeneration	93,746.54
Silviculture	21,881.28
Agroforestry	170,750.57
Improved Fallow	19,133.85
Watershed protection and erosion control	430

4.12.3.2 Climate impacts

The carbon sequestration for Haryana has been estimated for the restoration work carried out from 2011 to 2020 under different scenarios (A1 and A2) and assumptions (a1, a2, and a3). To estimate carbon sequestration, the IPCC GPG LULUCF 2003 methodology has been adopted. Haryana is classified under the Dry Season category, with an annual average rainfall of <1,000 mm. According to the IPCC GPG LULUCF 2003, the following cases of average annual increment are applicable for this level of rainfall – best case, (11.7 tdm/ha/yr), base case (6.45 tdm/ha/yr), and worst case (1.2 tdm/ha/yr), for the estimation of carbon sequestration.[159] The detailed methodology for estimating carbon sequestration is outlined in Section 1.4.1(B) and Annex I of the report. Based on this methodology, the total carbon sequestered and the per-hectare carbon sequestration are presented in the following graph and table, respectively.

To report on carbon sequestration while accounting for mortality rates, the Base Case (a2) assumption under the two scenarios has been applied, as it represents a balanced middle ground with neither too high nor too low values (refer to the detailed methodology in Section 1.4.1(B) and Annex I).

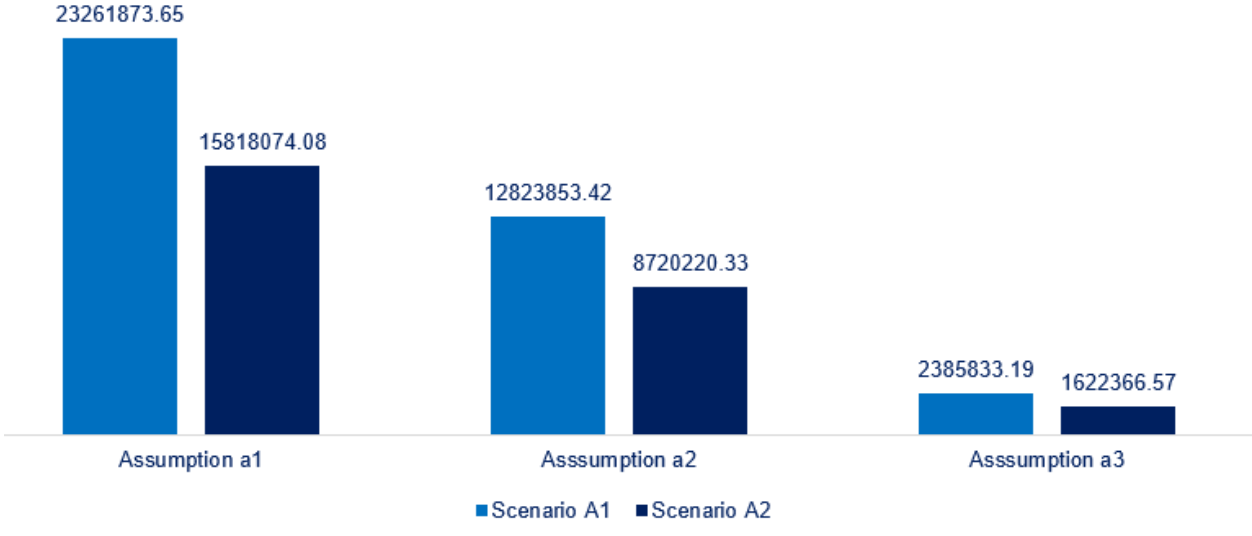


Figure 51: Total calculated tC sequestration in 10 years under two scenarios and three assumptions in Haryana

[159] GPG LULUCF table 3A.1.6 - for AGB only https://www.ipcc-nggip.iges.or.jp/public/gpglulucf/gpglulucf_files/Chp3/Anx_3A_1_Data_Tables.pdf

From 2011 to 2020, expressed as carbon, this corresponds to 12.62 million tonnes of carbon (tC) without factoring in mortality and 8.58 million tC when a mortality rate of 32%, was considered. An estimated 46.32 million tonnes of carbon dioxide (tCO_2e) were sequestered, excluding plantation mortality. When accounting for mortality, the sequestration was 31.50 million tCO_2e.[160]

Table 79: Carbon stock tC (per ha) in AGB and BGB carbon pools in area brought under restoration for different assumptions and scenarios in Haryana

Scenario	Assumption a1	Assumption a2	Assumption a3
Scenario A1	56.32	31.05	5.78
Scenario A2	38.30	21.11	3.93

4.12.3.3 Socio-economic impact

The socio-economic impact achieved has been measured in terms of man-days generated through FLR work in the state. According to SFD data for the period 2011 to 2020, a total of 0.18 million man-days of jobs were generated. This assessment accounts for the number of people involved in the implementation and maintenance of areas brought under restoration.

Table 80: Socio-economic impact (man-days generated) in Haryana

Socio-economic impact											
Year	**2011-12**	**2012-13**	**2013-14**	**2014-15**	**2015-16**	**2016-17**	**2017-18**	**2018-19**	**2019-20**	**2020-21**	**Total**
Number of man-days generated (in million)	0.02	0.02	0.02	0.02	0.02	0.02	0.019	0.019	0.019	0.019	**0.18**

4.12.3.4 Financial flow

The total financial flow towards FLR in the state has been reported as INR 29,828.40 million (USD 365.59 million).[161] Domestic public expenditure is the primary source of funding, according to data provided by the SFD for the period 2011 to 2020.

Table 81: Financial outflow from 2011–2020 in Haryana

Financial outflow											
Year	**2011-12**	**2012-13**	**2013-14**	**2014-15**	**2015-16**	**2016-17**	**2017-18**	**2018-19**	**2019-20**	**2020-21**	**Total**
FLR Funding in INR (million)	2203.1	2615.2	2594.4	3135.5	3252.6	2879.2	3173.3	3028.5	3346.6	3600.0	**29,828.40**

Table 82: Fund utilisation for bringing area under restoration in Haryana

Description	**Fund utilisation** (2011-12 to 2020-21)
Total area brought under restoration (ha)	406,093.19
Total fund invested in FLR activities (million INR)	29,828.40
Funds invested per hectare (million INR/ha)	0.07
Area brought under restoration per million rupees (ha/million INR)	13.61

[160] Mortality rates was not available at the time of publication of this report. Hence, law of averages was applied assigning the average mortality rate derived from mortality rates provided by 13 other States and UTs.

[161] Exchange Rate - 81.59 as assessed on 01 October 2022

4.13 Himachal Pradesh

4.13.1 Restoration Barometer

The following table summarises the key components of the Restoration Barometer:

Table 83: Highlights of Restoration Barometer for Himachal Pradesh

Highlights	
Area brought under restoration (in ha)	116,973.49
Financial flow (in million INR)	4,089.80
Socio-economic impacts (man-days generated) (in million)	13.42
Climate impacts: Estimated carbon sequestered (in million tC)	3.05 (0% Mortality)
	2.41 (21% Mortality)
Climate impacts: Estimated carbon dioxide sequestered (in million tCO_2e)	11.19 (0% Mortality)
	8.84 (21% Mortality)

4.13.2 Background

Himachal Pradesh, a mountainous state located in the Western Himalayas, is renowned for its picturesque landscapes and adventure tourism. The state spans a total geographical area of 55,673 sq km, accounting for 1.69% of India's TGA.[162] Approximately one-third of the state is permanently covered by snow, glaciers, and cold deserts, which inhibit tree growth. The temperature varies from sub-zero levels to a maximum of 35°C, while the average annual rainfall is approximately 1,800 mm.[163]

Himachal Pradesh has a population of 6.86 million, constituting 0.57% of India's total population. The rural population comprises 89.97%, with the remaining 10.03% residing in urban areas. The population density is 123 persons per sq km, which is lower than the national average. The 19th Livestock Census 2012 reported a total livestock population of 4.84 million.[164] The economy of Himachal Pradesh is predominantly driven by the tertiary and secondary sectors. Within the tertiary sector, tourism plays a major role in supporting economic growth. The secondary sector has witnessed significant investments in pharmaceutical industries, further bolstering industrial development. Meanwhile, the primary sector remains vital, with agriculture and food processing serving as key contributors to the state's economy.[165] The state's total forest cover is 15,442.95 sq km, constituting 27.73% of its geographical area.[166]

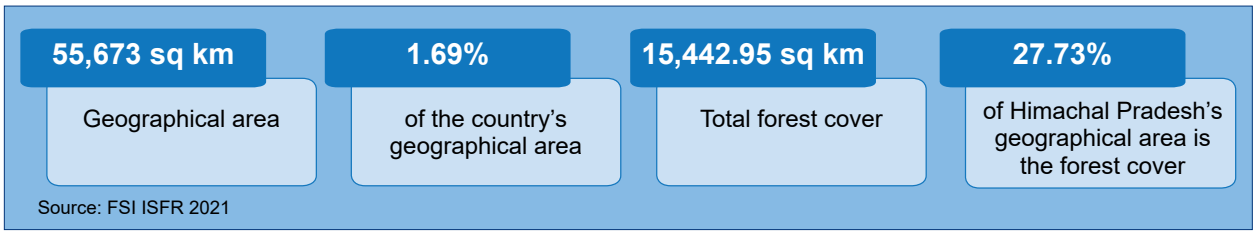


Figure 52: Geographical Area and Forest Cover of Himachal Pradesh

[162] ISFR 2021, https://fsi.nic.in/isfr-2021/chapter-13.pdf
[163] ISFR 2019, https://fsi.nic.in/isfr19/vol2/isfr-2019-vol-ii-himachal-pradesh.pdf
[164] ISFR 2019, https://fsi.nic.in/isfr19/vol2/isfr-2019-vol-ii-himachal-pradesh.pdf
[165] IBEF Infographics, https://www.ibef.org/states/himachal-pradesh-infographic
[166] ISFR 2021, https://fsi.nic.in/isfr-2021/chapter-13.pdf

As per ISFR 2011[167] and ISFR 2021[168], the following observations were made:

- In the last 10 years, from 2011 to 2020, there is an increase of 763.95 sq km, or 76,395 ha, in the forest cover.
- The tree cover of Himachal Pradesh constituted 1.21% of the state's TGA. In the last 10 years, there is an increase of 52 sq km, or 5,200 ha, in the tree cover area of the state.
- The average growing stock in Himachal Pradesh is 345.62 million cum in forest and 28.30 million cum in ToF. In the last 10 years, the average growing stock in the forest area and ToF has increased by 31.46 million cum.
- The total carbon stock of forest in the State, including the TOF patches which are more than one ha in size, is 258.07 million tonnes (946.26 $MtCO_2e$), which is 3.58% of the total forest carbon in the country.

As per the 2021 DLD Atlas of India, 2,400,300 ha of land, representing 43.11% of the state's TGA, is affected by various forms of desertification and land degradation. There has been an increase of 6,060 ha (0.10%) of degraded land from 2011–13 to 2018–19. The primary driver of land degradation is vegetation degradation (32.27%), followed by frost shattering (5.97%).[169]

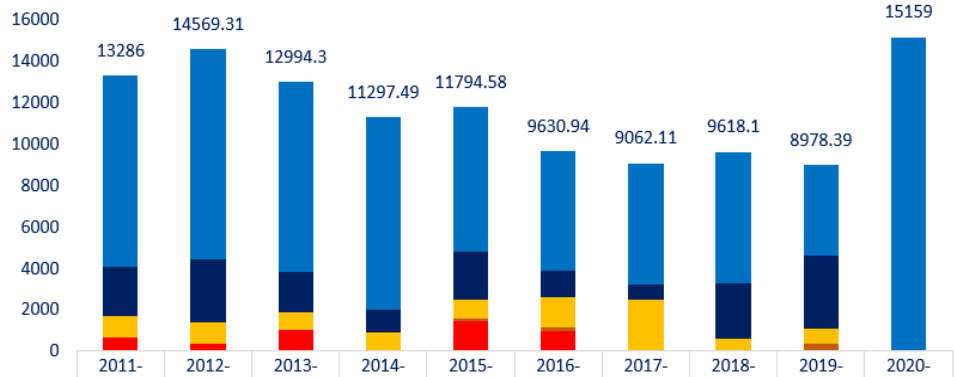
Table 84: Status of desertification and land degradation from 2018–19 and 2011–13 (area in ha) in Himachal Pradesh

Year	Vegetation Degradation	Water Erosion	Frost shattering	Manmade	Settlement
2018-19	1,796,300	268,824	332,423	656	2,097
2011-13	1,790,803	268,261	332,423	656	2,097

Source: ISRO 2021

4.13.3 Restoration Barometer: State Contribution

4.13.3.1 Area brought under restoration



	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20	2020-21
Planted forest and woodlots	9250	10,137.22	9191.53	9312.57	7007.37	5747.94	5835.55	6350.41	4347.67	15159
Natural regeneration	2330	3037.58	1918.84	1113.76	2314.64	1307.78	720.5	2692.15	3572.72	0
Silviculture	1073	1042	862.15	857.06	927.57	1445.22	2480.65	557.54	714.25	0
Agroforestry	3	0	0	0	100	157	25.41	18	343.75	0
Watershed protection and erosion control	630	352.51	1021.78	14.1	1445	973	0	0	0	0
Total	13286	14569.31	12994.3	11297.49	11794.58	9630.94	9062.11	9618.1	8978.39	15159

Figure 53: Area brought under restoration from 2011–2020 as reported by State Forest Department of Himachal Pradesh

[167] ISFR 2011, https://fsi.nic.in/forest-report-2011

[168] ISFR 2021, https://fsi.nic.in/forest-report-2021-details

[169] DLD Atlas of India, 2021, https://vedas.sac.gov.in/static/atlas/dsm/DLD_Atlas_SAC_2021.pdf

As of 2020, a total of 116,390.22 ha of the state's area had been brought under restoration since 2011, according to data submitted by the State Forest Department. Additionally, data from the Department of Land Resources (DoLR) indicate that 583.27 ha were restored between 2018 and 2020 by the DoLR.

Table 85: Area brought under restoration based on FLR interventions by State Forest Department of Himachal Pradesh

FLR interventions implemented	Area brought under restoration (in ha)
Planted forest and woodlots	82,339.26
Natural regeneration	19,007.97
Silviculture	9,959.44
Agroforestry	647.16
Watershed protection and erosion control	4,436.39

4.13.3.2 Climate impacts

The carbon sequestration for Himachal Pradesh has been estimated for the restoration work carried out from 2011 to 2020 under different scenarios (A1 and A2) and assumptions (a1, a2, and a3). To estimate carbon sequestration, the IPCC GPG LULUCF 2003 methodology has been adopted. Himachal Pradesh has been considered is classified under the Moist with Short Dry Season category, with an annual average rainfall ranging from 1,000 mm – 2,000 mm. According to the IPCC GPG LULUCF 2003, the following cases of average annual increment are applicable for this level of rainfall – best case (13.5 tdm/ha/yr), base case (7.8 tdm/ha/yr), and worst case (2.0 tdm/ha/yr), for the estimation of carbon sequestration.[170] The detailed methodology for estimating carbon sequestration is outlined in Section 1.4.1(B) and Annex I of the report. Based on this methodology, the total carbon sequestered and the per-hectare carbon sequestration are presented in the following graph and table, respectively.

To report on carbon sequestration while accounting for mortality rates, the Base Case (a2) assumption under the two scenarios has been applied, as it represents a balanced middle ground with neither too high nor too low values (refer to the detailed methodology in Section 1.4.1(B) and Annex I).

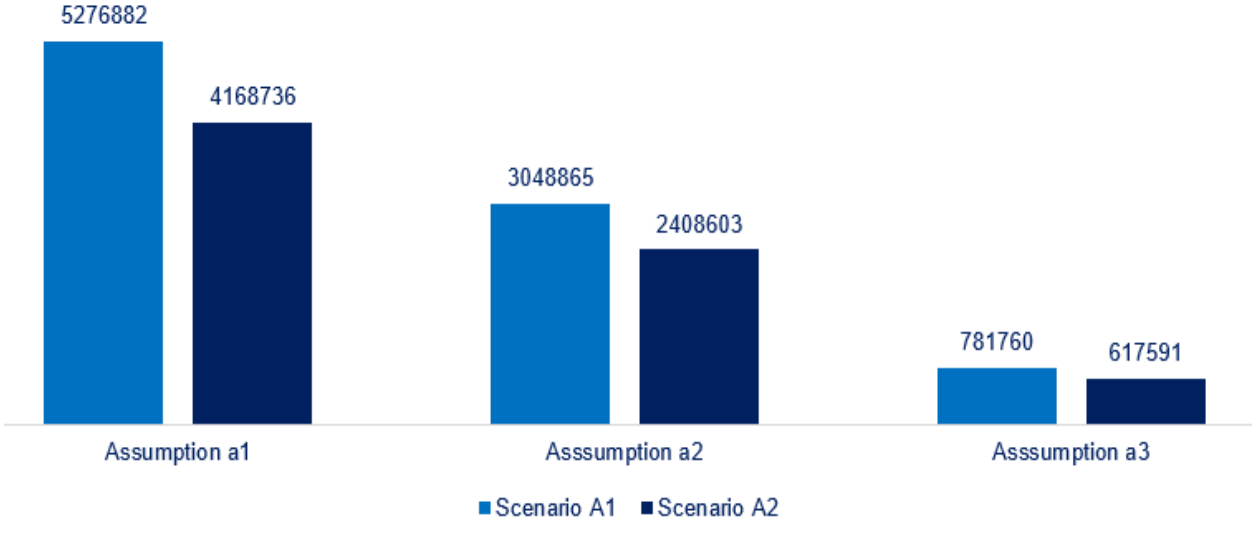


Figure 54: Total calculated tC sequestration in 10 years under two scenarios and three assumptions in Himachal Pradesh

[170] GPG LULUCF table 3A.1.6 - for AGB only https://www.ipcc-nggip.iges.or.jp/public/gpglulucf/gpglulucf_files/Chp3/Anx_3A_1_Data_Tables.pdf

From 2011 to 2020, expressed as carbon, this corresponds to 3.05 million tonnes of carbon (tC) without factoring in mortality and 2.41 million tC when a mortality rate of 21%, was considered. An estimated 11.19 million tonnes of carbon dioxide (tCO_2e) were sequestered, excluding plantation mortality. When accounting for mortality, the sequestration was 8.84 million tCO_2e.[171]

Table 86: Carbon stock tC (per ha) in AGB and BGB carbon pools in area brought under restoration for different assumptions and scenarios in Himachal Pradesh

Scenario	Assumption a1	Assumption a2	Assumption a3
Scenario A1	45.11	26.06	6.68
Scenario A2	35.64	20.59	5.28

4.13.3.3 Socio-economic impact

The socio-economic impact achieved has been measured in terms of man-days generated through FLR work in the state. According to SFD data for the period 2011 to 2020, a total of 13.42 million man-days of jobs were generated. This assessment accounts for the number of people involved in the implementation and maintenance of areas brought under restoration.

Table 87: Socio-economic impact (man-days generated) in Himachal Pradesh

Socio-economic impact											
Year	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20	2020-21	Total
Number of man-days generated (in million)	1.75	1.61	1.66	1.61	1.35	1.10	0.94	0.87	0.88	1.65	**13.42**

4.13.3.4 Financial flow

The total financial flow towards FLR in the state has been reported as INR 4,089.80 million (USD 50.13 million).[172] Domestic public expenditure is the primary source of funding, according to data provided by the SFD for the period 2011 to 2020.

Table 88: Financial outflow from 2011–2020 in Himachal Pradesh

Financial outflow											
Year	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20	2020-21	Total
FLR Funding in INR (million)	321.5	348.9	415.6	455.7	404.8	368.1	329.8	326.8	365.7	752.9	**4,089.80**

Table 89: Fund utilisation for bringing area under restoration in Himachal Pradesh

Description	**Fund utilisation** (2011-12 to 2020-21)
Total area brought under restoration (ha)	116,390.22
Total fund invested in FLR activities (million INR)	4,089.80
Funds invested per hectare (million INR/ha)	0.04
Area brought under restoration per million rupees (ha/million INR)	28.46

[171] Mortality rates was not available at the time of publication of this report. Hence, law of averages was applied assigning the average mortality rate derived from mortality rates provided by 13 other States and UTs

[172] Exchange Rate - 81.59 as assessed on 01 October 2022

4.14 Jammu and Kashmir including Ladakh

4.14.1 Restoration Barometer

The following table summarises the key components of the Restoration Barometer:

Table 90: Highlights of Restoration Barometer for Jammu and Kashmir, including Ladakh

Highlights	
Area brought under restoration (in ha)	104,229.12
Financial flow (in million INR)	5,723.40
Socio-economic impacts (man-days generated) (in million)	6.83
Climate impacts: Estimated carbon sequestered (in million tC)	2.44 (0% Mortality)
	1.83 (25% Mortality)
Climate impacts: Estimated carbon dioxide sequestered (in million tCO_2e)	8.95 (0% Mortality)
	6.71 (25% Mortality)

4.14.2 Background

Jammu and Kashmir, along with Ladakh, form a Union Territory located in northern India and is globally popular as a top tourist destination. The combined TGA of the UT is 222,679 sq km, covering 6.77% of India's TGA.[173] Dominated by the Himalayan system, the region experiences significant altitudinal variations. The average annual temperature ranges from sub-zero levels in winter to a maximum of 40°C. Annual rainfall varies between 600 mm and 800 mm.[174]

The UT has a population of 12.54 million, accounting for 1.04% of India's total population. Rural areas house 72.62% of the population, while 27.38% reside in urban areas. The tribal population constitutes 11.91% of the total population. The population density is 125 persons per sq km, lower than the national average. According to the 19th Livestock Census 2012, the total livestock population is 9.20 million.[175] The economy of Jammu and Kashmir, including Ladakh, is predominantly service-oriented, with the tertiary sector as the primary driver. Key contributors include tourism, handlooms, handicrafts, gems and jewellery. In the primary sector, agriculture and allied activities, particularly horticulture, floriculture, and sericulture, play a significant

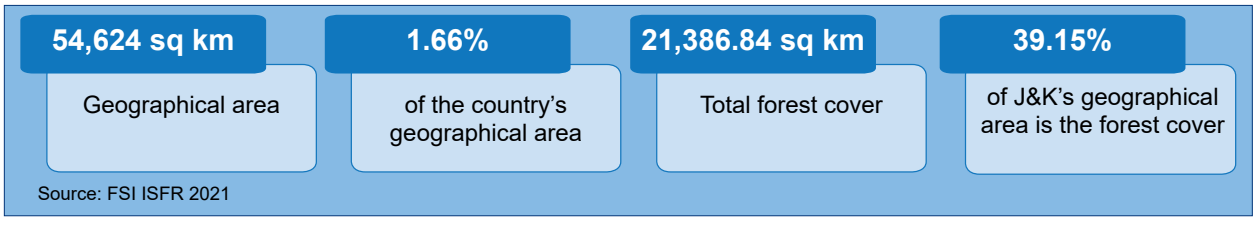


Figure 55: Geographical Area and Forest Cover of Jammu and Kashmir

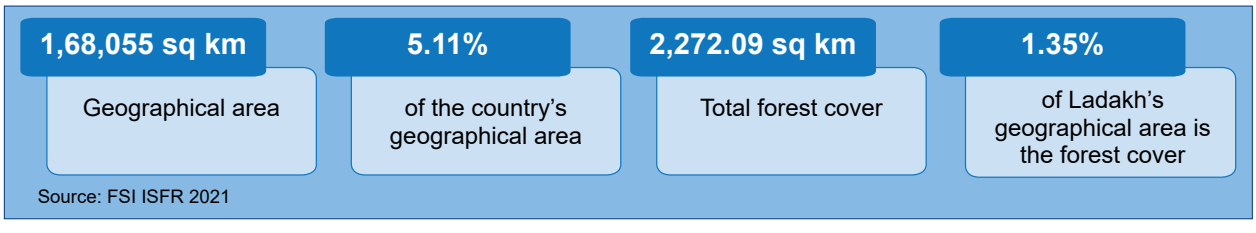


Figure 56: Geographical Area and Forest Cover of Ladakh

[173] ISFR 2021, https://fsi.nic.in/isfr-2021/chapter-13.pdf

[174] ISFR 2019, https://fsi.nic.in/isfr19/vol2/isfr-2019-vol-ii-jammu-kashmir.pdf

[175] ISFR 2019, https://fsi.nic.in/isfr19/vol2/isfr-2019-vol-ii-jammu-kashmir.pdf

role in economic development.[176] The total forest cover of the UT is 21,386.84 sq km, accounting for 39.15% of its geographical area.[177]

As per ISFR 2011[178] and ISFR 2021[179], the following observations were made:

- In the last 10 years, from 2011 to 2020, there is an increase of 1,152.16 sq km, or 115,216 ha, in the forest cover.
- The tree cover of Jammu and Kashmir (including Ladakh) constituted 7.0% of the UT's TGA. In the last 10 years, there is a decrease of 2,085 sq km, or 208,500 ha, in the tree cover area of the UT.
- The average growing stock in Jammu and Kashmir including Ladakh is 345.53 million cum in forest and 144.05 million cum in ToF. In the last 10 years, the average growing stock in the forest area increased by 118.14 million cum while decreased for ToF by 3.69 million cum.
- The total carbon stock of forest in the UT, including the TOF patches which are more than one ha in size, is 401.57 million tonnes (1,472.43 $MtCO_2e$), which is 5.58% of the total forest carbon in the country.

As per the 2021 DLD Atlas of India, 1,129,503 ha of land, representing 20.86% of the state's TGA, is affected by various forms of desertification and land degradation. There has been an increase of 64,783 ha (1.19%) of degraded land from 2011–13 to 2018–19. The primary driver of land degradation is vegetation degradation (16.04%), followed by water erosion (2.79%).[180]

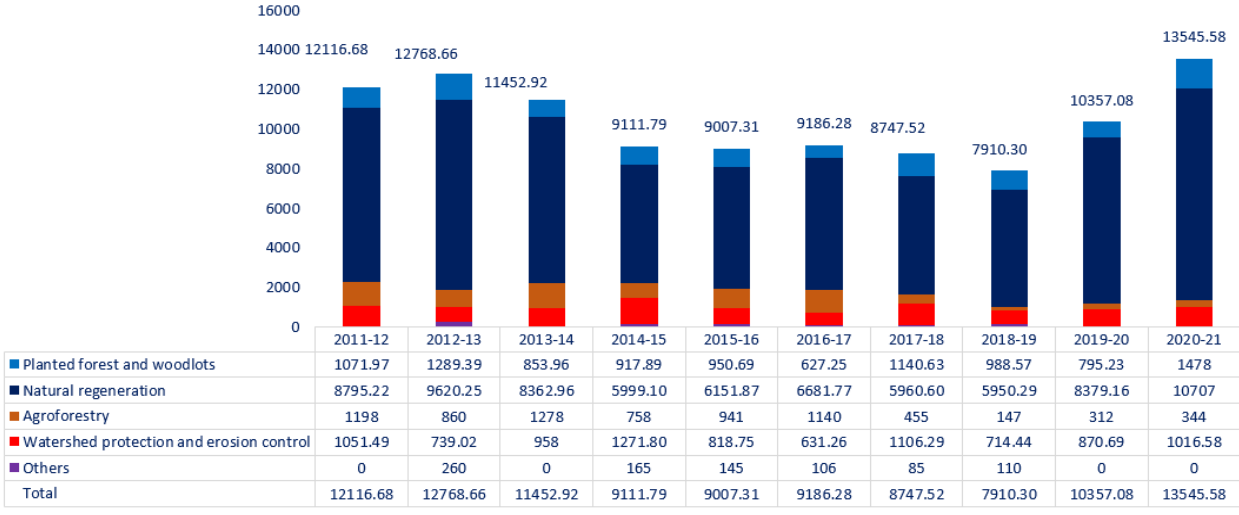
Table 91: Status of desertification and land degradation from 2018–19 and 2011–13 (area in ha) in Jammu and Kashmir including Ladakh

Year	Vegetation Degradation	Water Erosion	Water Logging	Frost Shattering	Settlement
2018-19	868,556	151,031	78,858	9,051	22,008
2011-13	832,760	136,918	70,159	9,051	15,832

Source: ISRO 2021

4.14.3 Restoration Barometer: UT Contribution

4.14.3.1 Area brought under restoration



	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20	2020-21
Planted forest and woodlots	1071.97	1289.39	853.96	917.89	950.69	627.25	1140.63	988.57	795.23	1478
Natural regeneration	8795.22	9620.25	8362.96	5999.10	6151.87	6681.77	5960.60	5950.29	8379.16	10707
Agroforestry	1198	860	1278	758	941	1140	455	147	312	344
Watershed protection and erosion control	1051.49	739.02	958	1271.80	818.75	631.26	1106.29	714.44	870.69	1016.58
Others	0	260	0	165	145	106	85	110	0	0
Total	12116.68	12768.66	11452.92	9111.79	9007.31	9186.28	8747.52	7910.30	10357.08	13545.58

Figure 57: Area brought under restoration from 2011–2020 as reported by the State Forest Department of Jammu and Kashmir, including Ladakh

[176] IBEF Infographics, https://www.ibef.org/states/jammu-kashmir-infographic, https://www.ibef.org/states/ladakh-infographics
[177] ISFR 2021, https://fsi.nic.in/isfr-2021/chapter-13.pdf
[178] ISFR 2011, https://fsi.nic.in/forest-report-2011
[179] ISFR 2021, https://fsi.nic.in/forest-report-2021-details
[180] DLD Atlas of India, 2021, https://vedas.sac.gov.in/static/atlas/dsm/DLD_Atlas_SAC_2021.pdf

As of 2020, a total of 104,204.12 ha of the UT's area had been brought under restoration since 2011, according to data submitted by the Forest Department. Additionally, data from the Department of Land Resources (DoLR) indicate that 25 ha were restored between 2018 and 2020 by the DoLR.

Table 92: Area brought under restoration based on FLR interventions by FD of Jammu and Kashmir, including Ladakh

FLR interventions implemented	Area brought under restoration (in ha)
Planted forest and woodlots	10,113.58
Natural regeneration	76,608.22
Agroforestry	7,433
Watershed protection and erosion control	9,178.32
Others	871

4.14.3.2 Climate impacts

The carbon sequestration for Jammu and Kashmir including Ladakh been estimated for the restoration work carried out from 2011 to 2020 under different scenarios (A1 and A2) and assumptions (a1, a2, and a3). To estimate carbon sequestration, the IPCC GPG LULUCF 2003 methodology has been adopted. Jammu and Kashmir including Ladakh has been considered under the Moist with Long Dry Season category, with an annual average rainfall ranging from 1,000 mm – 2,000 mm. According to the IPCC GPG LULUCF 2003, the following cases of average annual increment are applicable for this level of rainfall – best case (12.6 tdm/ha/yr), base case (7.1 tdm/ha/yr), and worst case (1.6 tdm/ha/yr), for the estimation of carbon sequestration.[181] The detailed methodology for estimating carbon sequestration is outlined in Section 1.4.1(B) and Annex I of the report. Based on this methodology, the total carbon sequestered and the per-hectare carbon sequestration are presented in the following graph and table, respectively.

To report on carbon sequestration while accounting for mortality rates, the Base Case (a2) assumption under the two scenarios has been applied, as it represents a balanced middle ground with neither too high nor too low values (refer to the detailed methodology in Section 1.4.1(B) and Annex I).

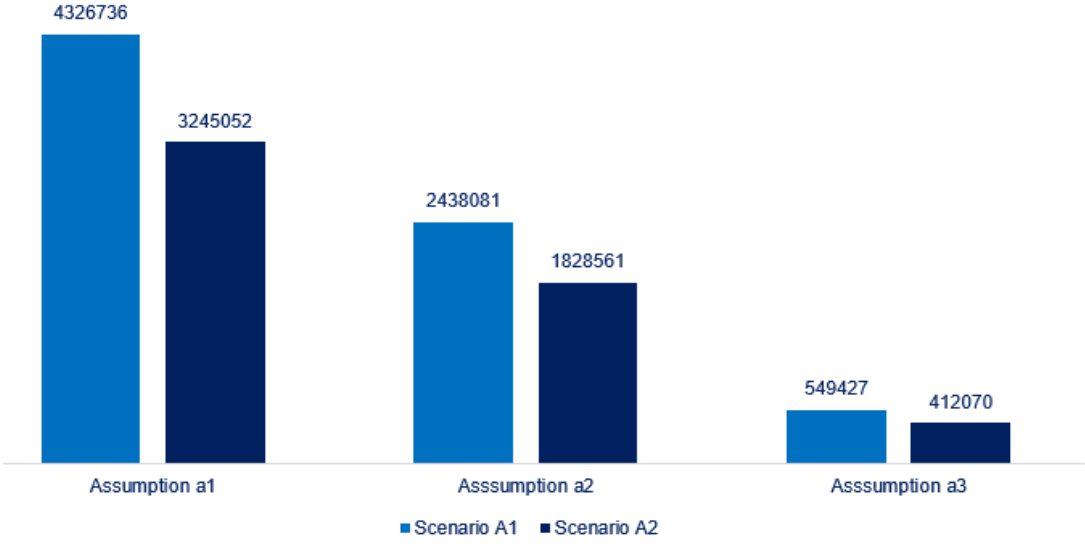


Figure 58: Total calculated tC sequestration in 10 years under two scenarios and three assumptions in Jammu and Kashmir, including Ladakh

[181] GPG LULUCF table 3A.1.6 - for AGB only https://www.ipcc-nggip.iges.or.jp/public/gpglulucf/gpglulucf_files/Chp3/Anx_3A_1_Data_Tables.pdf

From 2011 to 2020, expressed as carbon, this corresponds to 2.44 million tonnes of carbon (tC) without factoring in mortality and 1.83 million tC when a mortality rate of 25%, was considered. An estimated 8.95 million tonnes of carbon dioxide (tCO_2e) were sequestered, excluding plantation mortality. When accounting for mortality, the sequestration was 6.71 million tCO_2e.[182]

Table 93: Carbon stock tC (per ha) in AGB and BGB carbon pools in area brought under restoration for different assumptions and scenarios in Jammu and Kashmir, including Ladakh

Scenario	Assumption a1	Assumption a2	Assumption a3
Scenario A1	41.51	23.39	5.27
Scenario A2	31.13	17.54	3.95

4.14.3.3 Socio-economic impact

The socio-economic impact achieved has been measured in terms of man-days generated through FLR work in the UT. According to FD data for the period 2011 to 2020, a total of 6.83 million man-days of jobs were generated. This assessment accounts for the number of people involved in the implementation and maintenance of areas brought under restoration.

Table 94: Socio-economic impacts (man-days generated) in Jammu and Kashmir, including Ladakh

Socio-economic impact											
Year	**2011-12**	**2012-13**	**2013-14**	**2014-15**	**2015-16**	**2016-17**	**2017-18**	**2018-19**	**2019-20**	**2020-21**	**Total**
Number of man-days generated (in million)	0.86	1.46	1.07	0.79	0.79	0.24	0.58	0.39	0.32	0.31	**6.83**

4.14.3.4 Financial flow

The total financial flow towards FLR in the UT has been reported as INR 5,723.40 million (USD 70.15 million).[183] Domestic public expenditure is the primary source of funding, according to data provided by the FD for the period 2011 to 2020.

Table 95: Financial outflow from 2011–2020 in Jammu and Kashmir, including Ladakh

Financial outflow											
Year	**2011-12**	**2012-13**	**2013-14**	**2014-15**	**2015-16**	**2016-17**	**2017-18**	**2018-19**	**2019-20**	**2020-21**	**Total**
FLR Funding in INR (million)	350.6	382.9	532.9	478.1	451.6	516.9	768.8	641.2	731.0	869.4	**5,723.40**

Table 96: Fund utilisation for bringing area under restoration in Jammu and Kashmir, including Ladakh

Description	**Fund utilisation** (2011-12 to 2020-21)
Total area brought under restoration (ha)	104,204.12
Total fund invested in FLR activities (million INR)	5,723.40
Funds invested per hectare (million INR/ha)	0.05
Area brought under restoration per million rupees (ha/million INR)	18.21

[182] Mortality rates was not available at the time of publication of this report. Hence, law of averages was applied assigning the average mortality rate derived from mortality rates provided by 13 other States and UTs

[183] Exchange Rate - 81.59 as assessed on 01 October 2022

4.15 Jharkhand

4.15.1 Restoration Barometer

The following table summarises the key components of the Restoration Barometer:

Table 97: Highlights of Restoration Barometer for Jharkhand

Highlights	
Area brought under restoration (in ha)	111,059
Financial flow (in million INR)	23,937.50
Socio-economic impacts (man-days generated) (in million)	65.23
Climate impacts: Estimated carbon sequestered (in million tC)	1.84 (0% Mortality)
	1.56 (15% Mortality)
Climate impacts: Estimated carbon dioxide sequestered (in million tCO_2e)	6.75 (0% Mortality)
	5.74 (15% Mortality)

4.15.2 Background

Jharkhand, situated in eastern India, was established as a separate state in 2000 from the southern region of Bihar. The state is rich in minerals and renowned for its tribal culture. It covers a TGA of 79,716 sq km, comprising 2.42% of India's TGA.[184] The state experiences a tropical climate, with hot summers and cold winters. Average annual temperatures range from 4°C to 47°C, with annual rainfall of about 900 mm.[185]

Jharkhand has a population of 32.99 million, with 75.95% residing in rural areas and 24.05% in urban centres. The tribal population constitutes 26.21% of the total. The population density is 414 persons per sq km, slightly higher than the national average. The 19th Livestock Census 2012 reported a total livestock population of 18.05 million.[186] The tertiary and secondary sectors significantly drive the economy of Jharkhand. The state is recognised globally for its rich mineral resources, which play a crucial role in its industrial development in India. In the primary sector, agriculture and forestry are key contributors to the state's economy.[187] The total forest cover of Jharkhand is 23,721.14 sq km, constituting 29.76% of its geographical area.[188]

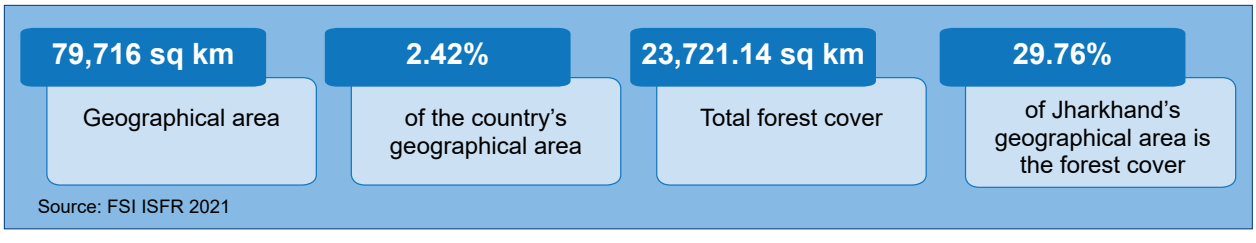


Figure 59: Geographical Area and Forest Cover of Jharkhand

[184] ISFR 2021, https://fsi.nic.in/isfr-2021/chapter-13.pdf
[185] ISFR 2019, https://fsi.nic.in/isfr19/vol2/isfr-2019-vol-ii-jharkhand.pdf
[186] ISFR 2019, https://fsi.nic.in/isfr19/vol2/isfr-2019-vol-ii-jharkhand.pdf
[187] IBEF Infographics, https://www.ibef.org/states/jharkhand-infographic
[188] ISFR 2021, https://fsi.nic.in/isfr-2021/chapter-13.pdf

As per ISFR 2011[189] and ISFR 2021[190], the following observations were made:

- In the last 10 years, from 2011 to 2020, there is an increase of 744.14 sq km, or 74,414 ha, in the forest cover.
- The tree cover of Jharkhand constituted 3.59% of the state's TGA. In the last 10 years, there is a decrease of 47 sq km, or 4,700 ha, in the tree cover area of the state.
- The average growing stock in Jharkhand is 100.80 million cum in forest and 74.35 million cum in ToF. In the last 10 years, the average growing stock in the forest area decreased by 15.51 million cum while increased for ToF by 23.04 million cum.
- The total carbon stock of forest in the State, including the TOF patches which are more than one ha in size, is 184.81 million tonnes (677.64 $MtCO_2e$), which is 2.57% of the total forest carbon in the country.

As per the 2021 DLD Atlas of India, 5,482,260 ha of land, representing 68.77% of the state's TGA, is affected by various forms of desertification and land degradation. There has been a decrease of 16,466 ha (0.21%) of degraded land from 2011–13 to 2018–19. The primary driver of land degradation is water erosion (49.12%), followed by vegetation degradation (17.81%).[191]

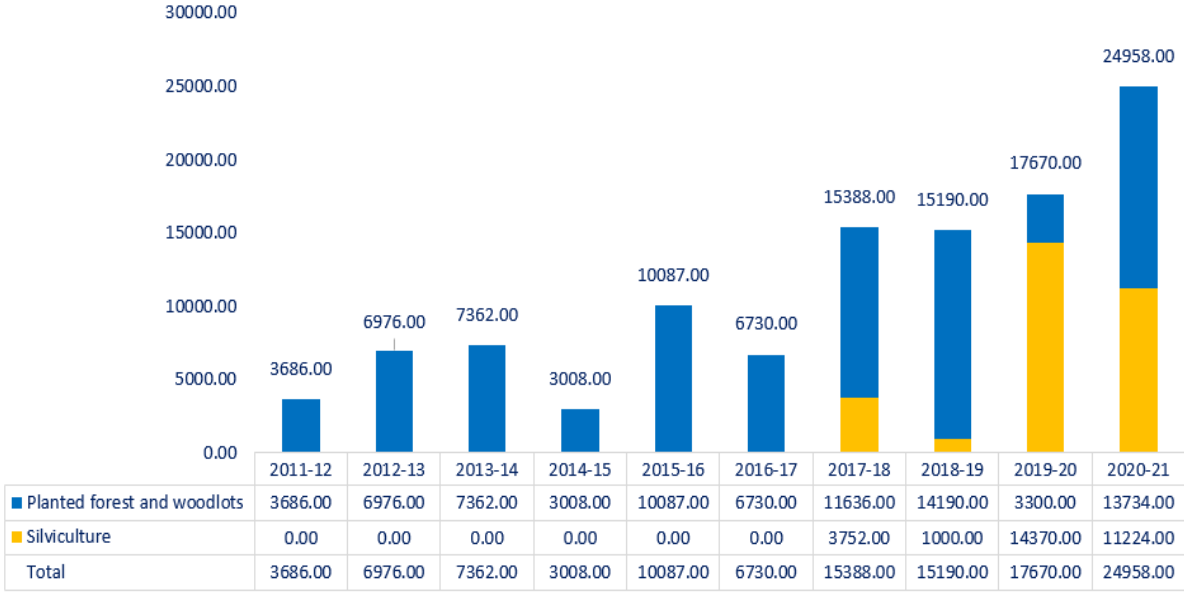
Table 98: Status of desertification and land degradation from 2018–19 and 2011–13 (area in ha) in Jharkhand

Year	Vegetation Degradation	Water Erosion	Manmade	Settlement
2018-19	1419362	3915868	95301	51730
2011-13	1379038	4036785	52734	30169

Source: ISRO 2021

4.15.3 Restoration Barometer: State Contribution

4.15.3.1 Area brought under restoration



	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20	2020-21
Planted forest and woodlots	3686.00	6976.00	7362.00	3008.00	10087.00	6730.00	11636.00	14190.00	3300.00	13734.00
Silviculture	0.00	0.00	0.00	0.00	0.00	0.00	3752.00	1000.00	14370.00	11224.00
Total	3686.00	6976.00	7362.00	3008.00	10087.00	6730.00	15388.00	15190.00	17670.00	24958.00

Figure 60: Area brought under restoration from 2011–2020 as reported by State Forest Department of Jharkhand

[189] ISFR 2011, https://fsi.nic.in/forest-report-2011

[190] ISFR 2021, https://fsi.nic.in/forest-report-2021-details

[191] DLD Atlas of India, 2021, https://vedas.sac.gov.in/static/atlas/dsm/DLD_Atlas_SAC_2021.pdf

As of 2020, a total of 111,055 of the state's area had been brought under restoration since 2011, according to data submitted by the State Forest Department. Additionally, data from the Department of Land Resources (DoLR) indicate that 4 ha were restored between 2018 and 2020 by the DoLR.

Table 99: Area brought under restoration based on FLR interventions by State Forest Department of Jharkhand

FLR interventions implemented	Area brought under restoration (in ha)
Planted forest and woodlots	80,709
Silviculture	30,346

4.15.3.2 Climate impacts

The carbon sequestration for Jharkhand has been estimated for the restoration work carried out from 2011 to 2020 under different scenarios (A1 and A2) and assumptions (a1, a2, and a3). To estimate carbon sequestration, the IPCC GPG LULUCF 2003 methodology has been adopted. Jharkhand is classified under the Moist with Long Dry Season category, with an annual average rainfall ranging from 1,000 mm – 2,000 mm. According to the IPCC GPG LULUCF 2003, the following cases of average annual increment are applicable for this level of rainfall – best case (12.6 tdm/ha/yr), base case (7.1 tdm/ha/yr), and worst case (1.6 tdm/ha/yr), for the estimation of carbon sequestration.[192] The detailed methodology for estimating carbon sequestration is outlined in Section 1.4.1(B) and Annex I of the report. Based on this methodology, the total carbon sequestered and the per-hectare carbon sequestration are presented in the following graph and table, respectively.

To report on carbon sequestration while accounting for mortality rates, the Base Case (a2) assumption under the two scenarios has been applied, as it represents a balanced middle ground with neither too high nor too low values (refer to the detailed methodology in Section 1.4.1(B) and Annex I).

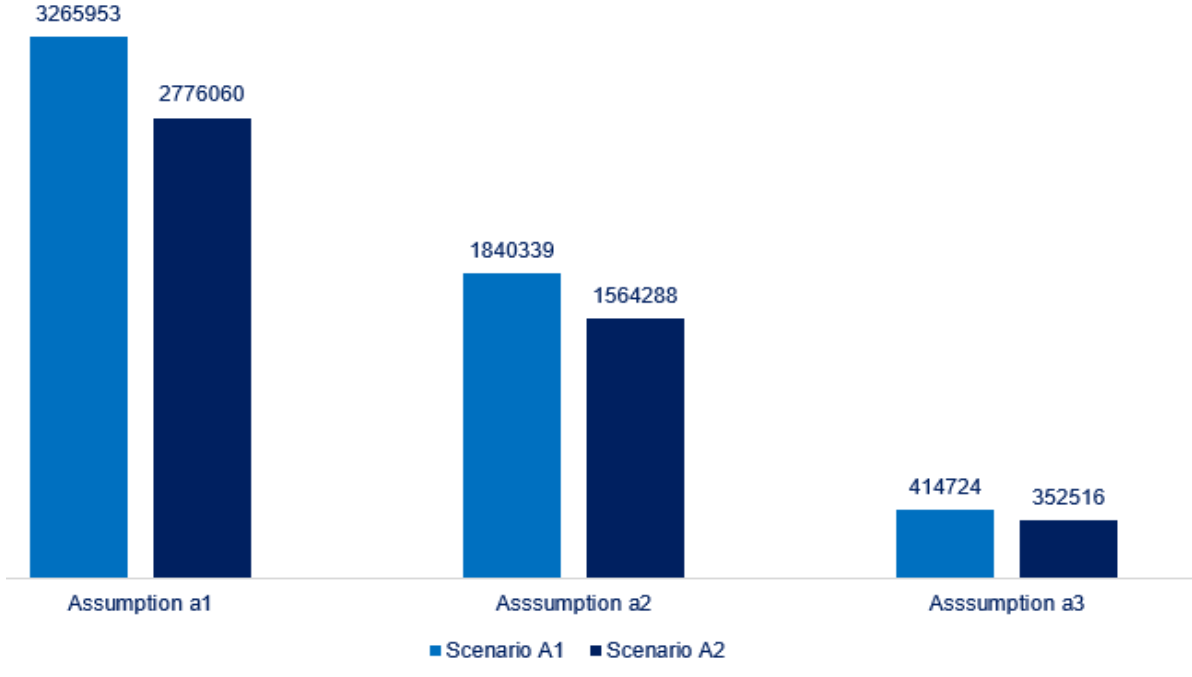


Figure 61: Total calculated tC sequestration in 10 years under two scenarios and three assumptions in Jharkhand

[192] GPG LULUCF table 3A.1.6 - for AGB only https://www.ipcc-nggip.iges.or.jp/public/gpglulucf/gpglulucf_files/Chp3/Anx_3A_1_Data_Tables.pdf

From 2011 to 2020, expressed as carbon, this corresponds to 1.84 million tonnes of carbon (tC) without factoring in mortality and 1.56 million tC when a mortality rate of 15%, was considered. An estimated 6.75 million tonnes of carbon dioxide (tCO_2e) were sequestered, excluding plantation mortality. When accounting for mortality, the sequestration was 5.74 million tCO_2e.[193]

Table 100: Carbon stock tC (per ha) in AGB and BGB carbon pools in area brought under restoration for different assumptions and scenarios in Jharkhand

Scenario	Assumption a1	Assumption a2	Assumption a3
Scenario A1	29.41	16.57	3.73
Scenario A2	25	14.09	3.17

4.15.3.3 Socio-economic impact

The socio-economic impact achieved has been measured in terms of man-days generated through FLR work in the state. According to SFD data for the period 2011 to 2020, a total of 65.23 million man-days of jobs were generated. This assessment accounts for the number of people involved in the implementation and maintenance of areas brought under restoration.

Table 101: Socio-economic impact (man-days generated) in Jharkhand

Socio-economic impact											
Year	**2011-12**	**2012-13**	**2013-14**	**2014-15**	**2015-16**	**2016-17**	**2017-18**	**2018-19**	**2019-20**	**2020-21**	**Total**
Number of man-days generated (in million)	4.22	5.09	3.68	5.77	6.44	8.78	9.59	7.22	8.22	6.20	**65.23**

4.15.3.4 Financial flow

The total financial flow towards FLR in the state has been reported as INR 23,937.50 million (USD 293.39 million).[194] Domestic public expenditure is the primary source of funding, according to data provided by the SFD for the period 2011 to 2020.

Table 102: Financial outflow from 2011–2020 in Jharkhand

Financial outflow											
Year	**2011-12**	**2012-13**	**2013-14**	**2014-15**	**2015-16**	**2016-17**	**2017-18**	**2018-19**	**2019-20**	**2020-21**	**Total**
FLR Funding in INR (million)	941.4	1,325.7	981.8	1,703.8	2,281.8	3,243.9	3,676.1	2,856.8	3,426.2	3,500.0	**23,937.50**

Table 103: Fund utilisation for bringing area under restoration in Jharkhand

Description	**Fund utilisation** (2011-12 to 2020-21)
Total area brought under restoration (ha)	111,055
Total fund invested in FLR activities (million INR)	23,937.50
Funds invested per hectare (million INR/ha)	0.22
Area brought under restoration per million rupees (ha/million INR)	4.64

[193] Mortality rates was not available at the time of publication of this report. Hence, law of averages was applied assigning the average mortality rate derived from mortality rates provided by 13 other States and UTs

[194] Exchange Rate - 81.59 as assessed on 01 October 2022

4.16 Karnataka

4.16.1 Restoration Barometer

The following table summarises the key components of the Restoration Barometer:

Table 104: Highlights of Restoration Barometer for Karnataka

Highlights	
Area brought under restoration (in ha)	692,182
Financial flow (in million INR)	42,540.95
Socio-economic impacts (man-days generated) (in million)	Not Available
Climate impacts: Estimated carbon sequestered (in million tC)	17.56 (0% Mortality)
	13.87 (21% Mortality)
Climate impacts: Estimated carbon dioxide sequestered (in million tCO_2e)	64.43 (0% Mortality)
	50.90 (21% Mortality)

4.16.2 Background

Karnataka, located in southern India, is known for its rich cultural heritage, wildlife, and national parks. The state covers a TGA of 191,791 sq km, comprising 5.83% of India's TGA.[195] The state's topography includes the hilly Western Ghats and the inland plateau. Karnataka experiences a humid tropical climate, with average annual temperatures ranging from 25°C to 35°C. Average annual rainfall varies between 2,000 mm and 3,200 mm.[196]

The population of Karnataka is 61.13 million, accounting for 5.05% of India's total population. Rural areas house 61.13% of the population, while 38.67% live in urban centres. The tribal population constitutes 6.96% of the total. The population density is 319 persons per sq km, slightly below than the national average. The 19th Livestock Census 2012 reported a livestock population of 27.70 million.[197] The tertiary sector mainly drives Karnataka's economy. The state has established itself as an IT hub, contributing significantly to the services sector. In the primary sector, agriculture continues to be the key contributor, with forestry and allied activities also playing a vital role in the state's economy.[198] The state's total forest cover is 38,729.99 sq km, forming 20.19% of its geographical area.[199]

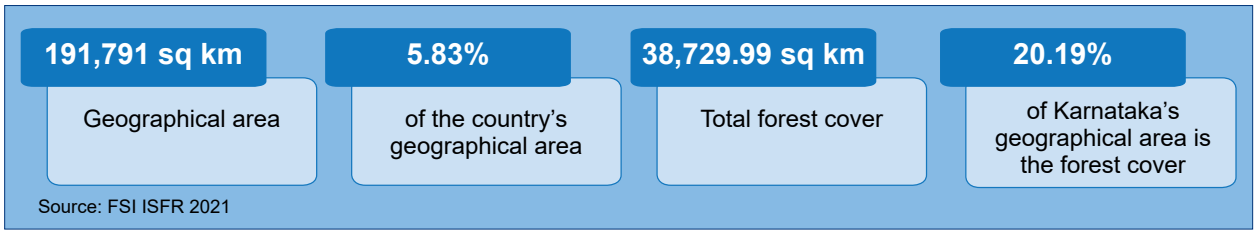


Figure 62: Geographical Area and Forest Cover of Karnataka

[195] ISFR 2021, https://fsi.nic.in/isfr-2021/chapter-13.pdf
[196] ISFR 2019, https://fsi.nic.in/isfr19/vol2/isfr-2019-vol-ii-karnataka.pdf
[197] ISFR 2019, https://fsi.nic.in/isfr19/vol2/isfr-2019-vol-ii-karnataka.pdf
[198] IBEF Infographics, https://www.ibef.org/states/karnataka-infographic
[199] ISFR 2021, https://fsi.nic.in/isfr-2021/chapter-13.pdf

As per ISFR 2011[200] and ISFR 2021[201], the following observations were made:

- In the last 10 years, from 2011 to 2020, there is an increase of 2,535.99 sq km, or 253,599 ha, in the forest cover.
- The tree cover of Karnataka constituted 3.91% of the state's TGA. In the last 10 years, there is an increase of 1,761 sq km, or 176,100 ha, in the tree cover area of the state.
- The average growing stock in Karnataka is 302.14 million cum in forest and 121.72 million cum in ToF. In the last 10 years, the average growing stock in the forest area decreased by 13.02 million cum while increased for ToF by 19.99 million cum.
- The total carbon stock of forest in the State, including the TOF patches which are more than one ha in size, is 376.40 million tonnes (1,380.13 $MtCO_2e$), which is 5.22% of the total forest carbon in the country.

As per the 2021 DLD Atlas of India, 6,959,847 ha of land, representing 36.29% of the state's TGA, is affected by various forms of desertification and land degradation. There has been an increase of 8,847 ha (0.05%) of degraded land from 2011–13 to 2018–19. The primary driver of land degradation is water erosion (26.13%), followed by vegetation degradation (8.85%).[202]

Table 105: Status of desertification and land degradation from 2018–19 and 2011–13 (area in ha) in Karnataka

Year	Vegetation Degradation	Water Erosion	Wind Erosion	Salinity	Manmade	Barren/ Rocky	Settlement
2018-19	1,697,479	5,012,171	2,159	89,122	38,794	3,252	116,871
2011-13	1,712,386	5,043,041	2,159	86,740	20,876	3,389	82,409

Source: ISRO 2021

4.16.3 Restoration Barometer: State Contribution

4.16.3.1 Area brought under restoration

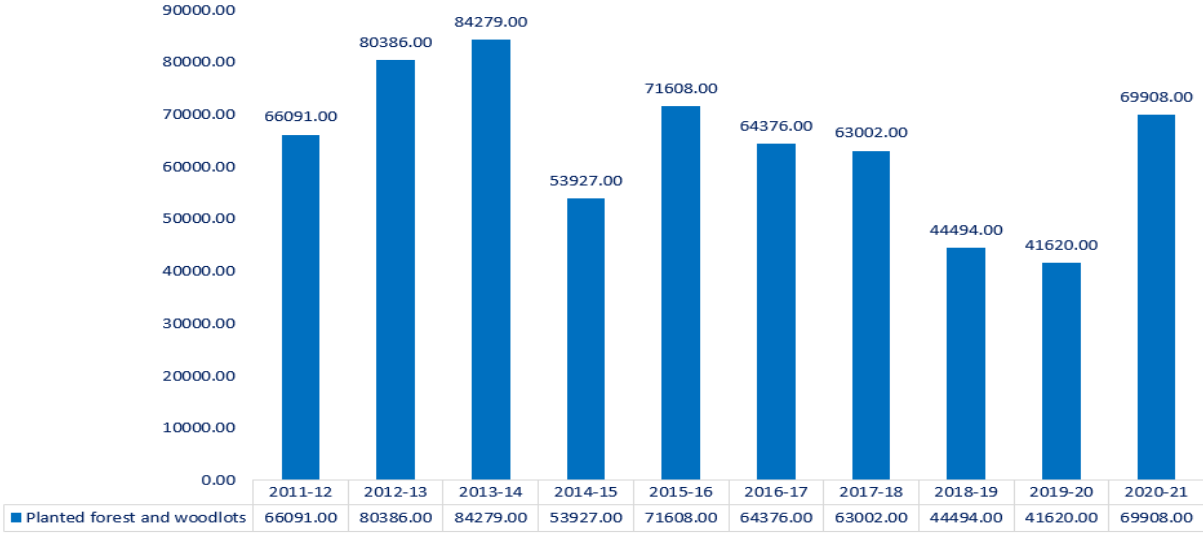


Figure 63: Area brought under restoration from 2011–2020 as reported by State Forest Department of Karnataka

[200] ISFR 2011, https://fsi.nic.in/forest-report-2011

[201] ISFR 2021, https://fsi.nic.in/forest-report-2021-details

[202] DLD Atlas of India, 2021, https://vedas.sac.gov.in/static/atlas/dsm/DLD_Atlas_SAC_2021.pdf

As of 2020, a total of 639,691 ha of the state's area had been brought under restoration since 2011, according to data submitted by the State Forest Department. Additionally, data from the Department of Land Resources (DoLR) indicate that 52,491 ha were restored between 2018 and 2020 by the DoLR.

Table 106: Area brought under restoration based on FLR interventions by State Forest Department of Karnataka

FLR interventions implemented	Area brought under restoration (in ha)
Planted forest and woodlots	639,691

4.16.3.2 Climate impacts

The carbon sequestration for Karnataka has been estimated for the restoration work carried out from 2011 to 2020 under different scenarios (A1 and A2) and assumptions (a1, a2, and a3). To estimate carbon sequestration, the IPCC GPG LULUCF 2003 methodology has been adopted. Karnataka is classified under the Moist with Short Dry Season category, with an annual average rainfall ranging from 1,000 mm – 2,000 mm. According to the IPCC GPG LULUCF 2003, the following cases of average annual increment are applicable for this level of rainfall – best case (13.5 tdm/ha/yr), base case (7.8 tdm/ha/yr), and worst case (2 tdm/ha/yr), for the estimation of carbon sequestration.[203] The detailed methodology for estimating carbon sequestration is outlined in Section 1.4.1(B) and Annex I of the report. Based on this methodology, the total carbon sequestered and the per-hectare carbon sequestration are presented in the following graph and table, respectively.

To report on carbon sequestration while accounting for mortality rates, the Base Case (a2) assumption under the two scenarios has been applied, as it represents a balanced middle ground with neither too high nor too low values (refer to the detailed methodology in Section 1.4.1(B) and Annex I).

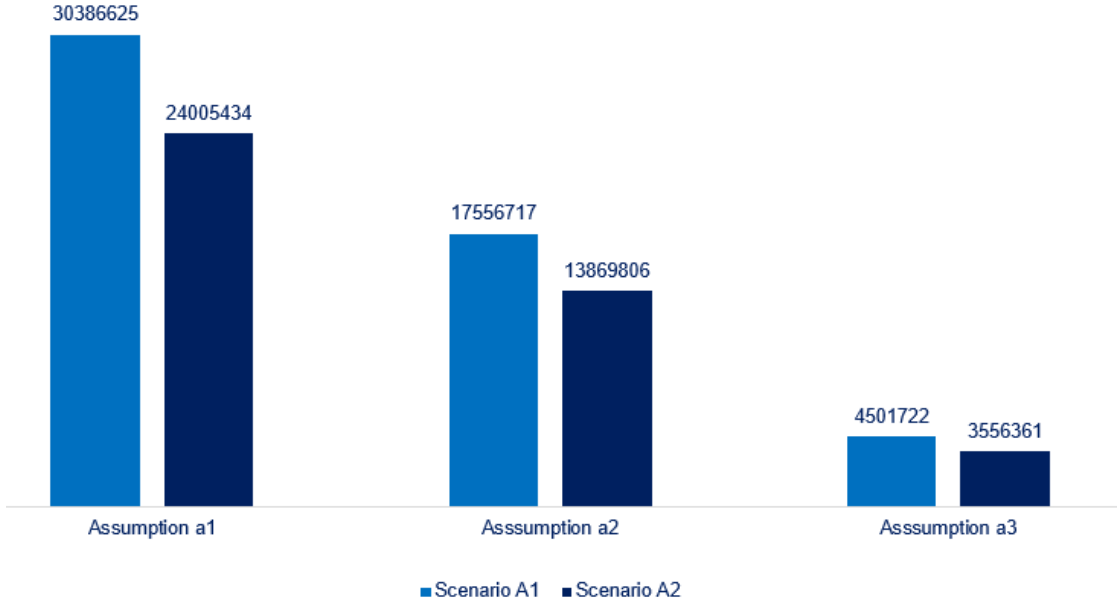


Figure 64: Total calculated tC sequestration in 10 years under two scenarios and three assumptions in Karnataka

[203] GPG LULUCF table 3A.1.6 - for AGB only https://www.ipcc-nggip.iges.or.jp/public/gpglulucf/gpglulucf_files/Chp3/Anx_3A_1_Data_Tables.pdf

From 2011 to 2020, expressed as carbon, this corresponds to 17.56 million tonnes of carbon (tC) without factoring in mortality and 13.87 million tC when a mortality rate of 21%, was considered. An estimated 64.43 million tonnes of carbon dioxide (tCO_2e) were sequestered, excluding plantation mortality. When accounting for mortality, the sequestration was 50.90 million tCO_2e.[204]

Table 107: Carbon stock tC (per ha) in AGB and BGB carbon pools in area brought under restoration for different assumptions and scenarios in Karnataka

Scenario	Assumption a1	Assumption a2	Assumption a3
Scenario A1	43.90	25.36	6.50
Scenario A2	34.68	20.04	5.14

4.16.3.3 Socio-economic impact

The socio-economic impact achieved in terms of man-days generated through the FLR work in the UT was not available at the time of publication.

Note: The data were not available at the time of publication.

4.16.3.4 Financial flow

The total financial flow towards FLR in the state has been reported as INR 42,540.95 million (USD 521.40 million).[205] Domestic public expenditure is the primary source of funding, according to data provided by the SFD for the period 2011 to 2020.

Table 108: Financial outflow from 2011–2020 in Karnataka

Financial outflow											
Year	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20	2020-21	Total
FLR Funding in INR (million)	1,848.06	2,359.44	2,479.30	3,183.52	2,497.48	4,222.90	5,370.53	9,901.06	10,572.93	105.73	**42,540.95**

Table 109: Fund utilisation for bringing area under restoration in Karnataka

Description	**Fund utilisation** (2011-12 to 2020-21)
Total area brought under restoration (ha)	639,691
Total fund invested in FLR activities (million INR)	42,540.95
Funds invested per hectare (million INR/ha)	0.07
Area brought under restoration per million rupees (ha/million INR)	15.04

[204] Mortality rates was not available at the time of publication of this report. Hence, law of averages was applied assigning the average mortality rate derived from mortality rates provided by 13 other States and UTs

[205] Exchange Rate - 81.59 as assessed on 01 October 2022

4.17 Kerala

4.17.1 Restoration Barometer

The following table summarises the key components of the Restoration Barometer:

Table 110: Highlights of Restoration Barometer for Kerala

Highlights	
Area brought under restoration (in ha)	7,861.19
Financial flow (in million INR)	45,675.28
Socio-economic impacts (man-days generated) (in million)	0.81
Climate impacts: Estimated carbon sequestered (in million tC)	0.14 (0% Mortality)
	0.11 (21% Mortality)
Climate impacts: Estimated carbon dioxide sequestered (in million tCO_2e)	0.51 (0% Mortality)
	0.41 (21% Mortality)

4.17.2 Background

Kerala, situated in the southernmost part of India, is renowned for its ecotourism initiatives and tranquil backwaters. The state is a coastal region along the Arabian Sea. It covers a total geographical area of 38,852 sq km, representing 1.18% of India's TGA.[206] Kerala experiences a humid tropical climate, with annual average temperatures ranging from 19.8°C to 36.7°C and annual rainfall varying between 1,520 mm and 4,075 mm.[207]

The state has a population of 33.41 million, representing 2.76% of India's total population. The rural and urban populations constitute 66.64% and 33.36%, respectively, of the total population of the state. The tribal population accounts for 6.99% of the state's total population. The average population density of the state is 860 persons per sq km, which is significantly higher than the national average. The 19th Livestock Census of 2012 reported a total livestock population of 2.73 million.[208]

Kerala's economy is primarily driven by the tertiary sector, with tourism, trade, and services playing significant roles. In the primary sector, agriculture is the key contributor, supported by a thriving forestry sector. The state is known for its high literacy rates and robust healthcare system, further strengthening its service-based economy.[209] The total forest cover of Kerala is 21,253.49 sq km, forming 54.70% of its geographical area.[210]

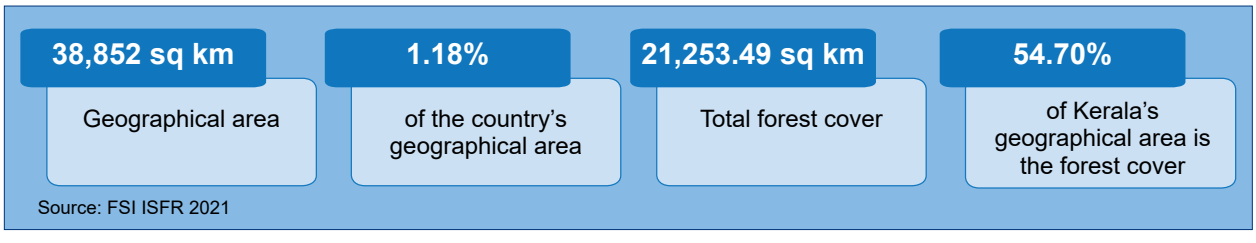


Figure 65: Geographical Area and Forest Cover of Kerala

[206] ISFR 2021, https://fsi.nic.in/isfr-2021/chapter-13.pdf
[207] ISFR 2019, https://fsi.nic.in/isfr19/vol2/isfr-2019-vol-ii-kerala.pdf
[208] ISFR 2019, https://fsi.nic.in/isfr19/vol2/isfr-2019-vol-ii-kerala.pdf
[209] IBEF Infographics, https://www.ibef.org/states/kerala-infographic
[210] ISFR 2021, https://fsi.nic.in/isfr-2021/chapter-13.pdf

As per ISFR 2011[211] and ISFR 2021[212], the following observations were made:

- In the last 10 years, from 2011 to 2020, there is an increase of 3,953.49 sq km, or 395,349 ha, in the forest cover.
- The tree cover of Kerala constituted 7.26% of the state's TGA. In the last 10 years, there is an increase of 65 sq km, or 6,500 ha, in the tree cover area of the state.
- The average growing stock in Kerala is 160.53 million cum in forest and 61.04 million cum in ToF. In the last 10 years, the average growing stock in the forest area and ToF has increased by 29.93 million cum.
- The total carbon stock of forest in the State, including the TOF patches which are more than one ha in size, is 205.52 million tonnes (753.57 $MtCO_2e$), which is 2.85% of the total forest carbon in the country.

As per the 2021 DLD Atlas of India, 422,299 ha of land, representing 10.87% of the state's TGA, is affected by various forms of desertification and land degradation. There has been an increase of 42,712 ha (1.10%) of degraded land from 2011–13 to 2018–19. The primary driver of land degradation is vegetation degradation (9.24%), followed by settlement (1.27%).[213]

Table 111: Status of desertification and land degradation from 2018–19 and 2011–13 (area in ha) in Kerala

Year	Vegetation Degradation	Water Logging	Manmade	Settlement
2018-19	359046	11989	1759	49505
2011-13	337613	11989	-	29984

Source: ISRO 2021

4.17.3 Restoration Barometer: State Contribution

4.17.3.1 Area brought under restoration

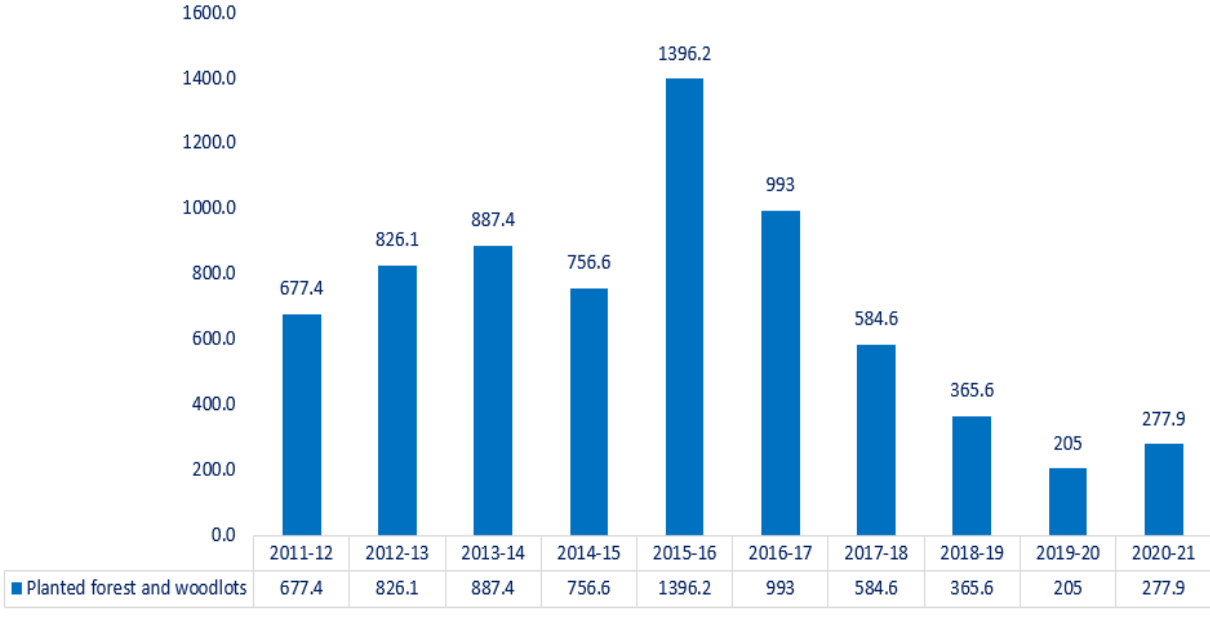


Figure 66: Area brought under restoration from 2011–2020 as reported by the State Forest Department of Kerala

[211] ISFR 2011, https://fsi.nic.in/forest-report-2011

[212] ISFR 2021, https://fsi.nic.in/forest-report-2021-details

[213] DLD Atlas of India, 2021, https://vedas.sac.gov.in/static/atlas/dsm/DLD_Atlas_SAC_2021.pdf

As of 2020, a total of 6,969.66 ha of the state's area had been brought under restoration since 2011, according to data submitted by the State Forest Department. Additionally, data from the Department of Land Resources (DoLR) indicate that 891.53 ha were restored between 2018 and 2020 by the DoLR.

Table 112: Area brought under restoration based on FLR interventions by State Forest Department of Kerala

FLR interventions implemented	Area brought under restoration (in ha)
Planted forest and woodlots	6,969.66

4.17.3.2 Climate impacts

The carbon sequestration for Kerala has been estimated for the restoration work carried out from 2011 to 2020 under different scenarios (A1 and A2) and assumptions (a1, a2, and a3). To estimate carbon sequestration, the IPCC GPG LULUCF 2003 methodology has been adopted. Kerala is classified under the Wet Season category, with an annual average rainfall of >2,000 mm. According to the IPCC GPG LULUCF 2003, the following cases of average annual increment are applicable for this level of rainfall – best case (8 tdm/ha/yr), base case (5.2 tdm/ha/yr), and worst case (2.4 tdm/ha/yr), for the estimation of carbon sequestration.[214] The detailed methodology for estimating carbon sequestration is outlined in Section 1.4.1(B) and Annex I of the report. Based on this methodology, the total carbon sequestered and the per-hectare carbon sequestration are presented in the following graph and table, respectively.

To report on carbon sequestration while accounting for mortality rates, the Base Case (a2) assumption under the two scenarios has been applied, as it represents a balanced middle ground with neither too high nor too low values (refer to the detailed methodology in Section 1.4.1(B) and Annex I).

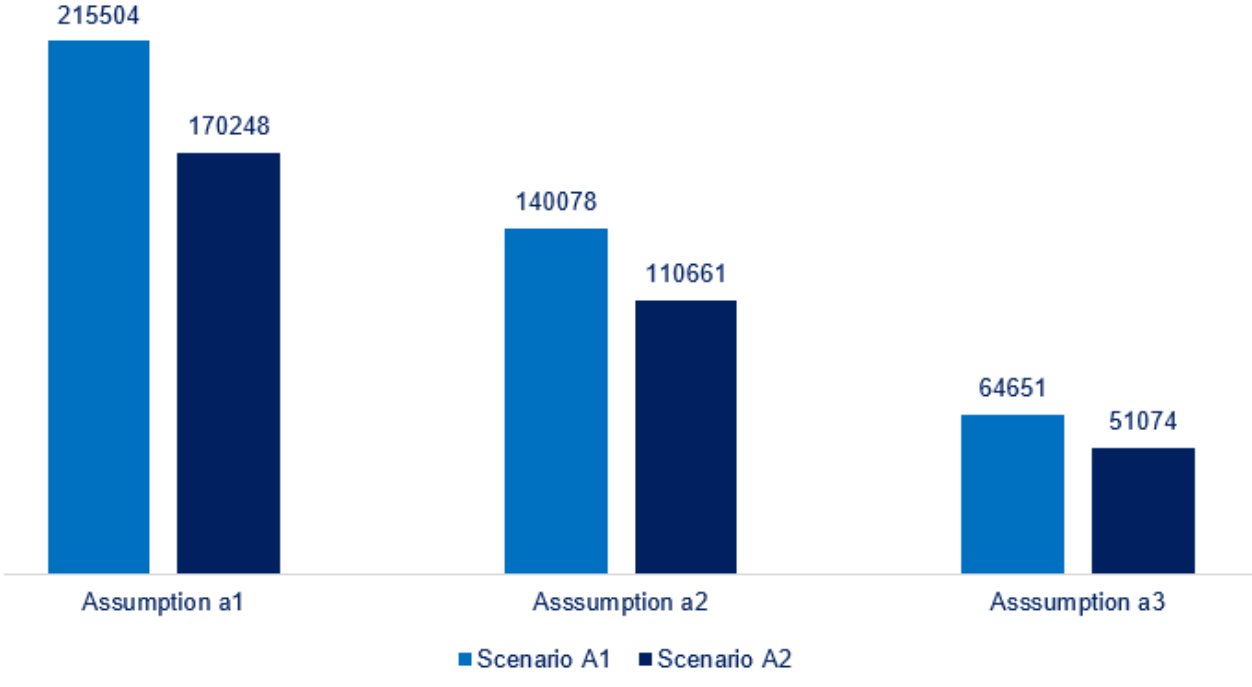


Figure 67: Total calculated tC sequestration in 10 years under two scenarios and three assumptions in Kerala

[214] GPG LULUCF table 3A.1.6 - for AGB only https://www.ipcc-nggip.iges.or.jp/public/gpglulucf/gpglulucf_files/Chp3/Anx_3A_1_Data_Tables.pdf

From 2011 to 2020, expressed as carbon, this corresponds to 0.14 million tonnes of carbon (tC) without factoring in mortality and 0.11 million tC when a mortality rate of 21%, was considered. An estimated 0.51 million tonnes of carbon dioxide (tCO_2e) were sequestered, excluding plantation mortality. When accounting for mortality, the sequestration was 0.41 million tCO_2e.[215]

Table 113: Carbon stock tC (per ha) in AGB and BGB carbon pools in area brought under restoration for different assumptions and scenarios in Kerala

Scenario	Assumption a1	Assumption a2	Assumption a3
Scenario A1	27.41	17.82	8.22
Scenario A2	21.66	14.08	6.50

4.17.3.3 Socio-economic impact

The socio-economic impact achieved has been measured in terms of man-days generated through FLR work in the state. According to SFD data for the period 2011 to 2020, a total of 0.81 million man-days of jobs were generated. This assessment accounts for the number of people involved in the implementation and maintenance of areas brought under restoration.

Table 114: Socio-economic impact (man-days generated) in Kerala

Socio-economic impact											
Year	**2011-12**	**2012-13**	**2013-14**	**2014-15**	**2015-16**	**2016-17**	**2017-18**	**2018-19**	**2019-20**	**2020-21**	**Total**
Number of man-days generated (in million)	0.06	0.08	0.08	0.09	0.21	0.12	0.08	0.04	0.03	0.02	**0.81**

4.17.3.4 Financial flow

The total financial flow towards FLR in the state has been reported as INR 45,675.28 million (USD 559.81 million).[216] Domestic public expenditure is the primary source of funding, according to data provided by the SFD for the period 2011 to 2020.

Table 115: Financial outflow from 2011–2020 in Kerala

Financial outflow											
Year	**2011-12**	**2012-13**	**2013-14**	**2014-15**	**2015-16**	**2016-17**	**2017-18**	**2018-19**	**2019-20**	**2020-21**	**Total**
FLR Funding in INR (million)	3,428.55	3,285.8	5,501.09	3,939.7	10,667.05	7,841.99	4,912.21	2,615.72	1,892.28	1,590.89	**45,675.28**

Table 116: Fund utilisation for bringing area under restoration in Kerala

Description	**Fund utilisation** (2011-12 to 2020-21)
Total area brought under restoration (ha)	6,969.66
Total fund invested in FLR activities (million INR)	45,675.28
Funds invested per hectare (million INR/ha)	6.55
Area brought under restoration per million rupees (ha/million INR)	0.15

[215] Mortality rates was not available at the time of publication of this report. Hence, law of averages was applied assigning the average mortality rate derived from mortality rates provided by 13 other States and UTs

[216] Exchange Rate - 81.59 as assessed on 01 October 2022

4.18 Lakshadweep

4.18.1 Restoration Barometer

The following table summarises the key components of the Restoration Barometer:

Table 117: Highlights of Restoration Barometer for Lakshadweep

Highlights	
Area brought under restoration (in ha)	97.67
Financial flow (in million INR)	20.50
Socio-economic impacts (man-days generated) (in million)	0.0003
Climate impacts: Estimated carbon sequestered (in million tC)	0.003 (0% Mortality)
	0.003 (21% Mortality)
Climate impacts: Estimated carbon dioxide sequestered (in million tCO_2e)	0.01 (0% Mortality)
	0.01 (21% Mortality)

4.18.2 Background

Lakshadweep, located in the Arabian Sea, is a Union Territory of India, prominent for its lush green landscape and pristine beaches. The total geographical area of the UT is 30 sq km, accounting for 0.001% of the nation's total TGA.[217] The UT consists of 36 coral islands, including 12 atolls, three reefs, and five submerged sandbanks. The average annual temperature in the UT ranges from 25°C to 35°C, while the annual rainfall varies between 1,000 mm and 2,000 mm.[218]

The UT has a population of 0.064 million, with rural and urban populations constituting 21.94% and 78.06%, respectively, of the total population. The average population density of the UT is 2,149 persons per sq km, significantly higher than the national average. According to the 19th Livestock Census of 2012, the total livestock population stands at 0.049 million.[219]

Lakshadweep's economy is primarily based on agriculture, fisheries, and tourism, with forestry-based economic activities also making a significant contribution to the region's economic growth.[220] The total forest cover of the UT is 27.10 sq km, which represents 90.33% of the UT's total area.[221]

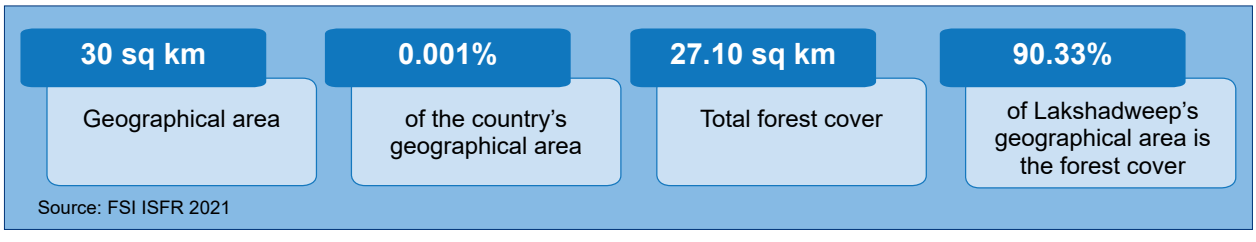


Figure 68: Geographical Area and Forest Cover of Lakshadweep

[217] ISFR 2021, https://fsi.nic.in/isfr-2021/chapter-13.pdf
[218] ISFR 2019, https://fsi.nic.in/isfr19/vol2/isfr-2019-vol-ii-lakshadweep.pdf
[219] ISFR 2019, https://fsi.nic.in/isfr19/vol2/isfr-2019-vol-ii-lakshadweep.pdf
[220] IBEF Infographics, https://www.ibef.org/states/lakshadweep-infographic
[221] ISFR 2021, https://fsi.nic.in/isfr-2021/chapter-13.pdf

As per ISFR 2011[222] and ISFR 2021[223], the following observations were made:

- In the last 10 years, from 2011 to 2020, there is an increase of 0.10 sq km, or 10 ha, in the forest cover.
- The tree cover of Lakshadweep constituted 0.17% of the UT's TGA. In the last 10 years, there is a decrease of 3.95 sq km, or 395 ha, in the tree cover area of the UT.
- The average growing stock in Lakshadweep is nil in forest and 0.05 million cum in ToF. In the last 10 years, the average growing stock in the forest area and ToF has increased by 0.001 million cum.
- The total carbon stock of forest in the UT, including the TOF patches which are more than one ha in size, is 0.21 million tonnes (0.77 $MtCO_2e$), which is 0.003% of the total forest carbon in the country.

As per the 2021 DLD Atlas of India, negligible land degradation is observed in the Union Territory of Lakshadweep. Hence, the area of this UT is included in the No Apparent Degradation (NAD) class in the DLD Atlas of India.[224]

4.18.3 Restoration Barometer: UT Contribution

4.18.3.1 Area brought under restoration

As of 2020, a total of 97.67 ha of the UT area had been brought under restoration since 2011, according to data submitted by the Forest Department.

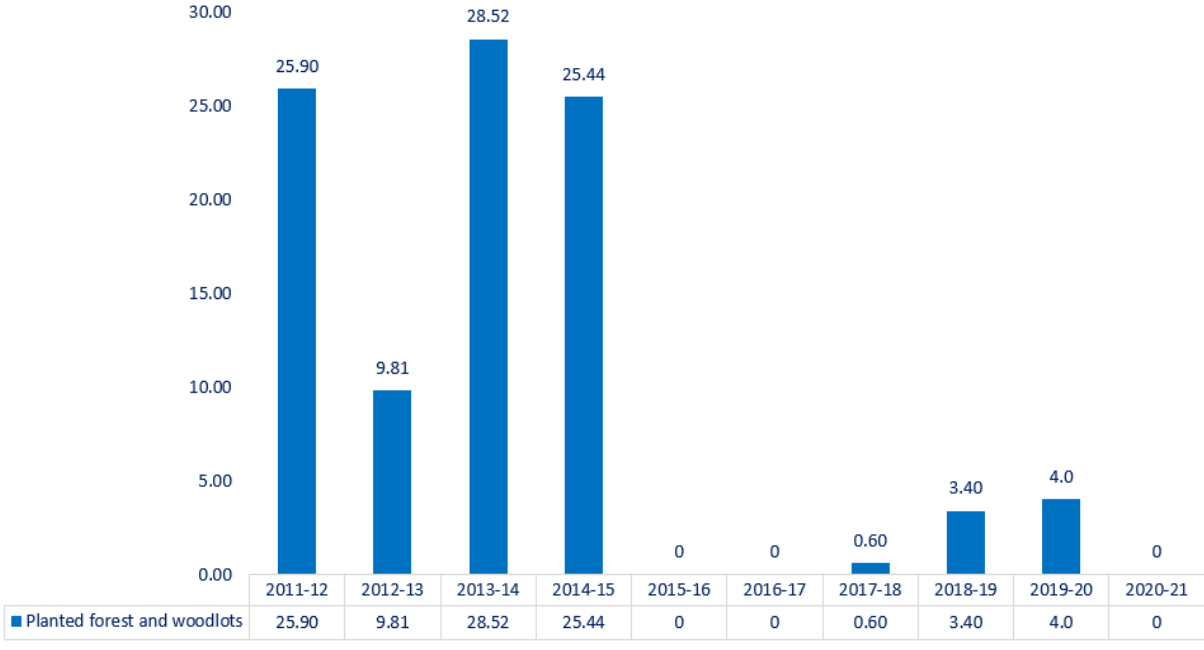


Figure 69: Area brought under restoration from 2011–2020 as reported by the State Forest Department of Lakshadweep

[222] ISFR 2011, https://fsi.nic.in/forest-report-2011

[223] ISFR 2021, https://fsi.nic.in/forest-report-2021-details

[224] DLD Atlas of India, 2021, https://vedas.sac.gov.in/static/atlas/dsm/DLD_Atlas_SAC_2021.pdf

Table 118: Area brought under restoration based on FLR interventions by FD of Lakshadweep

FLR interventions implemented	Area brought under restoration (in ha)
Planted forest and woodlots	97.67

4.18.3.2 Climate impacts

The carbon sequestration for Lakshadweep has been estimated for the restoration work carried out from 2011 to 2020 under different scenarios (A1 and A2) and assumptions (a1, a2, and a3). To estimate carbon sequestration, the IPCC GPG LULUCF 2003 methodology has been adopted. Lakshadweep is classified under the Moist with Long Dry Season category, with an annual average rainfall ranging from 1,000 mm – 2,000 mm. According to the IPCC GPG LULUCF 2003, the following cases of average annual increment are applicable for this level of rainfall – best case (12.6 tdm/ha/yr), base case (7.1 tdm/ha/yr), and worst case (1.6 tdm/ha/yr), for the estimation of carbon sequestration.[225] The detailed methodology for estimating carbon sequestration is outlined in Section 1.4.1(B) and Annex I of the report. Based on this methodology, the total carbon sequestered and the per-hectare carbon sequestration are presented in the following graph and table, respectively.

To report on carbon sequestration while accounting for mortality rates, the Base Case (a2) assumption under the two scenarios has been applied, as it represents a balanced middle ground with neither too high nor too low values (refer to the detailed methodology in Section 1.4.1(B) and Annex I).

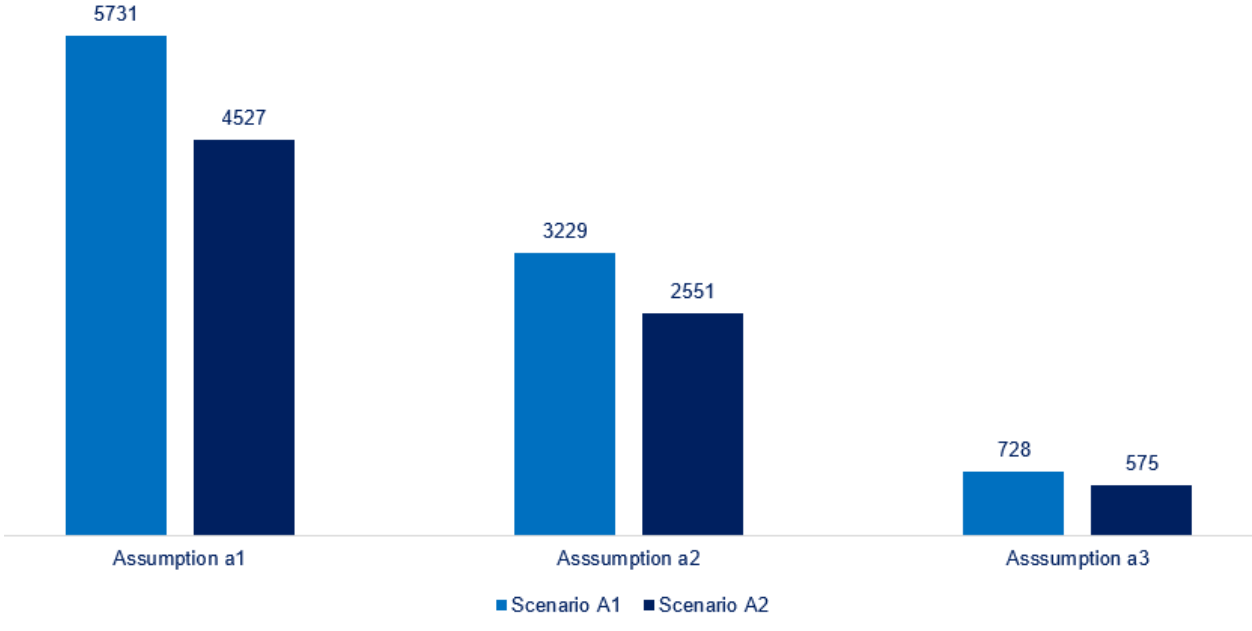


Figure 70: Total calculated tC sequestration in 10 years under two scenarios and three assumptions in Lakshadweep

[225] GPG LULUCF table 3A.1.6 - for AGB only https://www.ipcc-nggip.iges.or.jp/public/gpglulucf/gpglulucf_files/Chp3/Anx_3A_1_Data_Tables.pdf

From 2011 to 2020, expressed as carbon, this corresponds to 0.003 million tonnes of carbon (tC) without factoring in mortality and 0.003 million tC when a mortality rate of 21%, was considered. An estimated 0.01 million tonnes of carbon dioxide (tCO_2e) were sequestered, excluding plantation mortality. When accounting for mortality, the sequestration was 0.01 million tCO_2e.[226]

Table 119: Carbon stock tC (per ha) in AGB and BGB carbon pools in area brought under restoration for different assumptions and scenarios in Lakshadweep

Scenario	Assumption a1	Assumption a2	Assumption a3
Scenario A1	58.67	33.06	7.45
Scenario A2	46.35	26.12	5.89

4.18.3.3 Socio-economic impact

The socio-economic impact achieved has been measured in terms of man-days generated through FLR work in the UT. According to FD data for the period 2011 to 2020, a total of 251 (0.0003 million) man-days of jobs were generated. This assessment accounts for the number of people involved in the implementation and maintenance of areas brought under restoration.

Table 120: Socio-economic impact (man-days generated) in Lakshadweep

Socio-economic impact											
Year	**2011-12**	**2012-13**	**2013-14**	**2014-15**	**2015-16**	**2016-17**	**2017-18**	**2018-19**	**2019-20**	**2020-21**	**Total**
Number of man-days generated (in million)	0	0	0	0	0	0	0.000088	0.000088	0.000043	0.000032	**0.0003**

4.18.3.4 Financial flow

The total financial flow towards FLR in the UT has been reported as INR 20.5 million (USD 0.25 million).[227] Domestic public expenditure is the primary source of funding, according to data provided by the FD for the period 2011 to 2020.

Table 121: Financial outflow from 2011–2020 in Lakshadweep

Financial outflow											
Year	**2011-12**	**2012-13**	**2013-14**	**2014-15**	**2015-16**	**2016-17**	**2017-18**	**2018-19**	**2019-20**	**2020-21**	**Total**
FLR Funding in INR (million)	0	0	0	0	0	0	6.5	5.0	5.0	4.0	**20.50**

Table 122: Fund utilisation for bringing area under restoration in Lakshadweep

Description	**Fund utilisation** (2011-12 to 2020-21)
Total area brought under restoration (ha)	97.67
Total fund invested in FLR activities (million INR)	20.50
Funds invested per hectare (million INR/ha)	0.21
Area brought under restoration per million rupees (ha/million INR)	4.76

[226] Mortality rates was not available at the time of publication of this report. Hence, law of averages was applied assigning the average mortality rate derived from mortality rates provided by 13 other States and UTs

[227] Exchange Rate - 81.59 as assessed on 01 October 2022

4.19 Madhya Pradesh

4.19.1 Restoration Barometer

The following table summarises the key components of the Restoration Barometer:

Table 123: Highlights of Restoration Barometer for Madhya Pradesh

Highlights	
Area brought under restoration (in ha)	3,776,593.85
Financial flow (in million INR)	70,515.40
Socio-economic impacts (man-days generated) (in million)	134.21
Climate impacts: Estimated carbon sequestered (in million tC)	96.22 (0% Mortality)
	57.73 (40% Mortality)
Climate impacts: Estimated carbon dioxide sequestered (in million tCO_2e)	353.14 (0% Mortality)
	211.88 (40% Mortality)

4.19.2 Background

Madhya Pradesh, located in central India, is the second-largest state in the country. The state is known for its historical sites, serene lakes, and waterfalls. The total geographical area of the state is 308,252 sq km, which accounts for 9.38% of the nation's total TGA.[228] The state experiences a sub-tropical climate, characterised by hot summers and cold winters, with the average annual temperature ranging from 22°C to 25°C. The annual rainfall varies between 800 mm and 1,800 mm.[229]

The state has a population of 72.63 million, which constitutes 6.0% of India's total population. The rural and urban populations represent 72.37% and 27.63%, respectively, of the state's total population. The average population density of the state is 236 persons per sq km, which is lower than the national average. According to the 19th Livestock Census of 2012, the total livestock population is 36.33 million.[230] Madhya Pradesh's economy is primarily driven by the agricultural sector, which is the main contributor. Additionally, the forestry sector plays a significant role in the state's economy. Mining and services contribute to the secondary and tertiary sectors, respectively.[231] The total forest cover of the state is 77,492.60 sq km, which represents 25.14% of the state's total area.[232]

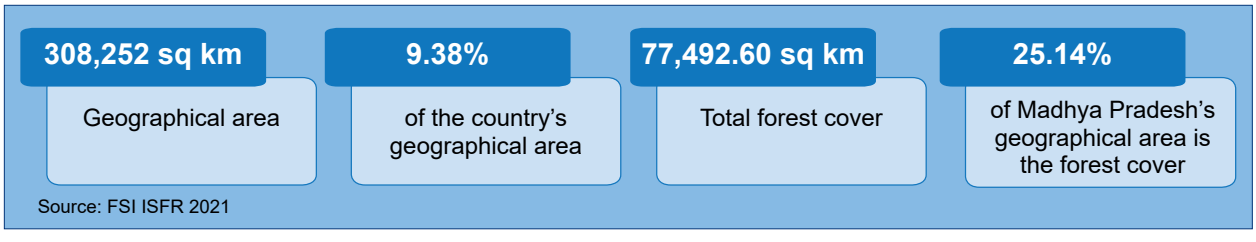


Figure 71: Geographical Area and Forest Cover of Madhya Pradesh

[228] ISFR 2021, https://fsi.nic.in/isfr-2021/chapter-13.pdf
[229] ISFR 2019, https://fsi.nic.in/isfr19/vol2/isfr-2019-vol-ii-madhya-pradesh.pdf
[230] ISFR 2019, https://fsi.nic.in/isfr19/vol2/isfr-2019-vol-ii-madhya-pradesh.pdf
[231] IBEF Infographics, https://www.ibef.org/states/madhya-pradesh-infographic
[232] ISFR 2021, https://fsi.nic.in/isfr-2021/chapter-13.pdf

As per ISFR 2011[233] and ISFR 2021[234], the following observations were made:

- In the last 10 years, from 2011 to 2020, there is an increase of 207.40 sq km, or 20,740 ha, in the forest cover.
- The tree cover of Madhya Pradesh constituted 2.61% of the state's TGA. In the last 10 years, there is an increase of 964 sq km, or 96,400 ha, in the tree cover area of the state.
- The average growing stock in Madhya Pradesh is 374.44 million cum in forest and 118.05 million cum in ToF. In the last 10 years, the average growing stock in the forest area and ToF has increased by 157.72 million cum.
- The total carbon stock of forest in the State, including the TOF patches which are more than one ha in size, is 609.25 million tonnes (2,233.92 $MtCO_2e$), which is 8.46% of the total forest carbon in the country.

As per the 2021 DLD Atlas of India, 3,859,735 ha of land, representing 12.52% of the state's TGA, is affected by various forms of desertification and land degradation. There has been an increase of 55,420 ha (0.18%) of degraded land from 2011–13 to 2018–19. The primary driver of land degradation is vegetation degradation (8.23%), followed by water erosion (3.66%).[235]

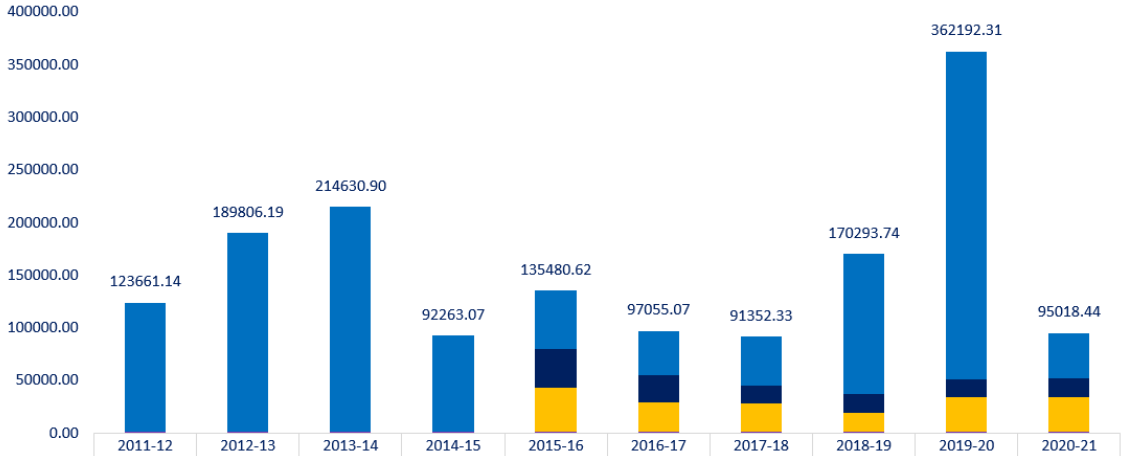
Table 124: Status of desertification and land degradation from 2018–19 and 2011–13 (area in ha) in Madhya Pradesh

Year	Vegetation Degradation	Water Erosion	Salinity	Water Logging	Manmade	Barren/ Rocky	Settlement
2018-19	2,537,442	1,129,718	6,854	7,788	42,018	30,873	105,043
2011-13	2,523,801	1,125,418	-	7,788	19,454	31,495	96,359

Source: ISRO 2021

4.19.3 Restoration Barometer: State Contribution

4.19.3.1 Area brought under restoration



	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20	2020-21
Planted forest and woodlots	122879.58	188968.32	213749.66	91412.51	55793.49	42150.89	46253.42	133584.32	310945.27	42831.33
Natural regeneration	0.00	0.00	0.00	0.00	36355.34	25617.63	17208.30	17623.67	17623.67	17841.40
Silviculture	0.00	0.00	0.00	0.00	42440.23	28424.99	26961.17	17847.19	32111.81	33396.68
Mangrove restoration	0.00	56.31	99.68	69.00	110.00	80.00	147.88	457.00	730.00	167.47
Others	781.56	781.56	781.56	781.56	781.56	781.56	781.56	781.56	781.56	781.56
Total	123661.14	189806.19	214630.90	92263.07	135480.62	97055.07	91352.33	170293.74	362192.31	95018.44

Figure 72: Area brought under restoration from 2011–2020 as reported by SFD of Madhya Pradesh

[233] ISFR 2011, https://fsi.nic.in/forest-report-2011

[234] ISFR 2021, https://fsi.nic.in/forest-report-2021-details

[235] DLD Atlas of India, 2021, https://vedas.sac.gov.in/static/atlas/dsm/DLD_Atlas_SAC_2021.pdf

As of 2020, a total of 3,776,577.65 ha of the state's area had been brought under restoration since 2011, according to data submitted by the State Forest Department. Additionally, data from the Department of Land Resources (DoLR) indicate that 16.20 ha were restored between 2018 and 2020 by the DoLR.

Table 125: Area brought under restoration based on FLR interventions by SFD of Madhya Pradesh

FLR interventions implemented	Area brought under restoration (in ha)
Planted forest and woodlots	2,047,650.09
Natural regeneration	1,726,906.56
Agroforestry	2,021

4.19.3.2 Climate impacts

The carbon sequestration for Madhya Pradesh has been estimated for the restoration work carried out from 2011 to 2020 under different scenarios (A1 and A2) and assumptions (a1, a2, and a3). To estimate carbon sequestration, the IPCC GPG LULUCF 2003 methodology has been adopted. Madhya Pradesh is classified under the Moist with Long Dry Season category, with an annual average rainfall ranging from 1,000 mm – 2,000 mm. According to the IPCC GPG LULUCF 2003, the following cases of average annual increment are applicable for this level of rainfall – best case (12.6 tdm/ha/yr), base case (7.1 tdm/ha/yr), and worst case (1.6 tdm/ha/yr), for the estimation of carbon sequestration.[236] The detailed methodology for estimating carbon sequestration is outlined in Section 1.4.1(B) and Annex I of the report. Based on this methodology, the total carbon sequestered and the per-hectare carbon sequestration are presented in the following graph and table, respectively.

To report on carbon sequestration while accounting for mortality rates, the Base Case (a2) assumption under the two scenarios has been applied, as it represents a balanced middle ground with neither too high nor too low values (refer to the detailed methodology in Section 1.4.1(B) and Annex I).

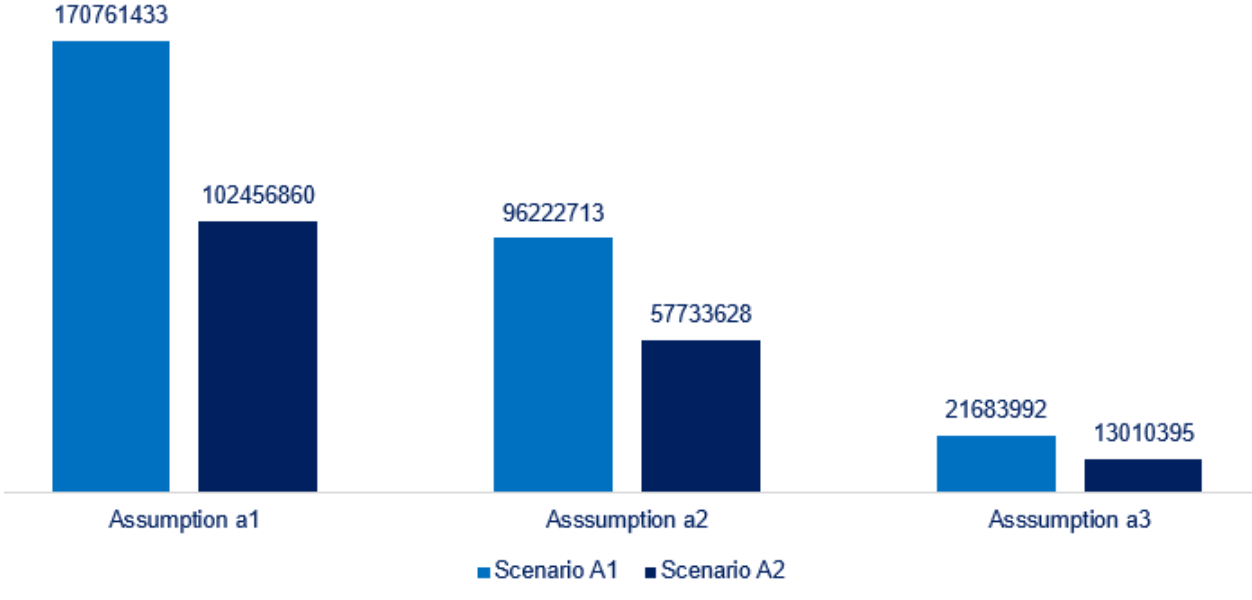


Figure 73: Total calculated tC sequestration in 10 years under two scenarios and three assumptions in Madhya Pradesh

[236] GPG LULUCF table 3A.1.6 - for AGB only https://www.ipcc-nggip.iges.or.jp/public/gpglulucf/gpglulucf_files/Chp3/Anx_3A_1_Data_Tables.pdf

From 2011 to 2020, expressed as carbon, this corresponds to 96.22 million tonnes of carbon (tC) without factoring in mortality and 57.73 million tC when a mortality rate of 40%, was considered. An estimated 353.14 million tonnes of carbon dioxide (tCO_2e) were sequestered, excluding plantation mortality. When accounting for mortality, the sequestration was 211.88 million tCO_2e.[237]

Table 126: Carbon stock tC (per ha) in AGB and BGB carbon pools in area brought under restoration for different assumptions and scenarios in Madhya Pradesh

Scenario	Assumption a1	Assumption a2	Assumption a3
Scenario A1	45.22	25.48	5.74
Scenario A2	27.13	15.29	3.45

4.19.3.3 Socio-economic impact

The socio-economic impact achieved has been measured in terms of man-days generated through FLR work in the state. According to SFD data for the period 2011 to 2020, a total of 134.21 million man-days of jobs were generated. This assessment accounts for the number of people involved in the implementation and maintenance of areas brought under restoration.

Table 127: Socio-economic impact (man-days generated) in Madhya Pradesh

Socio-economic impact											
Year	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20	2020-21	Total
Number of man-days generated (in million)	8.31	7.91	11.02	15.83	14.17	15.07	14.70	14.31	17.63	15.26	**134.21**

4.19.3.4 Financial flow

The total financial flow towards FLR in the state has been reported as INR 70,515.40 million (USD 852.01 million).[238] Domestic public expenditure is the primary source of funding, according to data provided by the SFD for the period 2011 to 2020.

Table 128: Financial outflow from 2011–2020 in Madhya Pradesh

Financial outflow											
Year	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20	2020-21	Total
FLR Funding in INR (million)	1,763.7	1,889.3	2,811.3	4,278.8	3,962.7	4,755.3	4,118.6	3,578.7	5,445.9	37,911.1	**70,515.40**

Table 129: Fund utilisation for bringing area under restoration in Madhya Pradesh

Description	**Fund utilisation** (2011-12 to 2020-21)
Total area brought under restoration (ha)	3,776,577.65
Total fund invested in FLR activities (million INR)	70,515.40
Funds invested per hectare (million INR/ha)	0.02
Area brought under restoration per million rupees (ha/million INR)	53.56

[237] Mortality rates was not available at the time of publication of this report. Hence, law of averages was applied assigning the average mortality rate derived from mortality rates provided by 13 other States and UTs

[238] Exchange Rate - 81.59 as assessed on 01 October 2022

4.20 Maharashtra

4.20.1 Restoration Barometer

The following table summarises the key components of the Restoration Barometer:

Table 130: Highlights of Restoration Barometer for Maharashtra

Highlights	
Area brought under restoration (in ha)	1,573,540.47
Financial flow (in million INR)	41,888.68
Socio-economic impacts (man-days generated) (in million)	18.56
Climate impacts: Estimated carbon sequestered (in million tC)	38.06 (0% Mortality)
	26.64 (30% Mortality)
Climate impacts: Estimated carbon dioxide sequestered (in million tCO_2e)	139.67 (0% Mortality)
	97.77 (30% Mortality)

4.20.2 Background

Maharashtra is the third-largest state in India, with an area of 307,713 sq km, which accounts for 9.36% of the country's TGA.[239] Maharashtra is the second most populous state in India and is located in the western peninsular region, occupying a significant portion of the Deccan Plateau. The state experiences a typical tropical climate, with the annual temperature varying from 25°C to 27°C. The annual rainfall varies between 400 mm and 6,000 mm.[240]

The state has a population of 112.37 million, which constitutes 9.28% of India's total population. The rural and urban populations represent 54.78% and 45.22%, respectively, of the state's total population. The tribal population constitutes 9.35% of the state's total population. The average population density of the state is 365 persons per sq km, which is slightly less than the national average. According to the 19th Livestock Census of 2012, the total livestock population is 32.48 million.[241] Maharashtra's GDP is primarily driven by the tertiary sector, which includes financial services and entertainment, forming the backbone of the state's economy. This is followed by the secondary sector, with key contributions from automobiles, textiles, and chemicals. In the primary sector, agriculture leads, supported by forestry and fishing activities, in driving economic growth.[242] The total forest cover of the state is 50,797.76 sq km, which represents 16.51% of the state's total area.[243]

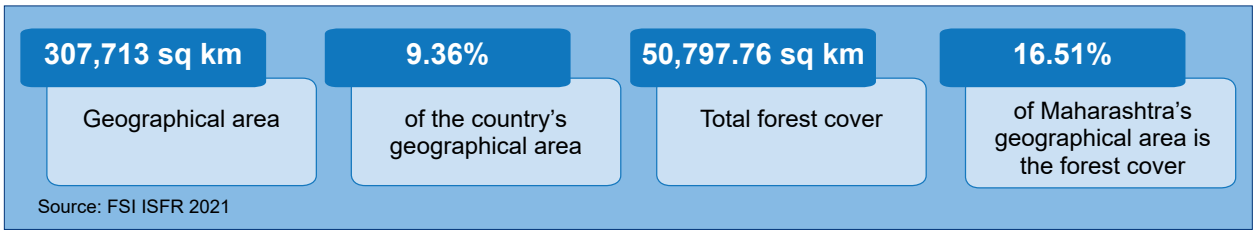


Figure 74: Geographical Area and Forest Cover of Maharashtra

[239] ISFR 2021, https://fsi.nic.in/isfr-2021/chapter-13.pdf
[240] ISFR 2019, https://fsi.nic.in/isfr19/vol2/isfr-2019-vol-ii-maharashtra.pdf
[241] ISFR 2019, https://fsi.nic.in/isfr19/vol2/isfr-2019-vol-ii-maharashtra.pdf
[242] IBEF Infographics, https://www.ibef.org/states/maharashtra-infographic
[243] ISFR 2021, https://fsi.nic.in/isfr-2021/chapter-13.pdf

As per ISFR 2011[244] and ISFR 2021[245], the following observations were made:

- In the last 10 years, from 2011 to 2020, there is an increase of 151.76 sq km, or 15,176 ha, in the forest cover.
- The tree cover of Maharashtra constituted 3.93% of the state's TGA. In the last 10 years, there is an increase of 3,029 sq km, or 302,900 ha, in the tree cover area of the state.
- The average growing stock in Maharashtra is 235.50 million cum in forest and 157.69 million cum in ToF. In the last 10 years, the average growing stock in the forest area decreased by 58.17 million cum while increased for ToF by 40.66 million cum.
- The total carbon stock of forest in the State, including the TOF patches which are more than one ha in size, is 451.61 million tonnes (1,655.90 $MtCO_2e$), which is 6.27% of the total forest carbon in the country.

As per the 2021 DLD Atlas of India, 14,306,029 ha of land, representing 46.49% of the state's TGA, is affected by various forms of desertification and land degradation. There has been an increase of 480,094 ha (1.56%) of degraded land from 2011–13 to 2018–19. The primary driver of land degradation is water erosion (26.70%), followed by vegetation degradation (16.71%).[246]

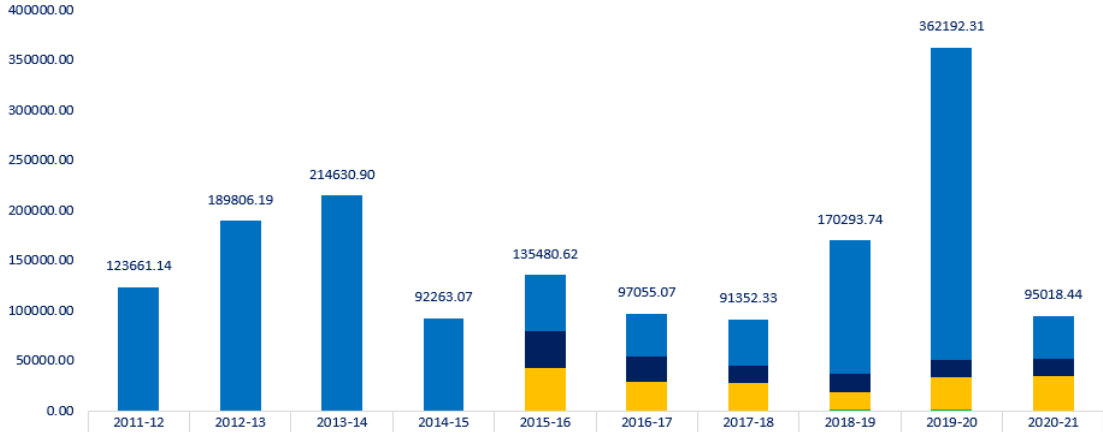
Table 131: Status of desertification and land degradation from 2018–19 and 2011–13 (area in ha) in Maharashtra

Year	Vegetation Degradation	Water Erosion	Salinity	Manmade	Barren/Rocky	Settlement
2018-19	5,142,353	8,217,047	28,713	49,022	497,661	371,234
2011-13	4,884,005	8,060,753	29,089	19,912	506,163	326,013

Source: ISRO 2021

4.20.3 Restoration Barometer: State Contribution

4.20.3.1 Area brought under restoration



	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20	2020-21
Planted forest and woodlots	122879.58	188968.32	213749.66	91412.51	55793.49	42150.89	46253.42	133584.32	310945.27	42831.33
Natural Regeneration	0.00	0.00	0.00	0.00	36355.34	25617.63	17208.30	17623.67	17623.67	17841.40
Silviculture	0.00	0.00	0.00	0.00	42440.23	28424.99	26961.17	17847.19	32111.81	33396.68
Mangrove	0.00	56.31	99.68	69.00	110.00	80.00	147.88	457.00	730.00	167.47
Others	781.56	781.56	781.56	781.56	781.56	781.56	781.56	781.56	781.56	781.56
Total	123661.14	189806.19	214630.90	92263.07	135480.62	97055.07	91352.33	170293.74	362192.31	95018.44

Figure 75: Area brought under restoration from 2011–2020 as reported by SFD of Maharashtra

[244] ISFR 2011, https://fsi.nic.in/forest-report-2011

[245] ISFR 2021, https://fsi.nic.in/forest-report-2021-details

[246] DLD Atlas of India, 2021, https://vedas.sac.gov.in/static/atlas/dsm/DLD_Atlas_SAC_2021.pdf

As of 2020, a total of 1,571,753.81 ha of the state's area had been brought under restoration since 2011, according to data submitted by the State Forest Department. Additionally, data from the Department of Land Resources (DoLR) indicate that 1,786.66 ha were restored between 2018 and 2020 by the DoLR.

Table 132: Area brought under restoration based on FLR interventions by SFD of Maharashtra

FLR interventions implemented	Area brought under restoration (in ha)
Planted forest and woodlots	1,248,568.79
Natural regeneration	132,270.01
Silviculture	181,182.07
Mangrove restoration	1,917.34
Others	7,815.60

4.20.3.2 Climate impacts

The carbon sequestration for Maharashtra has been estimated for the restoration work carried out from 2011 to 2020 under different scenarios (A1 and A2) and assumptions (a1, a2, and a3). To estimate carbon sequestration, the IPCC GPG LULUCF 2003 methodology has been adopted. Maharashtra is classified under the Moist with Short Dry Season category, with an annual average rainfall ranging from 1,000 mm – 2,000 mm. According to the IPCC GPG LULUCF 2003, the following cases of average annual increment are applicable for this level of rainfall – best case (13.5 tdm/ha/yr), base case (7.8 tdm/ha/yr), and worst case (2.0 tdm/ha/yr), for the estimation of carbon sequestration.[247] The detailed methodology for estimating carbon sequestration is outlined in Section 1.4.1(B) and Annex I of the report. Based on this methodology, the total carbon sequestered and the per-hectare carbon sequestration are presented in the following graph and table, respectively.

To report on carbon sequestration while accounting for mortality rates, the Base Case (a2) assumption under the two scenarios has been applied, as it represents a balanced middle ground with neither too high nor too low values (refer to the detailed methodology in Section 1.4.1(B) and Annex I).

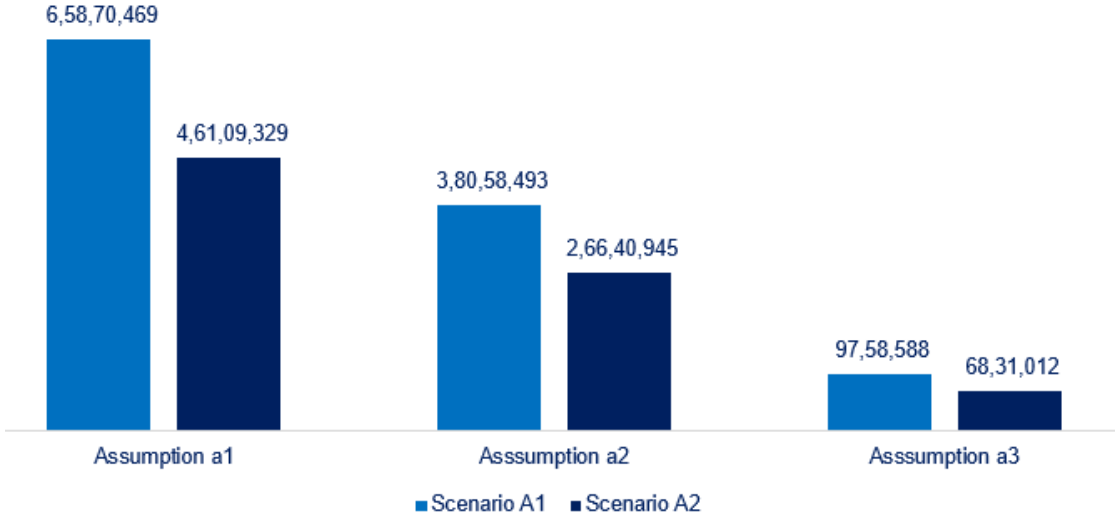


Figure 76: Total calculated tC sequestration in 10 years under two scenarios and three assumptions in Maharashtra

[247] GPG LULUCF table 3A.1.6 - for AGB only https://www.ipcc-nggip.iges.or.jp/public/gpglulucf/gpglulucf_files/Chp3/Anx_3A_1_Data_Tables.pdf

From 2011 to 2020, expressed as carbon, this corresponds to 38.06 million tonnes of carbon (tC) without factoring in mortality and 26.64 million tC when a mortality rate of 30%, was considered. An estimated 139.67 million tonnes of carbon dioxide (tCO_2e) were sequestered, excluding plantation mortality. When accounting for mortality, the sequestration was 97.77 million tCO_2e.[248]

Table 133: Carbon stock tC (per ha) in AGB and BGB carbon pools in area brought under restoration for different assumptions and scenarios in Maharashtra

Scenario	Assumption a1	Assumption a2	Assumption a3
Scenario A1	41.86	24.19	6.20
Scenario A2	29.30	16.93	4.34

4.20.3.3 Socio-economic impact

The socio-economic impact achieved has been measured in terms of man-days generated through FLR work in the state. According to SFD data for the period 2011 to 2020, a total of 18.56 million man-days of jobs were generated. This assessment accounts for the number of people involved in the implementation and maintenance of areas brought under restoration.

Table 134: Socio-economic impact (man-days generated) in Maharashtra

Socio-economic impact											
Year	**2011-12**	**2012-13**	**2013-14**	**2014-15**	**2015-16**	**2016-17**	**2017-18**	**2018-19**	**2019-20**	**2020-21**	**Total**
Number of man-days generated (in million)	0.44	0.65	0.52	0.36	2.73	2.03	3.22	4.47	2.21	1.93	**18.56**

4.20.3.4 Financial flow

The total financial flow towards FLR in the state has been reported as INR 41,888.68 million (USD 488.25 million).[249] Domestic public expenditure is the primary source of funding, according to data provided by the SFD for the period 2011 to 2020.

Table 135: Financial outflow from 2011–2020 in Maharashtra

Financial outflow											
Year	**2011-12**	**2012-13**	**2013-14**	**2014-15**	**2015-16**	**2016-17**	**2017-18**	**2018-19**	**2019-20**	**2020-21**	**Total**
FLR Funding in INR (million)	915.94	1,493.33	1,311.40	1,331.35	1,828.19	1,458.51	5,947.03	1,1005.10	15,947.83	650	**41,888.68**

Table 136: Fund utilisation for bringing area under restoration in Maharashtra

Description	**Fund utilisation** (2011-12 to 2020-21)
Total area brought under restoration (ha)	1,571,753.81
Total fund invested in FLR activities (million INR)	41,888.68
Funds invested per hectare (million INR/ha)	0.03
Area brought under restoration per million rupees (ha/million INR)	37.52

[248] Mortality rates was not available at the time of publication of this report. Hence, law of averages was applied assigning the average mortality rate derived from mortality rates provided by 13 other States and UTs

[249] Exchange Rate - 81.59 as assessed on 01 October 2022

4.21 Manipur

4.21.1 Restoration Barometer

The following table summarises the key components of the Restoration Barometer:

Table 137: Highlights of Restoration Barometer for Manipur

Highlights	
Area brought under restoration (in ha)	104,040.49
Financial flow (in million INR)	4,008.40
Socio-economic impacts (man-days generated) (in million)	8.80
Climate impacts: Estimated carbon sequestered (in million tC)	3.39 (0% Mortality)
	2.68 (21% Mortality)
Climate impacts: Estimated carbon dioxide sequestered (in million tCO_2e)	12.43 (0% Mortality)
	9.82 (21% Mortality)

4.21.2 Background

Manipur, located in the northeast of India, is a hilly state and one of the seven sister states. The state is famous for its rich culture and traditions, and scenic landscapes. The total geographical area of the state is 22,327 sq km, which accounts for 0.68% of the country's TGA.[250] The state experiences a tropical climate, with the average annual temperature ranging from 14.5°C to 38°C. The average annual rainfall varies between 1,200 mm and 2,700 mm.[251]

The state has a population of 2.86 million, which constitutes 0.24% of India's total population. The rural and urban populations represent 70.79 mm% and 29.21%, respectively, of the state total population. The average population density of the state is 115 persons per sq km, which is less than the national average. According to the 19th Livestock Census of 2012, the total livestock population is 0.70 million.[252] Manipur's economy is largely driven by the tertiary sector, with services being the main contributor. The primary sector, led by agriculture and forestry, makes a significant contribution to the economy, although it is smaller in comparison to the tertiary sector. The secondary sector, primarily driven by handicrafts and textiles, also contributes, but to a lesser extent.[253] The total forest cover of the state is 16,598.27 sq km, which represents 74.34% of the state's total area.[254]

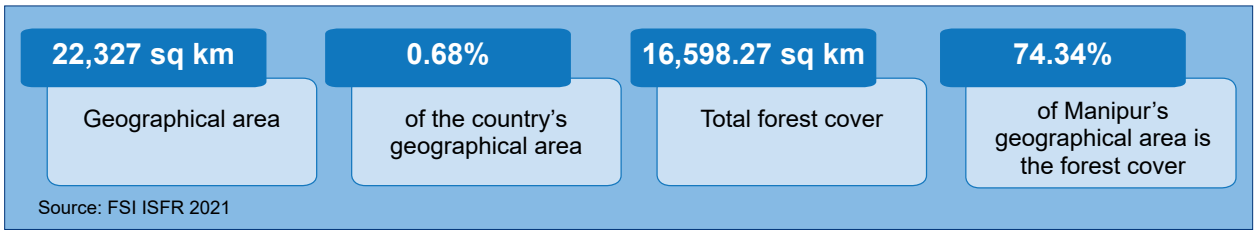


Figure 77: Geographical Area and Forest Cover of Manipur

[250] ISFR 2021, https://fsi.nic.in/isfr-2021/chapter-13.pdf
[251] ISFR 2019, https://fsi.nic.in/isfr19/vol2/isfr-2019-vol-ii-manipur.pdf
[252] ISFR 2019, https://fsi.nic.in/isfr19/vol2/isfr-2019-vol-ii-manipur.pdf
[253] IBEF Infographics, https://www.ibef.org/states/manipur-infographic
[254] ISFR 2021, https://fsi.nic.in/isfr-2021/chapter-13.pdf

As per ISFR 2011[255] and ISFR 2021[256], the following observations were made:

- In the last 10 years, from 2011 to 2020, there is an increase of 491.73 sq km, or 49,173 ha, in the forest cover.
- The tree cover of Manipur constituted 0.76% of the state's TGA. In the last 10 years, there is a decrease of 24 sq km, or 2,400 ha, in the tree cover area of the state.
- The average growing stock in Manipur is 54.99 million cum in forest and 5.10 million cum in ToF. In the last 10 years, the average growing stock in the forest area and ToF has increased by 21.48 million cum.
- The total carbon stock of forest in the State, including the TOF patches which are more than one ha in size, is 176.93 million tonnes (648.74 $MtCO_2e$), which is 2.46% of the total forest carbon in the country.

As per the 2021 DLD Atlas of India, 612,566 ha of land, representing 27.44% of the state's TGA, is affected by various forms of desertification and land degradation. There has been an increase of 10,607 ha (0.52%) of degraded land from 2011–13 to 2018–19. The primary driver of land degradation is vegetation degradation (26.17%), followed by settlement (0.68%).[257]

Table 138: Status of desertification and land degradation from 2018–19 and 2011–13 (area in ha) in Manipur

Year	Vegetation Degradation	Water Erosion	Water Logging	Settlement
2018-19	584,394	8,070	5,026	15,075
2011-13	575,603	8,070	5,026	13,260

Source: ISRO 2021

4.21.3 Restoration Barometer: State Contribution

4.21.3.1 Area brought under restoration

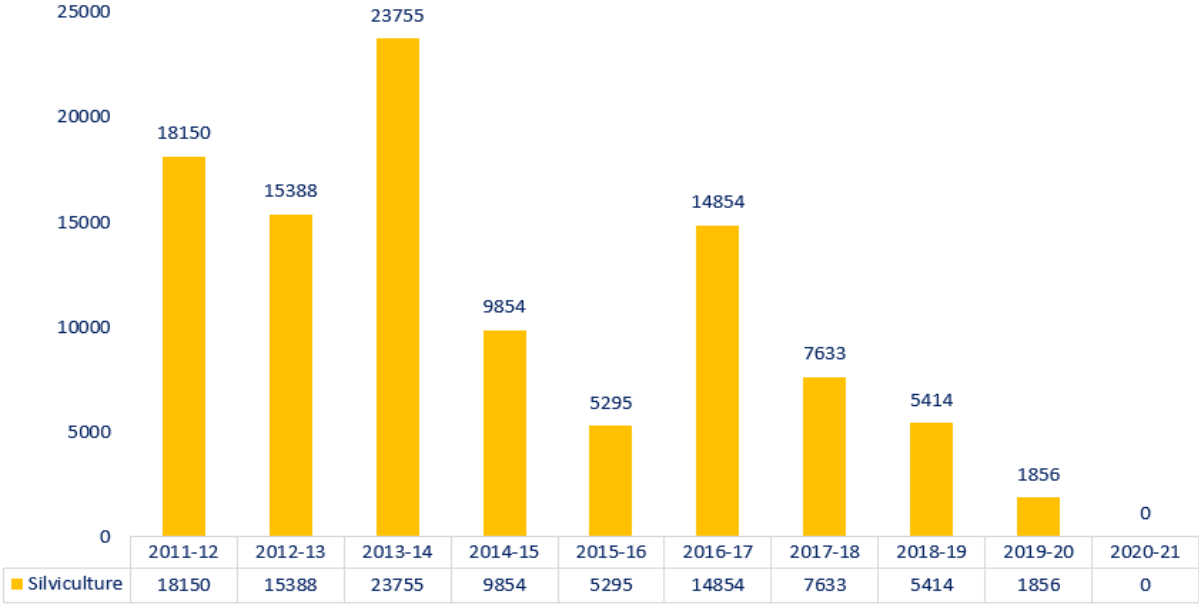


Figure 78: Area brought under restoration from 2011–2020 as reported by SFD of Manipur

[255] ISFR 2011, https://fsi.nic.in/forest-report-2011

[256] ISFR 2021, https://fsi.nic.in/forest-report-2021-details

[257] DLD Atlas of India, 2021, https://vedas.sac.gov.in/static/atlas/dsm/DLD_Atlas_SAC_2021.pdf

As of 2020, a total of 102,199 ha of the state's area had been brought under restoration since 2011, according to data submitted by the State Forest Department. Additionally, data from the Department of Land Resources (DoLR) indicates that 1,841.49 ha were restored between 2018 and 2020 by the DoLR.

Table 139: Area brought under restoration based on FLR interventions by SFD of Manipur

FLR interventions implemented	Area brought under restoration (in ha)
Silviculture	102,199

4.21.3.2 Climate impacts

The carbon sequestration for Manipur has been estimated for the restoration work carried out from 2011 to 2020 under different scenarios (A1 and A2) and assumptions (a1, a2, and a3). To estimate carbon sequestration, the IPCC GPG LULUCF 2003 methodology has been adopted. Manipur is classified under the Moist with Short Dry Season category, with an annual average rainfall ranging from 1,000 mm – 2,000 mm. According to the IPCC GPG LULUCF 2003, the following cases of average annual increment are applicable for this level of rainfall – best case (13.5 tdm/ha/yr), base case (7.8 tdm/ha/yr), and worst case (2.0 tdm/ha/yr), for the estimation of carbon sequestration.[258]

The detailed methodology for estimating carbon sequestration is outlined in Section 1.4.1(B) and Annex I of the report. Based on this methodology, the total carbon sequestered and the per-hectare carbon sequestration are presented in the following graph and table, respectively.

To report on carbon sequestration while accounting for mortality rates, the Base Case (a2) assumption under the two scenarios has been applied, as it represents a balanced middle ground with neither too high nor too low values (refer to the detailed methodology in Section 1.4.1(B) and Annex I).

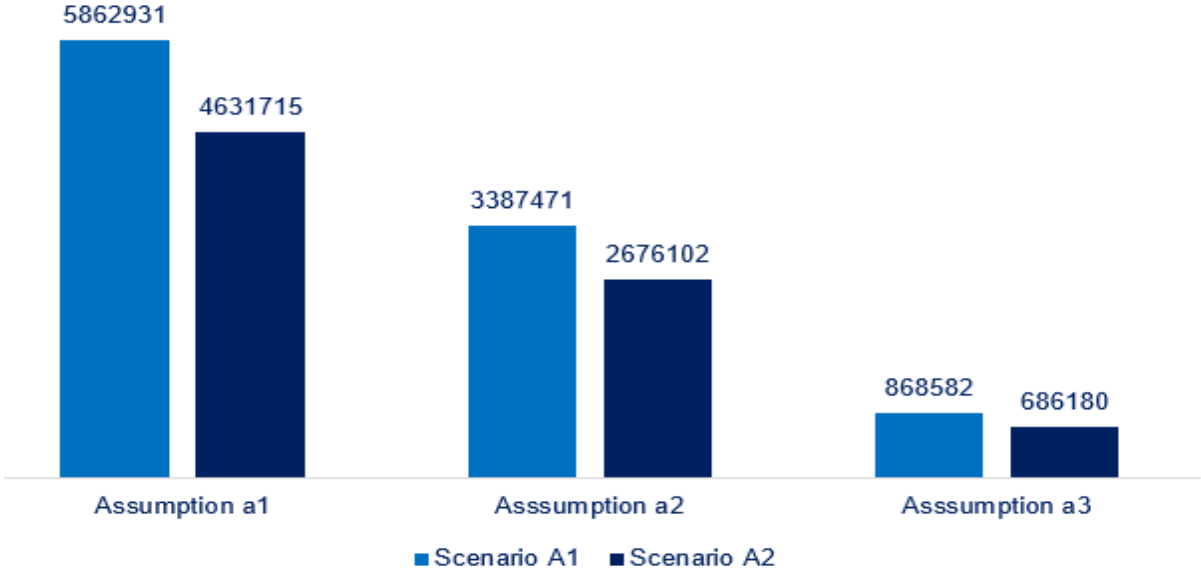


Figure 79: Total calculated tC sequestration in 10 years under two scenarios and three assumptions in Manipur

[258] GPG LULUCF table 3A.1.6 - for AGB only https://www.ipcc-nggip.iges.or.jp/public/gpglulucf/gpglulucf_files/Chp3/Anx_3A_1_Data_Tables.pdf

From 2011 to 2020, expressed as carbon, this corresponds to 3.39 million tonnes of carbon (tC) without factoring in mortality and 2.68 million tC when a mortality rate of 21%, was considered. An estimated 12.43 million tonnes of carbon dioxide (tCO_2e) were sequestered, excluding plantation mortality. When accounting for mortality, the sequestration was 9.82 million tCO_2e.[259]

Table 140: Carbon stock tC (per ha) in AGB and BGB carbon pools in area brought under restoration for different assumptions and scenarios in Manipur

Scenario	Assumption a1	Assumption a2	Assumption a3
Scenario A1	56.35	32.56	8.35
Scenario A2	44.52	25.72	6.60

4.21.3.3 Socio-economic impact

The socio-economic impact achieved has been measured in terms of man-days generated through FLR work in the state. According to SFD data for the period 2011 to 2020, a total of 0.88 million man-days of jobs were generated. This assessment accounts for the number of people involved in the implementation and maintenance of areas brought under restoration.

Table 141: Socio-economic impact (man-days generated) in Dadra & Nagar Haveli and Daman & Diu

Socio-economic impact		
Year	**2011-12 to 2020-21**	**Total**
Number of man-days generated (in million)	0.88	0.88

4.21.3.4 Financial flow

The total financial flow towards FLR in the state has been reported as INR 4,008.4 million (USD 49.13 million).[260] Domestic public expenditure is the primary source of funding, according to data provided by the SFD for the period 2011 to 2020.

Table 142: Financial outflow from 2011–2020 in Manipur

Financial outflow											
Year	**2011-12**	**2012-13**	**2013-14**	**2014-15**	**2015-16**	**2016-17**	**2017-18**	**2018-19**	**2019-20**	**2020-21**	**Total**
FLR Funding in INR (million)	476.8	772.2	302	264.8	425.6	297	434.2	461.2	574.6	-	**4,008.40**

Table 143: Fund utilisation for bringing area under restoration in Manipur

Description	**Fund utilisation** (2011-12 to 2020-21)
Total area brought under restoration (ha)	102,199
Total fund invested in FLR activities (million INR)	4,008.40
Funds invested per hectare (million INR/ha)	0.04
Area brought under restoration per million rupees (ha/million INR)	25.50

[259] Mortality rates was not available at the time of publication of this report. Hence, law of averages was applied assigning the average mortality rate derived from mortality rates provided by 13 other States and UTs

[260] Exchange Rate - 81.59 as assessed on 01 October 2022

4.22 Meghalaya

4.22.1 Restoration Barometer

The following table summarises the key components of the Restoration Barometer:

Table 144: Highlights of Restoration Barometer for Meghalaya

Highlights	
Area brought under restoration (in ha)	32,793.01
Financial flow (in million INR)	24,635.70
Socio-economic impacts (man-days generated) (in million)	5.97
Climate impacts: Estimated carbon sequestered (in million tC)	0.72 (0% Mortality)
	0.57 (21% Mortality)
Climate impacts: Estimated carbon dioxide sequestered (in million tCO_2e)	2.63 (0% Mortality)
	2.07 (21% Mortality)

4.22.2 Background

Meghalaya is one of the seven sister states of northeast India. The state is known for its high rainfall, subtropical forests, and biodiversity. The two highest rainfall spots in the world, Cherrapunjee and Mawsynram, are located in Meghalaya. The total geographical area of the state is 22,429 sq km, which accounts for 0.68% of the country's TGA.[261] The western part of the state is warmer, with the mean temperature ranging between 12°C and 33°C. The central upland is relatively cooler, with the mean temperature ranging between 2°C and 24°C. The average annual rainfall varies between 4,000 mm and 11,500 mm.[262]

The state has a population of 2.96 million, which constitutes 0.24% of India's total population. The rural and urban populations represent 79.93% and 20.07%, respectively, of the state's total population. The tribal population constitutes 21.09% of the state's total population. The average population density of the state is 132 persons per sq km, which is less than half of the national average. According to the 19th Livestock Census of 2012, the total livestock population is 1.95 million.[263] Meghalaya's economy is primarily driven by the tertiary sector, with services being the main contributor. The primary sector, led by agriculture and forestry, also holds a significant place in the economy. The secondary sector, driven by cement and limestone production, makes a comparatively smaller contribution than both the tertiary and primary sectors.[264] The total forest cover of the state is 17,046.07 sq km, which represents 76% of the state's total area.[265]

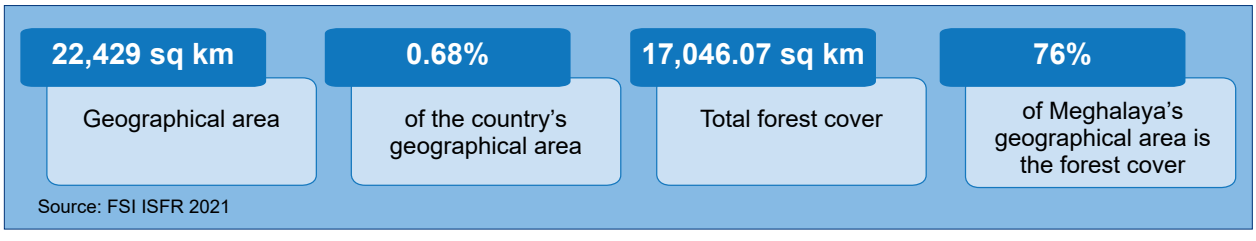


Figure 80: Geographical Area and Forest Cover of Meghalaya

[261] ISFR 2021, https://fsi.nic.in/isfr-2021/chapter-13.pdf
[262] ISFR 2019, https://fsi.nic.in/isfr19/vol2/isfr-2019-vol-ii-meghalaya.pdf
[263] ISFR 2019, https://fsi.nic.in/isfr19/vol2/isfr-2019-vol-ii-meghalaya.pdf
[264] IBEF Infographics, https://www.ibef.org/states/meghalaya-infographic
[265] ISFR 2021, https://fsi.nic.in/isfr-2021/chapter-13.pdf

As per ISFR 2011[266] and ISFR 2021[267], the following observations were made:

- In the last 10 years, from 2011 to 2020, there is an increase of 228.93 sq km, or 22,893 ha, in the forest cover.
- The tree cover of Meghalaya constituted 3.11% of the state's TGA. In the last 10 years, there is an increase of 120 sq km, or 12,000 ha, in the tree cover area of the state.
- The average growing stock in Meghalaya is 35.54 million cum in forest and 20.82 million cum in ToF. In the last 10 years, the average growing stock in the forest area and ToF has increased by 10.02 million cum.
- The total carbon stock of forest in the State, including the TOF patches which are more than one ha in size, is 183.39 million tonnes (672.43 $MtCO_2e$), which is 2.55% of the total forest carbon in the country.

As per the 2021 DLD Atlas of India, 557,576 ha of land, representing 24.86% of the state's TGA, is affected by various forms of desertification and land degradation. There has been an increase of 62,697 ha (2.8%) of degraded land from 2011–13 to 2018–19. The primary driver of land degradation is vegetation degradation (20.78%), followed by water erosion (3.20%).[268]

Table 145: Status of desertification and land degradation from 2018–19 and 2011–13 (area in ha) in Meghalaya

Year	Vegetation Degradation	Water Erosion	Water Logging	Manmade	Settlement
2018-19	466,072	71,772	9,916	642	9,175
2011-13	435,527	53,149	1,548	-	4,656

Source: ISRO 2021

4.22.3 Restoration Barometer: State Contribution

4.22.3.1 Area brought under restoration

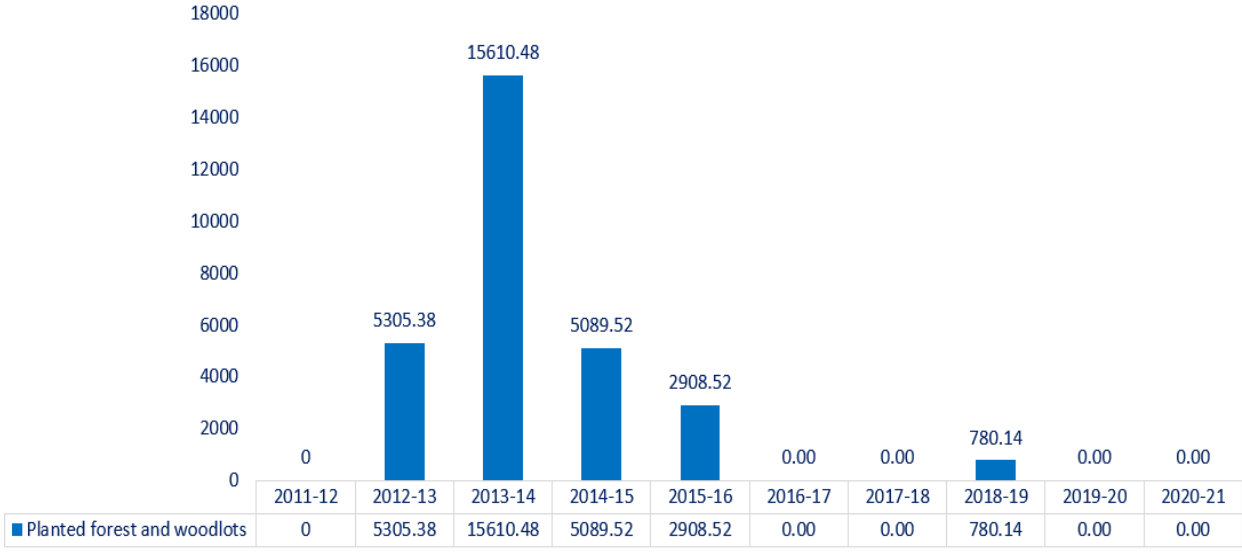


Figure 81: Area brought under restoration from 2011–2020 as reported by SFD of Meghalaya

[266] ISFR 2011, https://fsi.nic.in/forest-report-2011

[267] ISFR 2021, https://fsi.nic.in/forest-report-2021-details

[268] DLD Atlas of India, 2021, https://vedas.sac.gov.in/static/atlas/dsm/DLD_Atlas_SAC_2021.pdf

As of 2020, a total of 29,694.04 ha of the state's area had been brought under restoration since 2011, according to data submitted by the State Forest Department. Additionally, data from the Department of Land Resources (DoLR) indicate that 3,098.97 ha were restored between 2018 and 2020 by the DoLR.

Table 146: Area brought under restoration based on FLR interventions by SFD of Meghalaya

FLR interventions implemented	Area brought under restoration (in ha)
Planted forest & woodlots	29,694.04

4.22.3.2 Climate impacts

The carbon sequestration for Meghalaya has been estimated for the restoration work carried out from 2011 to 2020 under different scenarios (A1 and A2) and assumptions (a1, a2, and a3). To estimate carbon sequestration, the IPCC GPG LULUCF 2003 methodology has been adopted. Meghalaya is classified under the Wet Season category, with an annual average rainfall of >2,000 mm. According to the IPCC GPG LULUCF 2003, the following cases of average annual increment are applicable for this level of rainfall – best case (8 tdm/ha/yr), base case (5.2 tdm/ha/yr), and worst case (2.4 tdm/ha/yr), for the estimation of carbon sequestration.[269]

The detailed methodology for estimating carbon sequestration is outlined in Section 1.4.1(B) and Annex I of the report. Based on this methodology, the total carbon sequestered and the per-hectare carbon sequestration are presented in the following graph and table, respectively.

To report on carbon sequestration while accounting for mortality rates, the Base Case (a2) assumption under the two scenarios has been applied, as it represents a balanced middle ground with neither too high nor too low values (refer to the detailed methodology in Section 1.4.1(B) and Annex I).

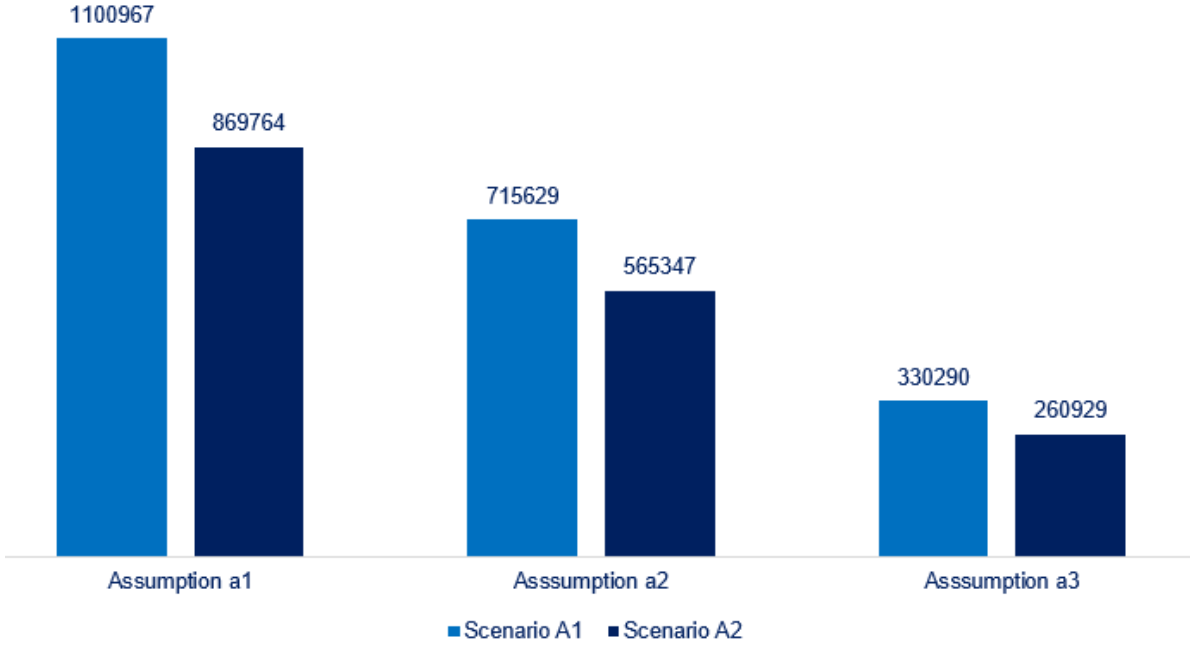


Figure 82: Total calculated tC sequestration in 10 years under two scenarios and three assumptions in Meghalaya

[269] GPG LULUCF table 3A.1.6 - for AGB only https://www.ipcc-nggip.iges.or.jp/public/gpglulucf/gpglulucf_files/Chp3/Anx_3A_1_Data_Tables.pdf

From 2011 to 2020, expressed as carbon, this corresponds to 0.72 million tonnes of carbon (tC) without factoring in mortality and 0.57 million tC when a mortality rate of 21%, was considered. An estimated 2.63 million tonnes of carbon dioxide (tCO_2e) were sequestered, excluding plantation mortality. When accounting for mortality, the sequestration was 2.07 million tCO_2e.[270]

Table 147: Carbon stock tC (per ha) in AGB and BGB carbon pools in area brought under restoration for different assumptions and scenarios in Meghalaya

Scenario	Assumption a1	Assumption a2	Assumption a3
Scenario A1	33.57	21.82	10.07
Scenario A2	26.52	17.24	7.96

4.22.3.3 Socio-economic impact

The socio-economic impact achieved has been measured in terms of man-days generated through FLR work in the state. According to SFD data for the period 2011 to 2020, a total of 5.97 million man-days of jobs were generated. This assessment accounts for the number of people involved in the implementation and maintenance of areas brought under restoration.

Table 148: Socio-economic impact (man-days generated) in Meghalaya

Socio-economic impact											
Year	**2011-12**	**2012-13**	**2013-14**	**2014-15**	**2015-16**	**2016-17**	**2017-18**	**2018-19**	**2019-20**	**2020-21**	**Total**
Number of man-days generated (in million)	1.03	3.03	0.99	0.56	0.31	0	0	0.05	0	0	**5.97**

4.22.3.4 Financial flow

The total financial flow towards FLR in the state has been reported as INR 24,635 million (USD 301.09 million).[271] Domestic public expenditure is the primary source of funding, according to data provided by the SFD for the period 2011 to 2020.

Table 149: Financial outflow from 2011–2020 in Meghalaya

Financial outflow											
Year	**2011-12**	**2012-13**	**2013-14**	**2014-15**	**2015-16**	**2016-17**	**2017-18**	**2018-19**	**2019-20**	**2020-21**	**Total**
FLR Funding in INR (million)	4,310	9,895.2	4,500	3,610	1,499.9	0	0	820.6	0	0	**24,635.70**

Table 150: Fund utilisation for bringing area under restoration in Meghalaya

Description	**Fund utilisation** (2011-12 to 2020-21)
Total area brought under restoration (ha)	29,694.04
Total fund invested in FLR activities (million INR)	24,635.70
Funds invested per hectare (million INR/ha)	0.83
Area brought under restoration per million rupees (ha/million INR)	1.21

[270] Mortality rates was not available at the time of publication of this report. Hence, law of averages was applied assigning the average mortality rate derived from mortality rates provided by 13 other States and UTs

[271] Exchange Rate - 81.59 as assessed on 01 October 2022

4.23 Mizoram

4.23.1 Restoration Barometer

The following table summarises the key components of the Restoration Barometer:

Table 151: Highlights of Restoration Barometer for Mizoram

Highlights	
Area brought under restoration (in ha)	164,185.76
Financial flow (in million INR)	3,352.43
Socio-economic impacts (man-days generated) (in million)	11.58
Climate impacts: Estimated carbon sequestered (in million tC)	2.84 (0% Mortality)
	2.24 (21% Mortality)
Climate impacts: Estimated carbon dioxide sequestered (in million tCO_2e)	10.42 (0% Mortality)
	8.24 (21% Mortality)

4.23.2 Background

Mizoram, located in the northeastern part of India, shares international borders with Bangladesh to the west and Myanmar to the east and south. The state is known for its evergreen hills and dense bamboo jungles. The total geographical area of the state is 21,081 sq km, which accounts for 0.64% of the country's TGA.[272] The state has a moist tropical to moist subtropical climate, with the annual temperature during winter ranging from 11°C to 24°C and in summer between 18°C and 29°C. The annual rainfall varies from 2,100 mm to 3,500 mm.[273]

The state has a population of 1.09 million, which constitutes 0.09% of India's total population. The rural and urban populations represent 47.89% and 52.11%, respectively, of the state's total population. The tribal population of the state constitutes 94.43%. The average population density of the state is 52 persons per sq km, which is significantly lower than the national average. According to the 19th Livestock Census of 2012, the total livestock population is 0.31 million.[274] Mizoram's economy is primarily driven by the tertiary sector, with services being the main contributor, followed by the secondary sector, particularly in handicrafts and textiles. The primary sector, led by agriculture and forestry, also plays a significant role, making a notable contribution to the state's economic activity.[275] The total forest cover of the state is 17,820 sq km, which represents 84.53% of the state's total area.[276]

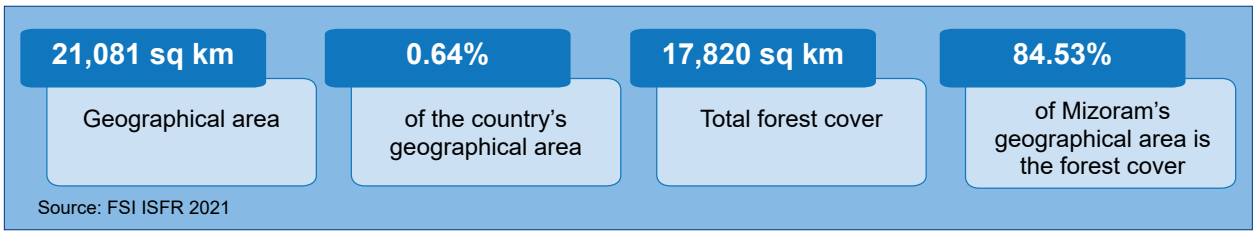


Figure 83: Geographical Area and Forest Cover of Mizoram

[272] ISFR 2021, https://fsi.nic.in/isfr-2021/chapter-13.pdf
[273] ISFR 2019, https://fsi.nic.in/isfr19/vol2/isfr-2019-vol-ii-mizoram.pdf
[274] ISFR 2019, https://fsi.nic.in/isfr19/vol2/isfr-2019-vol-ii-mizoram.pdf
[275] IBEF Infographics, https://www.ibef.org/states/mizoram-infographic
[276] ISFR 2021, https://fsi.nic.in/isfr-2021/chapter-13.pdf

As per ISFR 2011[277] and ISFR 2021[278], the following observations were made:

- In the last 10 years, from 2011 to 2020, there is an increase of 1,297 sq km, or 129,700 ha, in the forest cover.
- The tree cover of Mizoram constituted 2.11% of the state's TGA. In the last 10 years, there is an increase of 254 sq km, or 25,400 ha, in the tree cover area of the state.
- The average growing stock in Mizoram is 28.87 million cum in forest and 46.05 million cum in ToF. In the last 10 years, the average growing stock in the forest area decreased by 39.17 million cum while increased for ToF by 36.66 million cum.
- The total carbon stock of forest in the State, including the TOF patches which are more than one ha in size, is 158.64 million tonnes (581.68 $MtCO_2e$), which is 2.20% of the total forest carbon in the country.

As per the 2021 DLD Atlas of India, 275,827 ha of land, representing 13.08% of the state's TGA, is affected by various forms of desertification and land degradation. There has been an increase of 88,374 ha (4.19%) of degraded land from 2011–13 to 2018–19. The primary driver of land degradation is vegetation degradation (12.04%), followed by settlement (0.66%).[279]

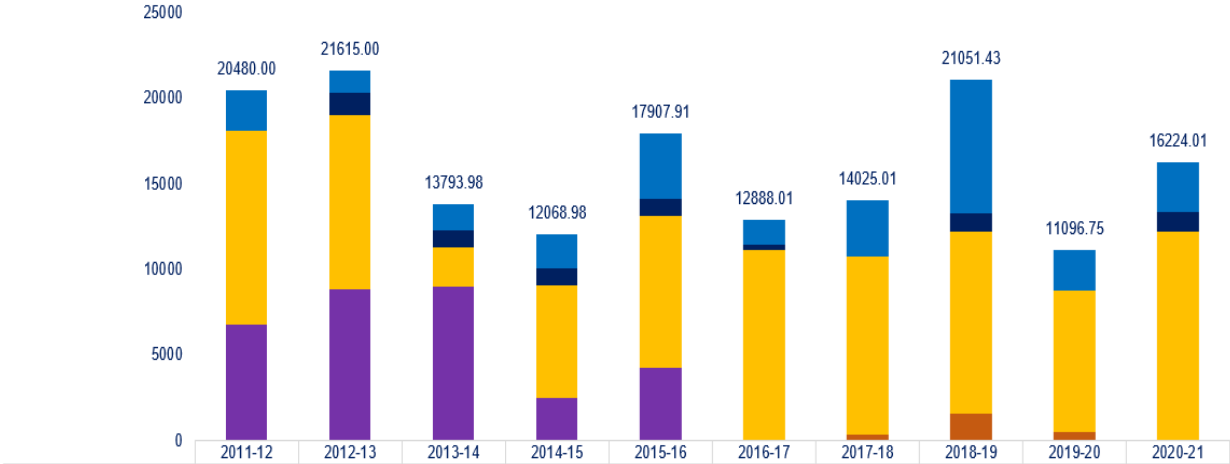
Table 152: Status of desertification and land degradation from 2018–19 and 2011–13 (area in ha) in Mizoram

Year	Vegetation Degradation	Water Erosion	Settlement
2018-19	253,871	8,119	13,837
2011-13	167,050	8,119	12,285

Source: ISRO 2021

4.23.3 Restoration Barometer: State Contribution

4.23.3.1 Area brought under restoration



	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20	2020-21
Planted forest and woodlots	2370.00	1300.00	1515.00	2000.00	3763.93	1475.10	3309.00	7818.62	2313.80	2876.50
Natural regeneration	0.00	1300.00	985.00	1000.00	1065.00	305.00	0.00	1000.00	0.00	1120.00
Silviculture	11360.00	10220.00	2293.98	6568.98	8878.98	11107.91	10388.01	10697.01	8276.45	12227.51
Agroforestry	0.00	0.00	0.00	0.00	0.00	0.00	328.00	1535.80	506.50	0.00
Others (Bamboo mission)	6750	8795	9000	2500	4200	0	0	0	0	0
Total	20480.00	21615.00	13793.98	12068.98	17907.91	12888.01	14025.01	21051.43	11096.75	16224.01

Figure 84: Area brought under restoration from 2011–2020 as reported by SFD of Mizoram

[277] ISFR 2011, https://fsi.nic.in/forest-report-2011

[278] ISFR 2021, https://fsi.nic.in/forest-report-2021-details

[279] DLD Atlas of India, 2021, https://vedas.sac.gov.in/static/atlas/dsm/DLD_Atlas_SAC_2021.pdf

As of 2020, a total of 161,151.08 ha of the state's area had been brought under restoration since 2011, according to data submitted by the State Forest Department. Additionally, data from the Department of Land Resources (DoLR) indicate that 3,034.68 ha were restored between 2018 and 2020 by the DoLR.

Table 153: Area brought under restoration based on FLR interventions by SFD of Mizoram

FLR interventions implemented	Area brought under restoration (in ha)
Planted Forest & woodlots	28,741.95
Natural regeneration	6,775
Silviculture	92,018.83
Agroforestry	2,370.30
Others (Bamboo mission)	31,245

4.23.3.2 Climate impacts

The carbon sequestration for Mizoram has been estimated for the restoration work carried out from 2011 to 2020 under different scenarios (A1 and A2) and assumptions (a1, a2, and a3). To estimate carbon sequestration, the IPCC GPG LULUCF 2003 methodology has been adopted. Mizoram is classified under the Wet Season category, with an annual average rainfall of >2,000 mm. According to the IPCC GPG LULUCF 2003, the following cases of average annual increment are applicable for this level of rainfall – best case (8 tdm/ha/yr), base case (5.2 tdm/ha/yr), and worst case (2.4 tdm/ha/yr), for the estimation of carbon sequestration.[280] The detailed methodology for estimating carbon sequestration is outlined in Section 1.4.1(B) and Annex I of the report. Based on this methodology, the total carbon sequestered and the per-hectare carbon sequestration are presented in the following graph and table, respectively.

To report on carbon sequestration while accounting for mortality rates, the Base Case (a2) assumption under the two scenarios has been applied, as it represents a balanced middle ground with neither too high nor too low values (refer to the detailed methodology in Section 1.4.1(B) and Annex I).

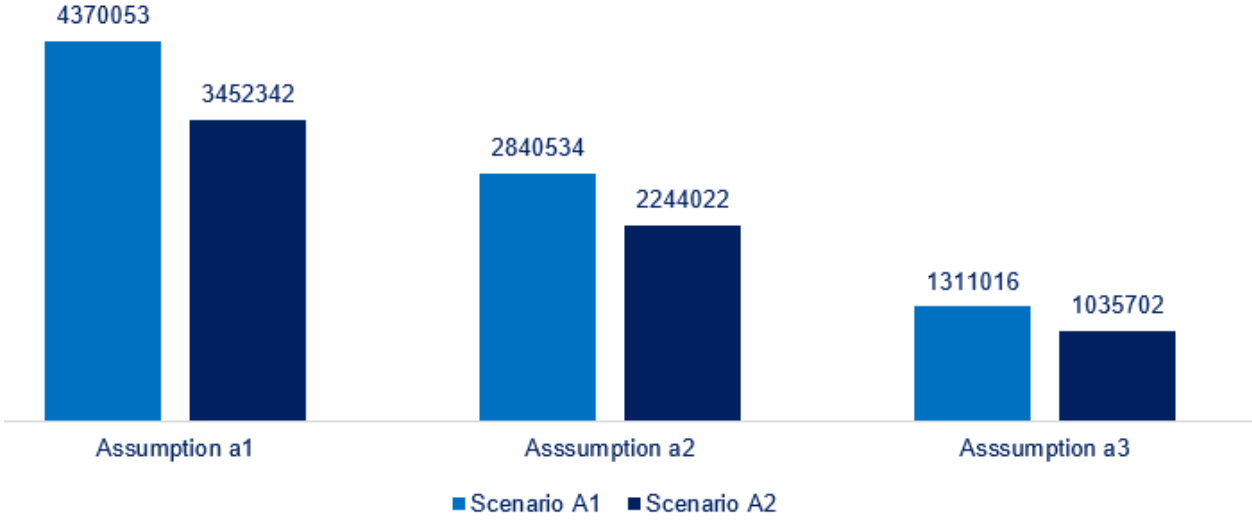


Figure 85: Total calculated tC sequestration in 10 years under two scenarios and three assumptions in Mizoram

[280] GPG LULUCF table 3A.1.6 - for AGB only https://www.ipcc-nggip.iges.or.jp/public/gpglulucf/gpglulucf_files/Chp3/Anx_3A_1_Data_Tables.pdf

From 2011 to 2020, expressed as carbon, this corresponds to 2.84 million tonnes of carbon (tC) without factoring in mortality and 2.24 million tC when a mortality rate of 21%, was considered. An estimated 10.42 million tonnes of carbon dioxide (tCO_2e) were sequestered, excluding plantation mortality. When accounting for mortality, the sequestration was 8.24 million tCO_2e.[281]

Table 154: Carbon stock tC (per ha) in AGB and BGB carbon pools in area brought under restoration for different assumptions and scenarios in Mizoram

Scenario	Assumption a1	Assumption a2	Assumption a3
Scenario A1	26.62	17.30	7.98
Scenario A2	21.03	13.67	6.31

4.23.3.3 Socio-economic impact

The socio-economic impact achieved has been measured in terms of man-days generated through FLR work in the state. According to SFD data for the period 2011 to 2020, a total of 11.58 million man-days of jobs were generated. This assessment accounts for the number of people involved in the implementation and maintenance of areas brought under restoration.

Table 155: Socio-economic impact (man-days generated) in Mizoram

Socio-economic impact											
Year	**2011-12**	**2012-13**	**2013-14**	**2014-15**	**2015-16**	**2016-17**	**2017-18**	**2018-19**	**2019-20**	**2020-21**	**Total**
Number of man-days generated (in million)	0.07	4.08	0.49	0.54	0.46	0.76	3.25	0.93	0.61	0.39	**11.58**

4.23.3.4 Financial flows

The total financial flow towards FLR in the state has been reported as INR 3,352.43 million (USD 40.09 million).[282] Domestic public expenditure is the primary source of funding, according to data provided by the SFD for the period 2011 to 2020.

Table 156: Financial outflow from 2011–2020 in Mizoram

Financial outflow											
Year	**2011-12**	**2012-13**	**2013-14**	**2014-15**	**2015-16**	**2016-17**	**2017-18**	**2018-19**	**2019-20**	**2020-21**	**Total**
FLR Funding in INR (million)	123.60	71.44	140.61	155.89	146.39	312.65	758.87	817.21	455.14	370.62	**3,352.43**

Table 157: Fund utilisation for bringing area under restoration in Mizoram

Description	**Fund utilisation** (2011-12 to 2020-21)
Total area brought under restoration (ha)	161,151.08
Total fund invested in FLR activities (million INR)	3,352.43
Funds invested per hectare (million INR/ha)	0.02
Area brought under restoration per million rupees (ha/million INR)	48.07

[281] Mortality rates was not available at the time of publication of this report. Hence, law of averages was applied assigning the average mortality rate derived from mortality rates provided by 13 other States and UTs

[282] Exchange Rate - 81.59 as assessed on 01 October 2022

4.24 Nagaland

4.24.1 Restoration Barometer

The following table summarises the key components of the Restoration Barometer:

Table 158: Highlights of Restoration Barometer for Nagaland

Highlights	
Area brought under restoration (in ha)	112,300.95
Financial flow (in million INR)	2,981.40
Socio-economic impacts (man-days generated) (in million)	5.96
Climate impacts: Estimated carbon sequestered (in million tC)	1.90 (0% Mortality)
	1.50 (21% Mortality)
Climate impacts: Estimated carbon dioxide sequestered (in million tCO_2e)	6.98 (0% Mortality)
	5.51 (21% Mortality)

4.24.2 Background

Nagaland, located in the northeastern part of India, shares its border with Myanmar. Nagaland is known as the land of festivals, and every tribal festival is celebrated with pomp, rich tribal attire, music, and colour. The total geographical area of the state is 16,579 sq km, which accounts for 0.50% of the country's TGA.[283] The state consists of a narrow strip of hilly terrain, with altitudes ranging from 194 metres to 3,826 metres. The climate is humid tropical, and the annual temperature ranges from 21°C to 40°C. The annual rainfall ranges from 1,800 mm to 2,500 mm.[284]

The state has a population of 1.98 million, which constitutes 0.16% of India's total population. The rural and urban populations represent 71.14% and 28.86%, respectively, of the state's total population. The tribal population of the state is 86.48%. The average population density of the state is 119 persons per sq km, which is less than half of the national average. The 19th Livestock Census of 2012 reported a total livestock population of 0.91 million.[285] Nagaland's economy is primarily driven by the tertiary sector, with services, including tourism, as the main contributor. The primary sector, led by agriculture, allied industries, and forestry, also plays a significant role. The secondary sector, particularly handicrafts and textiles, further contributes to the state's economy.[286] The total forest cover of the state is 12,251.14 sq km, which represents 73.90% of the state's area.[287]

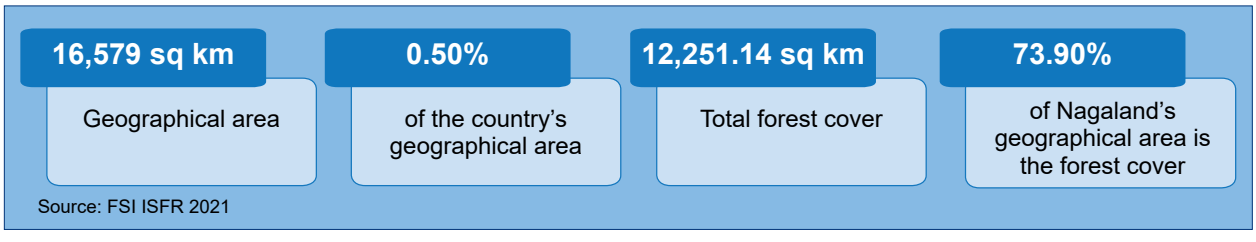


Figure 86: Geographical Area and Forest Cover of Nagaland

[283] ISFR 2021, https://fsi.nic.in/isfr-2021/chapter-13.pdf
[284] ISFR 2019, https://fsi.nic.in/isfr19/vol2/isfr-2019-vol-ii-nagaland.pdf
[285] ISFR 2019, https://fsi.nic.in/isfr19/vol2/isfr-2019-vol-ii-nagaland.pdf
[286] IBEF Infographics, https://www.ibef.org/states/nagaland-infographic
[287] ISFR 2021, https://fsi.nic.in/isfr-2021/chapter-13.pdf

As per ISFR 2011[288] and ISFR 2021[289], the following observations were made:

- In the last 10 years, from 2011 to 2020, there is an increase of 1,066.86 sq km, or 106,686 ha, in the forest cover.
- The tree cover of Nagaland constituted 2.20% of the state's TGA. In the last 10 years, there is an increase of 43 sq km, or 4,300 ha, in the tree cover area of the state.
- The average growing stock in Nagaland is 30.28 million cum in forest and 15.60 million cum in ToF. In the last 10 years, the average growing stock in the forest area decreased by 10.68 million cum while increased for ToF by 2.92 million cum.
- The total carbon stock of forest in the State, including the TOF patches which are more than one ha in size, is 134.93 million tonnes (494.74 $MtCO_2e$), which is 1.87% of the total forest carbon in the country.

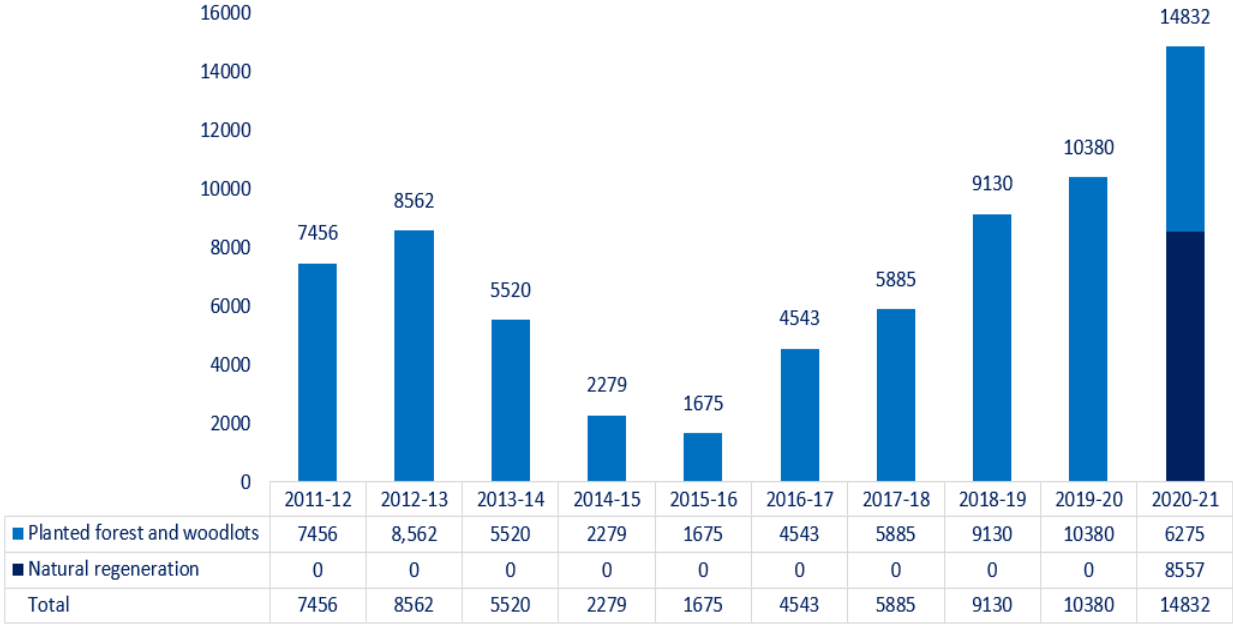
As per the 2021 DLD Atlas of India, 828,943 ha of land, representing 50% of the state's TGA, is affected by various forms of desertification and land degradation. There has been an increase of 42,265 ha (2.55%) of degraded land from 2011–13 to 2018–19. The primary driver of land degradation is vegetation degradation (49.45%), followed by settlement (0.55%).[290]

Table 159: Status of desertification and land degradation from 2018–19 and 2011–13 (area in ha) in Nagaland

Year	Vegetation Degradation	Settlement
2018-19	819753	9190
2011-13	778421	8257

Source: ISRO 2021

4.24.3 Restoration Barometer: State Contribution



	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20	2020-21
Planted forest and woodlots	7456	8,562	5520	2279	1675	4543	5885	9130	10380	6275
Natural regeneration	0	0	0	0	0	0	0	0	0	8557
Total	7456	8562	5520	2279	1675	4543	5885	9130	10380	14832

Figure 87: Area brought under restoration from 2011–2020 as reported by SFD of Nagaland

[288] ISFR 2011, https://fsi.nic.in/forest-report-2011

[289] ISFR 2021, https://fsi.nic.in/forest-report-2021-details

[290] DLD Atlas of India, 2021, https://vedas.sac.gov.in/static/atlas/dsm/DLD_Atlas_SAC_2021.pdf

As of 2020, a total of 70,262 ha of the state's area had been brought under restoration since 2011, according to data submitted by the State Forest Department. Additionally, data from the Department of Land Resources (DoLR) indicate that 42,038.95 ha were restored between 2018 and 2020 by the DoLR.

Table 160: Area brought under restoration based on FLR interventions by SFD of Nagaland

FLR interventions implemented	Area brought under restoration (in ha)
Planted forest and woodlots	61,705
Natural regeneration	8,557

4.24.3.2 Climate impacts

The carbon sequestration for Nagaland has been estimated for the restoration work carried out from 2011 to 2020 under different scenarios (A1 and A2) and assumptions (a1, a2, and a3). To estimate carbon sequestration, the IPCC GPG LULUCF 2003 methodology has been adopted. Nagaland is classified under the Moist with Short Dry Season category, with an annual average rainfall ranging from 1,000 mm – 2,000 mm. According to the IPCC GPG LULUCF 2003, the following cases of average annual increment are applicable for this level of rainfall – best case, (13.5 tdm/ha/yr), base case (7.8 tdm/ha/yr), and worst case (2.0 tdm/ha/yr), for the estimation of carbon sequestration.[291]

The detailed methodology for estimating carbon sequestration is outlined in Section 1.4.1(B) and Annex I of the report. Based on this methodology, the total carbon sequestered and the per-hectare carbon sequestration are presented in the following graph and table, respectively.

To report on carbon sequestration while accounting for mortality rates, the Base Case (a2) assumption under the two scenarios has been applied, as it represents a balanced middle ground with neither too high nor too low values (refer to the detailed methodology in Section 1.4.1(B) and Annex I).

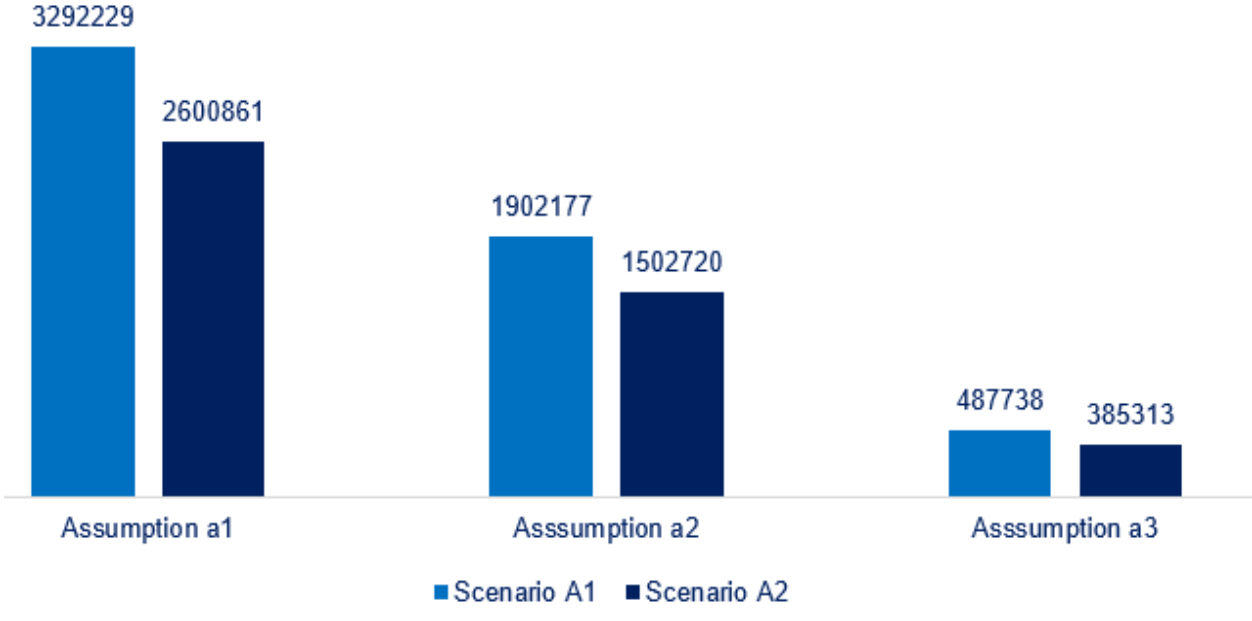


Figure 88: Total calculated tC sequestration in 10 years under two scenarios and three assumptions in Nagaland

[291] GPG LULUCF table 3A.1.6 - for AGB only https://www.ipcc-nggip.iges.or.jp/public/gpglulucf/gpglulucf_files/Chp3/Anx_3A_1_Data_Tables.pdf

From 2011 to 2020, expressed as carbon, this corresponds to 1.90 million tonnes of carbon (tC) without factoring in mortality and 1.50 million tC when a mortality rate of 21%, was considered. An estimated 6.98 million tonnes of carbon dioxide (tCO_2e) were sequestered, excluding plantation mortality. When accounting for mortality, the sequestration was 5.51 million tCO_2e.[292]

Table 161: Carbon stock tC (per ha) in AGB and BGB carbon pools in area brought under restoration for different assumptions and scenarios in Nagaland

Scenario	Assumption a1	Assumption a2	Assumption a3
Scenario A1	29.32	16.94	4.34
Scenario A2	23.16	13.38	3.43

4.24.3.3 Socio-economic impact

The socio-economic impact achieved has been measured in terms of man-days generated through FLR work in the state. According to SFD data for the period 2011 to 2020, a total of 5.96 million man-days of jobs were generated. This assessment accounts for the number of people involved in the implementation and maintenance of areas brought under restoration.

Table 162: Socio-economic impact (man-days generated) in Nagaland

Socio-economic impact											
Year	**2011-12**	**2012-13**	**2013-14**	**2014-15**	**2015-16**	**2016-17**	**2017-18**	**2018-19**	**2019-20**	**2020-21**	**Total**
Number of man-days generated (in million)	0.93	0.64	0.70	0.29	0.09	0.25	0.82	0.38	1.08	0.77	**5.96**

4.24.3.4 Financial flow

The total financial flow towards FLR in the state has been reported as INR 2,981.40 million (USD 36.54 million).[293] Domestic public expenditure is the primary source of funding, according to data provided by the SFD for the period 2011 to 2020.

Table 163: Financial outflow from 2011–2020 in Nagaland

Financial outflow											
Year	**2011-12**	**2012-13**	**2013-14**	**2014-15**	**2015-16**	**2016-17**	**2017-18**	**2018-19**	**2019-20**	**2020-21**	**Total**
FLR Funding in INR (million)	466.7	319.8	350.2	145.7	44.8	125.9	409.8	189.7	542	386.8	**2,981.40**

Table 164: Fund utilisation for bringing area under restoration in Nagaland

Description	**Fund utilisation** (2011-12 to 2020-21)
Total area brought under restoration (ha)	70,262
Total fund invested in FLR activities (million INR)	2,981.40
Funds invested per hectare (million INR/ha)	0.04
Area brought under restoration per million rupees (ha/million INR)	23.57

[292] Mortality rates was not available at the time of publication of this report. Hence, law of averages was applied assigning the average mortality rate derived from mortality rates provided by 13 other States and UTs

[293] Exchange Rate - 81.59 as assessed on 01 October 2022

4.25 Odisha

4.25.1 Restoration Barometer

The following table summarises the key components of the Restoration Barometer:

Table 165: Highlights of Restoration Barometer for Odisha

Highlights	
Area brought under restoration (in ha)	2,636,642.90
Financial flow (in million INR)	30,891.90
Socio-economic impacts (man-days generated) (in million)	98.56
Climate impacts: Estimated carbon sequestered (in million tC)	60.38 (0% Mortality)
	47.70 (21% Mortality)
Climate impacts: Estimated carbon dioxide sequestered (in million tCO_2e)	221.59 (0% Mortality)
	175.06 (21% Mortality)

4.25.2 Background

Odisha, located on the east coast of India, is rich in minerals and is also famous for its tribal culture. The total geographical area of the state is 155,707 sq km, which accounts for 4.74% of the country's TGA.[294] The state has a tropical climate, and the annual temperature ranges from 25°C to 28°C. The annual rainfall ranges from 1,200 mm to 1,600 mm.[295]

The state has a population of 41.97 million, which constitutes 3.47% of India's population. The rural and urban populations represent 83.32% and 16.68%, respectively, of the total population of the state. The tribal population constitutes 22.85% of the state's total population. The average population density of the state is 270 persons per sq km, which is less than the national average. The 19th Livestock Census of 2012 reported a total livestock population of 20.73 million.[296] Odisha's economy is driven almost equally by the tertiary, secondary, and primary sectors. Services are the main contributor to the tertiary sector. The secondary sector is supported by mining, steel, and power generation. The primary sector, led by agriculture, with rice and pulses as the main crops, contributes more than one-third to the state's economy.[297] The total forest cover of the state is 52,155.95 sq km, which represents 33.50% of the state's area.[298]

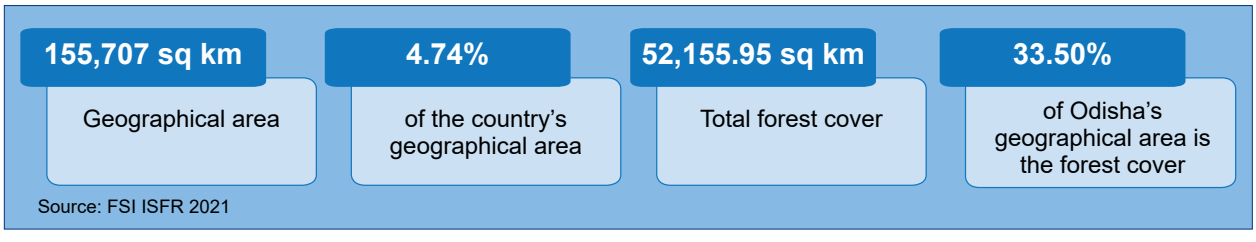


Figure 89: Geographical Area and Forest Cover of Odisha

[294] ISFR 2021, https://fsi.nic.in/isfr-2021/chapter-13.pdf
[295] ISFR 2019, https://fsi.nic.in/isfr19/vol2/isfr-2019-vol-ii-odisha.pdf
[296] ISFR 2019, https://fsi.nic.in/isfr19/vol2/isfr-2019-vol-ii-odisha.pdf
[297] IBEF Infographics, https://www.ibef.org/states/odisha-infographic
[298] ISFR 2021, https://fsi.nic.in/isfr-2021/chapter-13.pdf

As per ISFR 2011[299] and ISFR 2021[300], the following observations were made:

- In the last 10 years, from 2011 to 2020, there is an increase of 3,252.95 sq km, or 325,295 ha, in the forest cover.
- The tree cover of Odisha constituted 3.21% of the state's TGA. In the last 10 years, there is an increase of 703 sq km, or 70,300 ha, in the tree cover area of the state.
- The average growing stock in Odisha is 276.78 million cum in forest and 106.87 million cum in ToF. In the last 10 years, the average growing stock in the forest area decreased by 8.41 million cum while increased for ToF by 33.25 million cum.
- The total carbon stock of forest in the State, including the TOF patches which are more than one ha in size, is 444.83 million tonnes (1,631.04 $MtCO_2e$), which is 6.17% of the total forest carbon in the country.

As per the 2021 DLD Atlas of India, 5,359,014 ha of land, representing 34.42% of the state's TGA, is affected by various forms of desertification and land degradation. There has been an increase of 54,900 ha (0.36%) of degraded land from 2011–13 to 2018–19. The primary driver of land degradation is water erosion (28.51%), followed by vegetation degradation (4.80%).[301]

Table 166: Status of desertification and land degradation from 2018–19 and 2011–13 (area in ha) in Odisha

Year	Vegetation Degradation	Water Erosion	Water Logging	Manmade	Barren/ Rocky	Settlement
2018-19	747,574	4,439,799	43,992	72,883	5,128	49,638
2011-13	745,122	4,409,413	36,439	63,851	5,128	44,161

Source: ISRO 2021

4.25.3 Restoration Barometer: State Contribution

4.25.3.1 Area brought under restoration

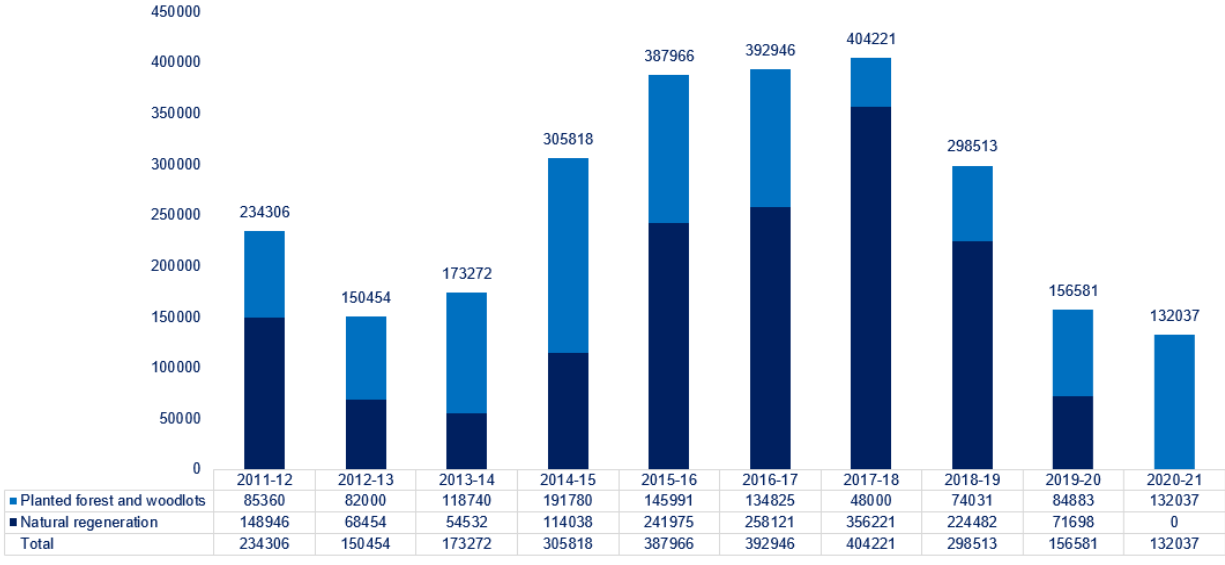


Figure 90: Area brought under restoration from 2011–2020 as reported by SFD of Odisha

[299] ISFR 2011, https://fsi.nic.in/forest-report-2011

[300] ISFR 2021, https://fsi.nic.in/forest-report-2021-details

[301] DLD Atlas of India, 2021, https://vedas.sac.gov.in/static/atlas/dsm/DLD_Atlas_SAC_2021.pdf

As of 2020, a total of 2,636,114 ha of the state's area had been brought under restoration since 2011, according to data submitted by the State Forest Department. Additionally, data from the Department of Land Resources (DoLR) indicate that 528.90 ha were restored between 2018 and 2020 by the DoLR.

Table 167: Area brought under restoration based on FLR interventions by SFD of Odisha

FLR interventions implemented	Area brought under restoration (in ha)
Planted forest and woodlots	1,097,647
Natural regeneration	1,538,467

4.25.3.2 Climate impacts

The carbon sequestration for Odisha has been estimated for the restoration work carried out from 2011 to 2020 under different scenarios (A1 and A2) and assumptions (a1, a2, and a3). To estimate carbon sequestration, the IPCC GPG LULUCF 2003 methodology has been adopted. Odisha is classified under the Moist with Long Dry Season category, with an annual average rainfall ranging from 1,000 mm – 2,000 mm. According to the IPCC GPG LULUCF 2003, the following cases of average annual increment are applicable for this level of rainfall – best case, (12.6 tdm/ha/yr), base case (7.1 tdm/ha/yr), and worst case (1.6 tdm/ha/yr), for the estimation of carbon sequestration.[302] The detailed methodology for estimating carbon sequestration is outlined in Section 1.4.1(B) and Annex I of the report. Based on this methodology, the total carbon sequestered and the per-hectare carbon sequestration are presented in the following graph and table, respectively.

To report on carbon sequestration while accounting for mortality rates, the Base Case (a2) assumption under the two scenarios has been applied, as it represents a balanced middle ground with neither too high nor too low values (refer to the detailed methodology in Section 1.4.1(B) and Annex I).

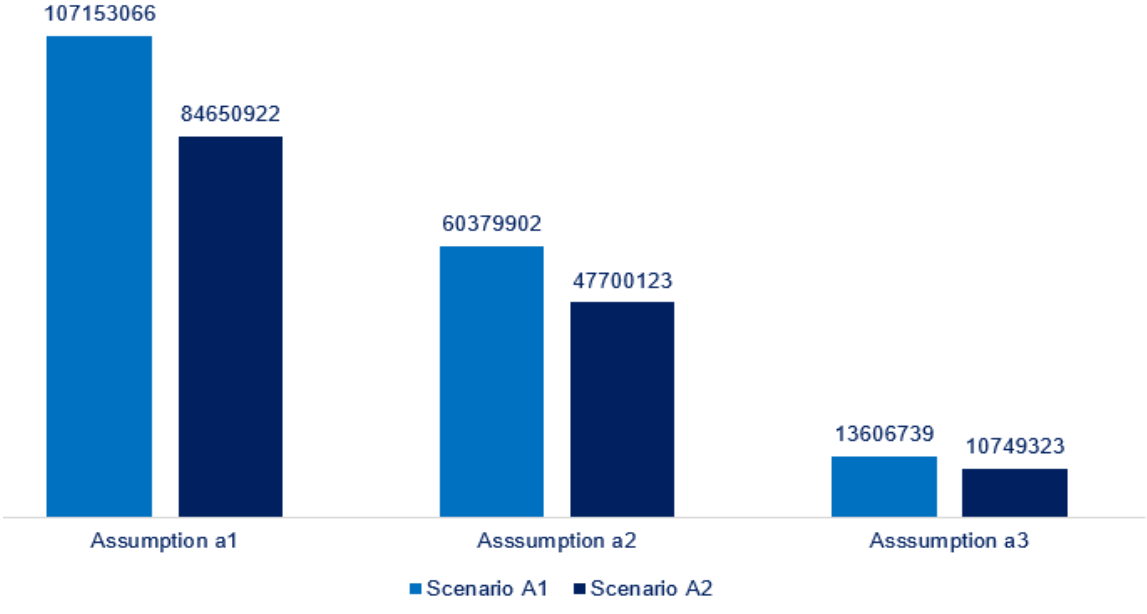


Figure 91: Total calculated tC sequestration in 10 years under two scenarios and three assumptions in Odisha

[302] GPG LULUCF table 3A.1.6 - for AGB only https://www.ipcc-nggip.iges.or.jp/public/gpglulucf/gpglulucf_files/Chp3/Anx_3A_1_Data_Tables.pdf

From 2011 to 2020, eas carbon, this corresponds to 60.38 million tonnes of carbon (tC) without factoring in mortality and 47.70 million tC when a mortality rate of 21%, was considered. An estimated 221.59 million tonnes of carbon dioxide (tCO_2e) were sequestered, excluding plantation mortality. When accounting for mortality, the sequestration was 175.06 million tCO_2e.[303]

Table 168: Carbon stock tC (per ha) in AGB and BGB carbon pools in area brought under restoration for different assumptions and scenarios in Odisha

Scenario	Assumption a1	Assumption a2	Assumption a3
Scenario A1	40.64	22.90	5.16
Scenario A2	32.11	18.09	4.08

4.25.3.3 Socio-economic impact

The socio-economic impact achieved has been measured in terms of man-days generated through FLR work in the state. According to SFD data for the period 2011 to 2020, a total of 98.56 million man-days of jobs were generated. This assessment accounts for the number of people involved in the implementation and maintenance of areas brought under restoration.

Table 169: Socio-economic impact (man-days generated) in Odisha

Socio-economic impact											
Year	**2011-12**	**2012-13**	**2013-14**	**2014-15**	**2015-16**	**2016-17**	**2017-18**	**2018-19**	**2019-20**	**2020-21**	**Total**
Number of man-days generated (in million)	14.92	10.14	13.42	13.34	15.74	12.20	0.41	6.73	10.20	1.45	**98.56**

4.25.3.4 Financial flow

The total financial flow towards FLR in the state has been reported as INR 30,891.90 million (USD 378.62 million).[304] Domestic public expenditure is the primary source of funding, according to data provided by the SFD for the period 2011 to 2020.

Table 170: Financial outflow from 2011–2020 in Odisha

Financial outflow											
Year	**2011-12**	**2012-13**	**2013-14**	**2014-15**	**2015-16**	**2016-17**	**2017-18**	**2018-19**	**2019-20**	**2020-21**	**Total**
FLR Funding in INR (million)	1,939.3	1,956.3	2,876	3,240.1	4,047.2	3,574	1,234.6	2,516.9	3,718.2	5,789.3	**30,891.90**

Table 171: Fund utilisation for bringing area under restoration in Odisha

Description	**Fund utilisation** (2011-12 to 2020-21)
Total area brought under restoration (ha)	2,636,114
Total fund invested in FLR activities (million INR)	30,891.90
Funds invested per hectare (million INR/ha)	0.01
Area brought under restoration per million rupees (ha/million INR)	85.33

[303] Mortality rates was not available at the time of publication of this report. Hence, law of averages was applied assigning the average mortality rate derived from mortality rates provided by 13 other States and UTs

[304] Exchange Rate - 81.59 as assessed on 01 October 2022

4.26 Puducherry

4.26.1 Restoration Barometer

The following table summarises the key components of the Restoration Barometer:

Table 172: Highlights of Restoration Barometer for Puducherry

Highlights	
Area brought under restoration (in ha)	1,393.55
Financial flow (in million INR)	16.50
Socio-economic impacts (man-days generated) (in million)	Not Available
Climate impacts: Estimated carbon sequestered (in million tC)	0.03 (0% Mortality)
	0.02 (21% Mortality)
Climate impacts: Estimated carbon dioxide sequestered (in million tCO_2e)	0.11 (0% Mortality)
	0.09 (21% Mortality)

4.26.2 Background

The Union Territory of Puducherry comprises the former French colonies/districts, namely Puducherry, Karaikal, Mahe, and Yanam, and these four small districts are unconnected to each other. The UT's total geographical area is 490 sq km, which accounts for 0.01% of the country's TGA.[305] The physiography is predominantly plain, with a tropical climate. The Union Territory experiences an average annual temperature ranging from 24.2°C to 33.3°C and receives an average annual rainfall of 1,834 mm.[306]

The UT has a population of 1.25 million, which constitutes 0.1% of India's population. The rural and urban populations represent 32% and 68%, respectively, of the total population of the Union Territory. The UT has no tribal population. The average population density is 2,547 persons per sq km, which is 6.7 times greater than the national average. The 19th Livestock Census of 2012 reported a total livestock population of 0.12 million.[307] Puducherry's economy is driven by the secondary, tertiary, and primary sectors. The secondary sector, led by manufacturing and marine products, makes the most significant contribution to growth. The tertiary sector, particularly hospitality and tourism, plays a major role. The primary sector, though smaller, remains important, with agriculture as the main activity.[308] The total forest cover of the UT is 53.30 sq km, which forms 10.88% of the UT's TGA.[309]

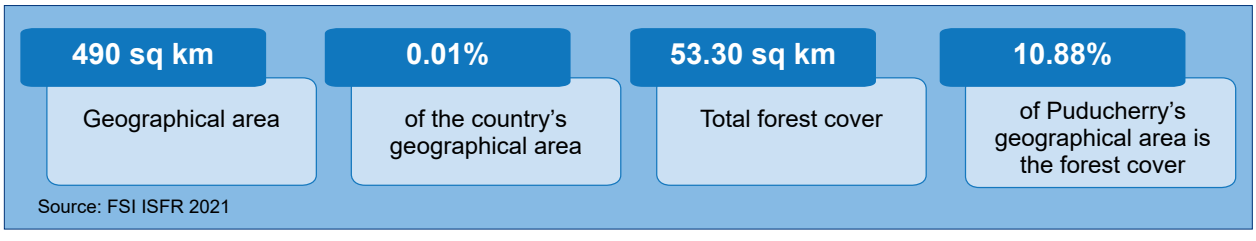


Figure 92: Geographical Area and Forest Cover of Puducherry

[305] ISFR 2021, https://fsi.nic.in/isfr-2021/chapter-13.pdf
[306] ISFR 2019, https://fsi.nic.in/isfr19/vol2/isfr-2019-vol-ii-puducherry.pdf
[307] ISFR 2019, https://fsi.nic.in/isfr19/vol2/isfr-2019-vol-ii-puducherry.pdf
[308] IBEF Infographics, https://www.ibef.org/states/puducherry-infographic
[309] ISFR 2021, https://fsi.nic.in/isfr-2021/chapter-13.pdf

As per ISFR 2011[310] and ISFR 2021[311], the following observations were made:

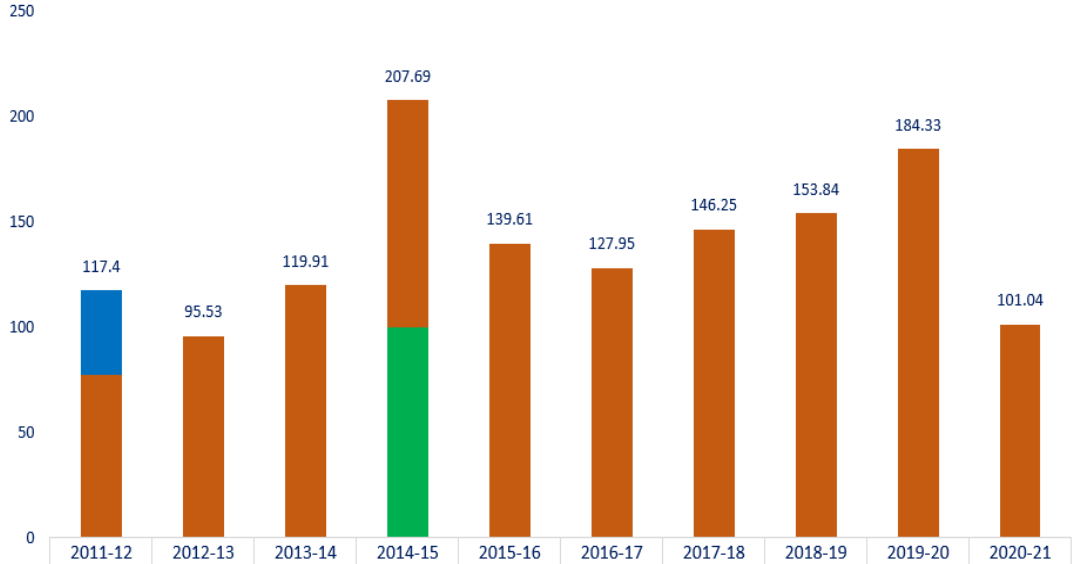
- In the last 10 years, from 2011 to 2020, there is an increase of 3.30 sq km, or 330 ha, in the forest cover.
- The tree cover of Puducherry constituted 4.69% of the UT's TGA. In the last 10 years, there is a decrease of eight sq km, or 800 ha, in the tree cover area of the UT.
- The average growing stock in Puducherry is 0.03 million cum in forest and 0.38 million cum in ToF. In the last 10 years, the average growing stock in the forest area decreased by 0.06 million cum while increased for ToF by 0.06 million cum.
- The total carbon stock of forest in the UT, including the TOF patches which are more than one ha in size, is 0.39 million tonnes (1.43 $MtCO_2e$), which is 0.01% of the total forest carbon in the country.

As per the 2021 DLD Atlas of India, negligible land degradation is observed in the Union Territory of Puducherry. Hence, the area of this UT is included in the No Apparent Degradation (NAD) class in the DLD Atlas of India.[312]

4.26.3 Restoration Barometer: UT Contribution

4.26.3.1 Area brought under restoration

As of 2020, a total of 1,393.55 ha of the UT area had been brought under restoration since 2011, according to data submitted by the Forest Department.



	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20	2020-21
Natural regeneration	40.46	0	0	0	0	0	0	0	0	0
Agroforestry	76.94	95.53	119.91	107.69	139.61	127.95	146.25	153.84	184.33	101.04
Mangrove restoration	0	0	0	100	0	0	0	0	0	0
Total	117.4	95.53	119.91	207.69	139.61	127.95	146.25	153.84	184.33	101.04

Figure 93: Area brought under restoration from 2011–2020 as reported by SFD of Puducherry

[310] ISFR 2011, https://fsi.nic.in/forest-report-2011

[311] ISFR 2021, https://fsi.nic.in/forest-report-2021-details

[312] DLD Atlas of India, 2021, https://vedas.sac.gov.in/static/atlas/dsm/DLD_Atlas_SAC_2021.pdf

Table 173: Area brought under restoration based on FLR interventions by FD of Puducherry

FLR interventions implemented	Area brought under restoration (in ha)
Natural regeneration	40.46
Agroforestry	1,253.09
Mangrove restoration	100

4.26.3.2 Climate impacts

The carbon sequestration for Puducherry has been estimated for the restoration work carried out from 2011 to 2020 under different scenarios (A1 and A2) and assumptions (a1, a2, and a3). To estimate carbon sequestration, the IPCC GPG LULUCF 2003 methodology has been adopted. Puducherry is classified under the Moist with Long Dry Season category, with an annual average rainfall ranging from 1,000 mm – 2,000 mm. According to the IPCC GPG LULUCF 2003, the following cases of average annual increment are applicable for this level of rainfall – best case (12.6 tdm/ha/yr), base case (7.1 tdm/ha/yr), and worst case (1.6 tdm/ha/yr), for the estimation of carbon sequestration.[313] The detailed methodology for estimating carbon sequestration is outlined in Section 1.4.1(B) and Annex I of the report.

Based on this methodology, the total carbon sequestered and the per-hectare carbon sequestration are presented in the following graph and table, respectively.

To report on carbon sequestration while accounting for mortality rates, the Base Case (a2) assumption under the two scenarios has been applied, as it represents a balanced middle ground with neither too high nor too low values (refer to the detailed methodology in Section 1.4.1(B) and Annex I).

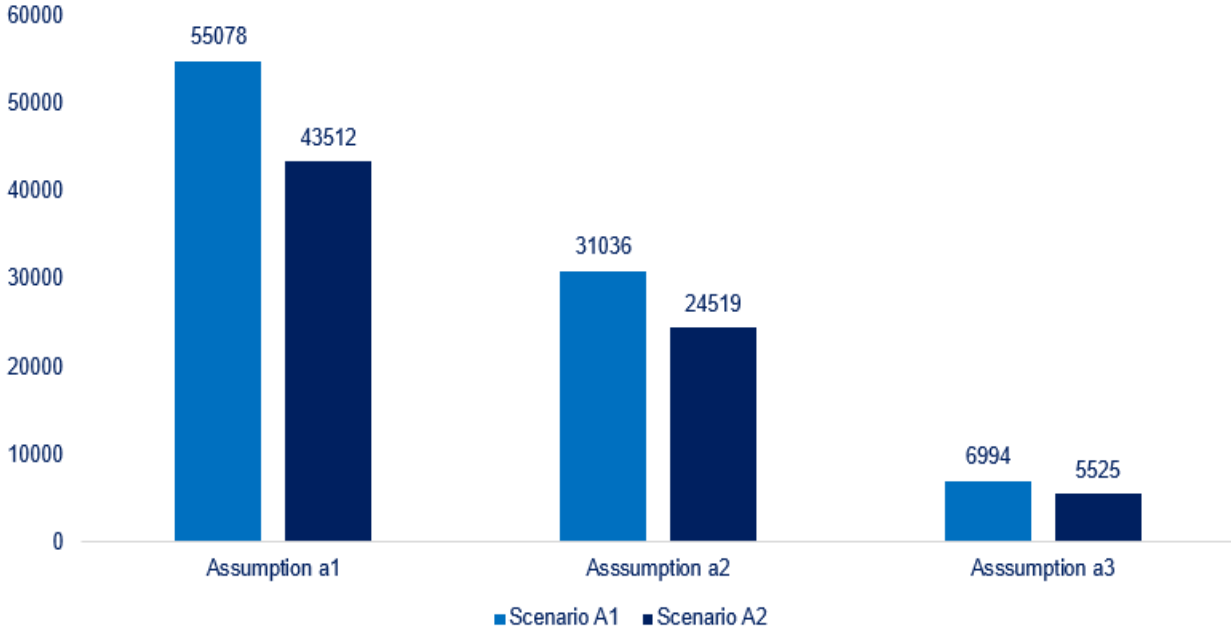


Figure 94: Total calculated tC sequestration in 10 years under two scenarios and three assumptions in Puducherry

[313] GPG LULUCF table 3A.1.6 - for AGB only https://www.ipcc-nggip.iges.or.jp/public/gpglulucf/gpglulucf_files/Chp3/Anx_3A_1_Data_Tables.pdf

From 2011 to 2020, expressed as carbon, this corresponds to 0.03 million tonnes of carbon (tC) without factoring in mortality and 0.02 million tC when a mortality rate of 21%, was considered. An estimated 0.11 million tonnes of carbon dioxide (tCO_2e) were sequestered, excluding plantation mortality. When accounting for mortality, the sequestration was 0.09 million tCO_2e.[314]

Table 174: Carbon stock tC (per ha) in AGB and BGB carbon pools in area brought under restoration for different assumptions and scenarios in Puducherry

Scenario	Assumption a1	Assumption a2	Assumption a3
Scenario A1	39.52	22.27	5.02
Scenario A2	31.22	17.59	3.96

4.26.3.3 Socio-economic impact

The socio-economic impact achieved in terms of man-days generated through the FLR work in the UT was not available at the time of publication.

Note: The data were not available at the time of publication.

4.26.3.4 Financial flow

The total financial flow towards FLR in the UT has been reported as INR 16.50 million (USD 0.20 million).[315] Domestic public expenditure is the primary source of funding, according to data provided by the FD for the period 2011 to 2020.

Table 175: Financial outflow from 2011–2020 in Puducherry

Financial outflow											
Year	**2011-12**	**2012-13**	**2013-14**	**2014-15**	**2015-16**	**2016-17**	**2017-18**	**2018-19**	**2019-20**	**2020-21**	**Total**
FLR Funding in INR (million)	1.70	2.50	2.60	2.60	1.60	1.10	1.30	1.10	0.50	1.50	**16.50**

Table 176: Fund utilisation for bringing area under restoration in Puducherry

Description	**Fund utilisation** (2011-12 to 2020-21)
Total area brought under restoration (ha)	1,393.55
Total fund invested in FLR activities (million INR)	16.50
Funds invested per hectare (million INR/ha)	0.01
Area brought under restoration per million rupees (ha/million INR)	84.46

[314] Mortality rates was not available at the time of publication of this report. Hence, law of averages was applied assigning the average mortality rate derived from mortality rates provided by 13 other States and UTs

[315] Exchange Rate - 81.59 as assessed on 01 October 2022

4.27 Punjab

4.27.1 Restoration Barometer

The following table summarises the key components of the Restoration Barometer:

Table 177: Highlights of Restoration Barometer for Punjab

Highlights	
Area brought under restoration (in ha)	75,663.81
Financial flow (in million INR)	2,931.10
Socio-economic impacts (man-days generated) (in million)	9.34
Climate impacts: Estimated carbon sequestered (in million tC)	1.45 (0% Mortality)
	1.28 (12% Mortality)
Climate impacts: Estimated carbon dioxide sequestered (in million tCO_2e)	5.33 (0% Mortality)
	4.69 (12% Mortality)

4.27.2 Background

Punjab is located in the north-western part of the country, with an area of 50,362 sq km, which constitutes 1.53% of the country's TGA.[316] It is also known as the land of five rivers. The State experiences a tropical, semi-arid, hot, and subtropical climate. The annual rainfall ranges from 480 mm to 960 mm, and the annual temperature varies from 0°C to 47°C. Agriculture is the mainstay of the state's economy due to its fertile soil with a variety of soil profile characteristics. Livestock and dairy farming provide an additional source of income.[317]

Punjab has a population of 27.74 million, accounting for 2.29% of India's population. The rural and urban populations comprise 62.52% and 37.48%, respectively. The average population density is 551 persons per sq km, which is higher than the national average. The 19th Livestock Census of 2012 reported a total livestock population of 8.12 million.[318]

Punjab's economy is driven by the tertiary sector, with services playing a key role. The secondary sector, including auto parts, textiles, pharmaceuticals, and agro-based industries, contributes nearly as much as the primary sector. Agriculture, supported by 82% of cultivable and fertile land, remains a significant contributor to the state's primary sector.[319] The total forest cover of the state is 1,846.65 sq km, which forms 3.67% of the state's TGA.[320]

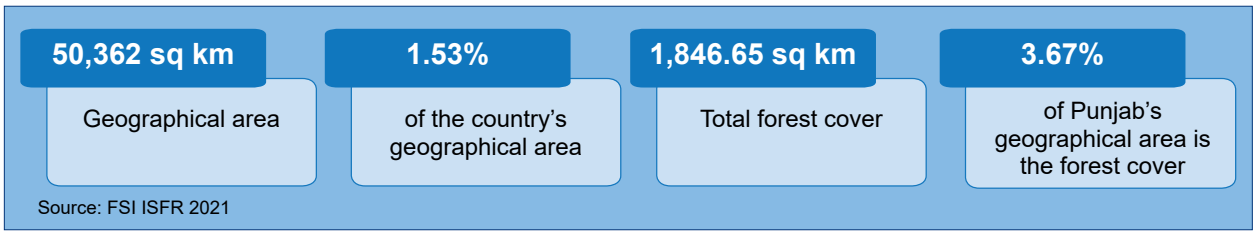


Figure 95: Geographical Area and Forest Cover of Punjab

[316] ISFR 2021, https://fsi.nic.in/isfr-2021/chapter-13.pdf
[317] ISFR 2019, https://fsi.nic.in/isfr19/vol2/isfr-2019-vol-ii-punjab.pdf
[318] ISFR 2019, https://fsi.nic.in/isfr19/vol2/isfr-2019-vol-ii-punjab.pdf
[319] IBEF Infographics, https://www.ibef.org/states/punjab-infographic
[320] ISFR 2021, https://fsi.nic.in/isfr-2021/chapter-13.pdf

As per ISFR 2011[321] and ISFR 2021[322], the following observations were made:

- In the last 10 years, from 2011 to 2020, there is an increase of 82.65 sq km, or 8,265 ha, in the forest cover.
- The tree cover of Punjab constituted 2.26% of the state's TGA. In the last 10 years, there is a decrease of 561 sq km, or 56,100 ha, in the tree cover area of the state.
- The average growing stock in Punjab is 12.61 million cum in forest and 20.31 million cum in ToF. In the last 10 years, the average growing stock in the forest area decreased by 3.10 million cum while increased for ToF by 1.01 million cum.
- The total carbon stock of forest in the State, including the TOF patches which are more than one ha in size, is 13.56 million tonnes (49.72 $MtCO_2e$), which is 0.19% of the total forest carbon in the country.

As per the 2021 DLD Atlas of India, 167,989 ha of land, representing 3.34% of the state's TGA, is affected by various forms of desertification and land degradation. There has been an increase of 23,336 ha (0.47%) of degraded land from 2011–13 to 2018–19. The primary driver of land degradation is settlement (2.24%), followed by vegetation degradation (0.75%).[323]

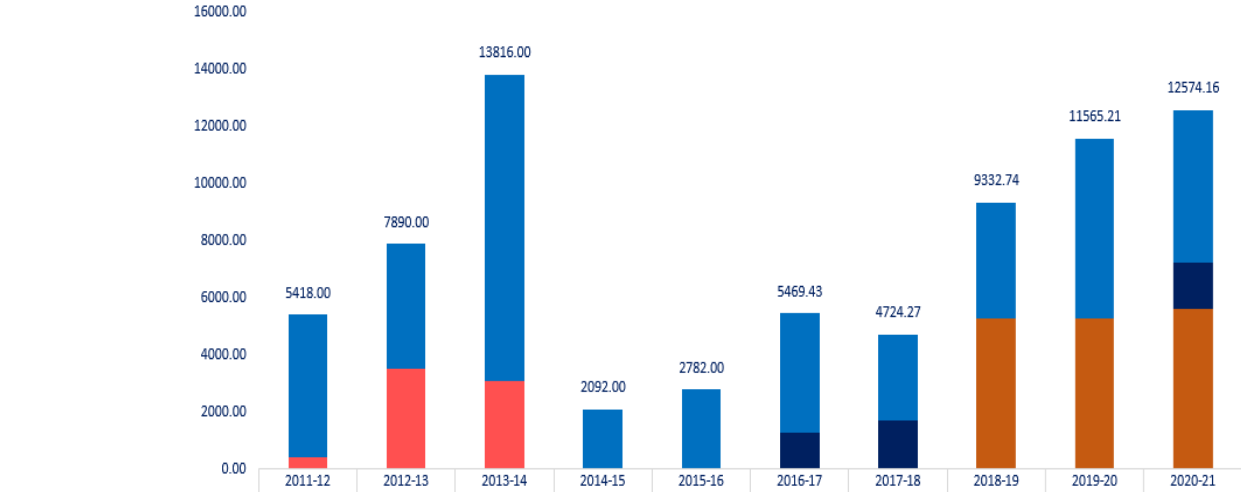
Table 178: Status of desertification and land degradation from 2018–19 and 2011–13 (area in ha) in Punjab

Year	Vegetation Degradation	Water Erosion	Manmade	Settlement
2018-19	37972	15344	1641	113032
2011-13	32561	14116	1641	96335

Source: ISRO 2021

4.27.3 Restoration Barometer: State Contribution

4.27.3.1 Area brought under restoration



	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20	2020-21
Planted forest and woodlots	5018.00	4390.00	10719.00	2092.00	2782.00	4183.43	2992.27	4062.19	6277.49	5349.93
Natural regeneration	0.00	0.00	0.00	0.00	0.00	1286.00	1732.00	0.00	0.00	1600.00
Agroforestry	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5270.55	5287.72	5624.23
Watershed protection and erosion control	400.00	3500.00	3097.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	5418.00	7890.00	13816.00	2092.00	2782.00	5469.43	4724.27	9332.74	11565.21	12574.16

Figure 96: Area brought under restoration from 2011–2020 as reported by SFD of Punjab

[321] ISFR 2011, https://fsi.nic.in/forest-report-2011

[322] ISFR 2021, https://fsi.nic.in/forest-report-2021-details

[323] DLD Atlas of India, 2021, https://vedas.sac.gov.in/static/atlas/dsm/DLD_Atlas_SAC_2021.pdf

As of 2020, a total of 75,663.81 ha of the state's area had been brought under restoration since 2011, according to data submitted by the State Forest Department.

Table 179: Area brought under restoration based on FLR interventions by SFD of Punjab

FLR interventions implemented	Area brought under restoration (in ha)
Planted forest and woodlots	47,866.31
Natural regeneration	4,618
Agroforestry	16,182.50
Watershed protection and erosion control	6,997

4.27.3.2 Climate impacts

The carbon sequestration for Punjab has been estimated for the restoration work carried out from 2011 to 2020 under different scenarios (A1 and A2) and assumptions (a1, a2, and a3). To estimate carbon sequestration, the IPCC GPG LULUCF 2003 methodology has been adopted. Punjab is classified under the Dry Season category, with an annual average rainfall of <1,000 mm. According to the IPCC GPG LULUCF 2003, the following cases of average annual increment are applicable for this level of rainfall – best case, (11.7 tdm/ha/yr), base case (6.45 tdm/ha/yr), and worst case (1.2 tdm/ha/yr), for the estimation of carbon sequestration.[324] The detailed methodology for estimating carbon sequestration is outlined in Section 1.4.1(B) and Annex I of the report. Based on this methodology, the total carbon sequestered and the per-hectare carbon sequestration are presented in the following graph and table, respectively.

To report on carbon sequestration while accounting for mortality rates, the Base Case (a2) assumption under the two scenarios has been applied, as it represents a balanced middle ground with neither too high nor too low values (refer to the detailed methodology in Section 1.4.1(B) and Annex I).

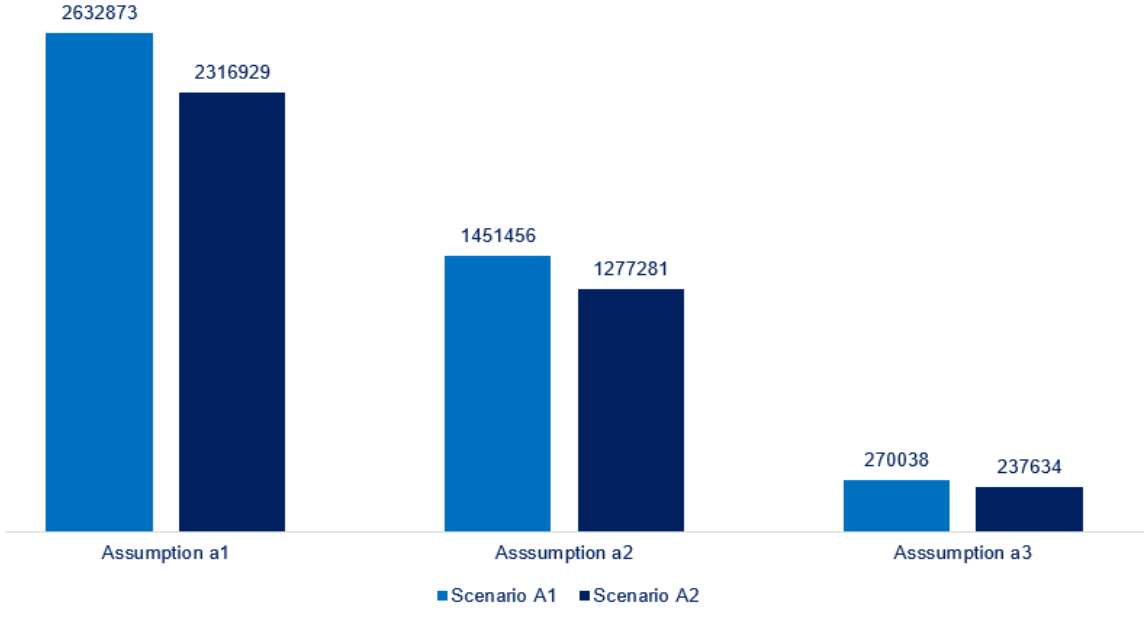


Figure 97: Total calculated tC sequestration in 10 years under two scenarios and three assumptions in Punjab

[324] GPG LULUCF table 3A.1.6 - for AGB only https://www.ipcc-nggip.iges.or.jp/public/gpglulucf/gpglulucf_files/Chp3/Anx_3A_1_Data_Tables.pdf

From 2011 to 2020, expressed as carbon, this corresponds to 1.45 million tonnes of carbon (tC) without factoring in mortality and 1.28 million tC when a mortality rate of 12%, was considered. An estimated 5.33 million tonnes of carbon dioxide (tCO_2e) were sequestered, excluding plantation mortality. When accounting for mortality, the sequestration was 4.69 million tCO_2e.[325]

Table 180: Carbon stock tC (per ha) in AGB and BGB carbon pools in area brought under restoration for different assumptions and scenarios in Punjab

Scenario	Assumption a1	Assumption a2	Assumption a3
Scenario A1	34.80	19.18	3.57
Scenario A2	30.62	16.88	3.14

4.27.3.3 Socio-economic impact

The socio-economic impact achieved has been measured in terms of man-days generated through FLR work in the state. According to SFD data for the period 2011 to 2020, a total of 9.34 million man-days of jobs were generated. This assessment accounts for the number of people involved in the implementation and maintenance of areas brought under restoration.

Table 181: Socio-economic impact (man-days generated) in Punjab

Socio-economic impact											
Year	**2011-12**	**2012-13**	**2013-14**	**2014-15**	**2015-16**	**2016-17**	**2017-18**	**2018-19**	**2019-20**	**2020-21**	**Total**
Number of man-days generated (in million)	0.79	2.36	1.45	0.18	0.50	0.83	0.89	0.57	0.82	0.96	**9.34**

4.27.3.4 Financial flow

The total financial flow towards FLR in the state has been reported as INR 2,931.10 million (USD 35.92 million).[326] Domestic public expenditure is the primary source of funding, according to data provided by the SFD for the period 2011 to 2020.

Table 182: Financial outflow from 2011–2020 in Punjab

Financial outflow											
Year	**2011-12**	**2012-13**	**2013-14**	**2014-15**	**2015-16**	**2016-17**	**2017-18**	**2018-19**	**2019-20**	**2020-21**	**Total**
FLR Funding in INR (million)	152	518.50	436.30	57.40	165.90	298.10	328	220.10	344.90	409.90	**2,931.10**

Table 183: Fund utilisation for bringing area under restoration in Punjab

Description	**Fund utilisation** (2011-12 to 2020-21)
Total area brought under restoration (ha)	75,663.81
Total fund invested in FLR activities (million INR)	2,931.10
Funds invested per hectare (million INR/ha)	0.04
Area brought under restoration per million rupees (ha/million INR)	25.81

[325] Mortality rates was not available at the time of publication of this report. Hence, law of averages was applied assigning the average mortality rate derived from mortality rates provided by 13 other States and UTs

[326] Exchange Rate - 81.59 as assessed on 01 October 2022

4.28 Rajasthan

4.28.1 Restoration Barometer

The following table summarises the key components of the Restoration Barometer:

Table 184: Highlights of Restoration Barometer for Rajasthan

Highlights	
Area brought under restoration (in ha)	546,789
Financial flow (in million INR)	27,670
Socio-economic impacts (man-days generated) (in million)	87.79
Climate impacts: Estimated carbon sequestered (in million tC)	12.97 (0% Mortality)
	10.24 (21% Mortality)
Climate impacts: Estimated carbon dioxide sequestered (in million tCO_2e)	47.58 (0% Mortality)
	37.59 (21% Mortality)

4.28.2 Background

Rajasthan is the largest state, with an area of 342,239 sq km, which constitutes 10.41% of the country's TGA.[327] It is situated in the north-western part of India and shares an international border with Pakistan. The state has an arid to semi-arid climate, with the average annual temperature ranging from 0°C to 50°C. The average annual rainfall ranges from 500 mm to 750 mm.[328]

The state has a population of 68.55 million, accounting for 5.66% of India's population. The rural and urban populations constitute 75.10% and 24.90%, respectively. The population density is 200 persons per sq km, which is much lower than the national average. The 19th Livestock Census of 2012 reported a total livestock population of 57.73 million.[329]

The tertiary sector, led by tourism and services, drives half of Rajasthan's economy. The secondary sector, encompassing mining, textiles, and handicrafts, contributes around one-fourth of the state's GDP. Meanwhile, the primary sector, centred on agriculture, supports nearly two-thirds of the population, complemented by livestock and dairy farming.[330] The total forest cover of the state is 16,654.96 sq km, which forms 4.87% of the state's area.[331]

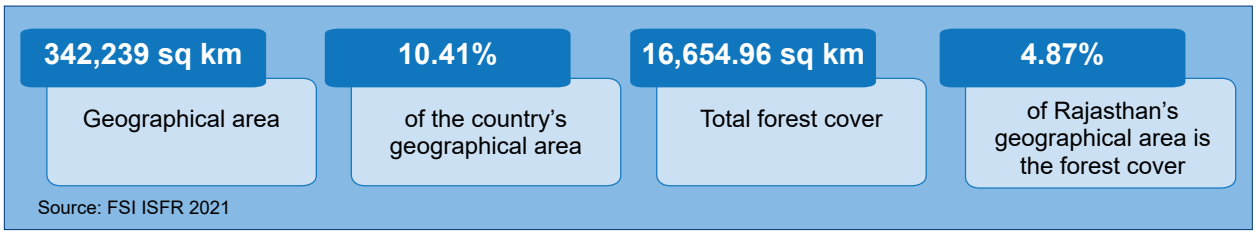


Figure 98: Geographical Area and Forest Cover of Rajasthan

[327] ISFR 2021, https://fsi.nic.in/isfr-2021/chapter-13.pdf
[328] ISFR 2019, https://fsi.nic.in/isfr19/vol2/isfr-2019-vol-ii-rajasthan.pdf
[329] ISFR 2019, https://fsi.nic.in/isfr19/vol2/isfr-2019-vol-ii-rajasthan.pdf
[330] IBEF Infographics, https://www.ibef.org/states/rajasthan-infographic
[331] ISFR 2021, https://fsi.nic.in/isfr-2021/chapter-13.pdf

As per ISFR 2011[332] and ISFR 2021[333], the following observations were made:

- In the last 10 years, from 2011 to 2020, there is an increase of 567.96 sq km, or 56,796 ha, in the forest cover.
- The tree cover of Rajasthan constituted 2.55% of the state's TGA. In the last 10 years, there is an increase of 461 sq km, or 46,100 ha, in the tree cover area of the state.
- The average growing stock in Rajasthan is 26.56 million cum in forest and 90.63 million cum in ToF. In the last 10 years, the average growing stock in the forest area decreased by 7.83 million cum while increased for ToF by 9.07 million cum.
- The total carbon stock of forest in the State, including the TOF patches which are more than one ha in size, is 110.77 million tonnes (406.16 $MtCO_2e$), which is 1.54% of the total forest carbon in the country.

As per the 2021 DLD Atlas of India, 21,237,665 ha of land, representing 62.06% of the state's TGA, is affected by various forms of desertification and land degradation. There has been a decrease of 288,847 ha (0.84%) of degraded land from 2011–13 to 2018–19. The primary driver of land degradation is wind erosion (43.37%), followed by vegetation degradation (7.64%).[334]

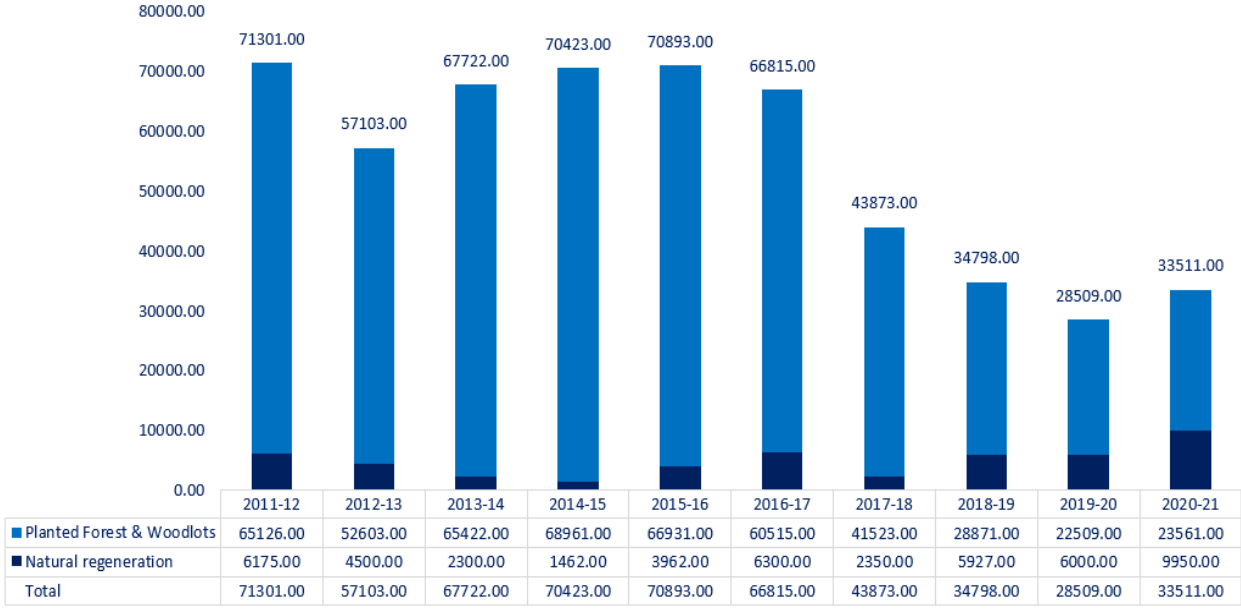
Table 185: Status of desertification and land degradation from 2018–19 and 2011–13 (area in ha) in Rajasthan

Year	Vegetation Degradation	Water Erosion	Wind Erosion	Salinity	Water Logging	Manmade	Barren/ Rocky	Settlement
2018-19	2,614,640	2,124,456	14,843,215	365,834	18,425	81,796	1,050,236	139,064
2011-13	2,606,221	2,116,314	15,197,874	363,768	18,421	53,058	1,052,374	118,482

Source: ISRO 2021

4.28.3 Restoration Barometer: State Contribution

4.28.3.1 Area brought under restoration



	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20	2020-21
Planted Forest & Woodlots	65126.00	52603.00	65422.00	68961.00	66931.00	60515.00	41523.00	28871.00	22509.00	23561.00
Natural regeneration	6175.00	4500.00	2300.00	1462.00	3962.00	6300.00	2350.00	5927.00	6000.00	9950.00
Total	71301.00	57103.00	67722.00	70423.00	70893.00	66815.00	43873.00	34798.00	28509.00	33511.00

Figure 99: Area brought under restoration from 2011–2020 as reported by SFD of Rajasthan

[332] ISFR 2011, https://fsi.nic.in/forest-report-2011

[333] ISFR 2021, https://fsi.nic.in/forest-report-2021-details

[334] DLD Atlas of India, 2021, https://vedas.sac.gov.in/static/atlas/dsm/DLD_Atlas_SAC_2021.pdf

As of 2020, a total of 544,948 ha of the state's area had been brought under restoration since 2011, according to data submitted by the State Forest Department. Additionally, data from the Department of Land Resources (DoLR) indicate that 1,841 ha were restored between 2018 and 2020 by the DoLR.

Table 186: Area brought under restoration based on FLR interventions by SFD of Rajasthan

FLR interventions implemented	Area brought under restoration (in ha)
Planted forest and woodlots	496,022
Natural regeneration	48,926

4.28.3.2 Climate impacts

The carbon sequestration for Rajasthan has been estimated for the restoration work carried out from 2011 to 2020 under different scenarios (A1 and A2) and assumptions (a1, a2, and a3). To estimate carbon sequestration, the IPCC GPG LULUCF 2003 methodology has been adopted. Rajasthan is classified under the Dry Season category, with an annual average rainfall of <1,000 mm. According to the IPCC GPG LULUCF 2003, the following cases of average annual increment are applicable for this level of rainfall – best case (11.7 tdm/ha/yr), base case (6.4 tdm/ha/yr), and worst case (1.2 tdm/ha/yr), for the estimation of carbon sequestration.[335] The detailed methodology for estimating carbon sequestration is outlined in Section 1.4.1(B) and Annex I of the report. Based on this methodology, the total carbon sequestered and the per-hectare carbon sequestration are presented in the following graph and table, respectively.

To report on carbon sequestration while accounting for mortality rates, the Base Case (a2) assumption under the two scenarios has been applied, as it represents a balanced middle ground with neither too high nor too low values (refer to the detailed methodology in Section 1.4.1(B) and Annex I).

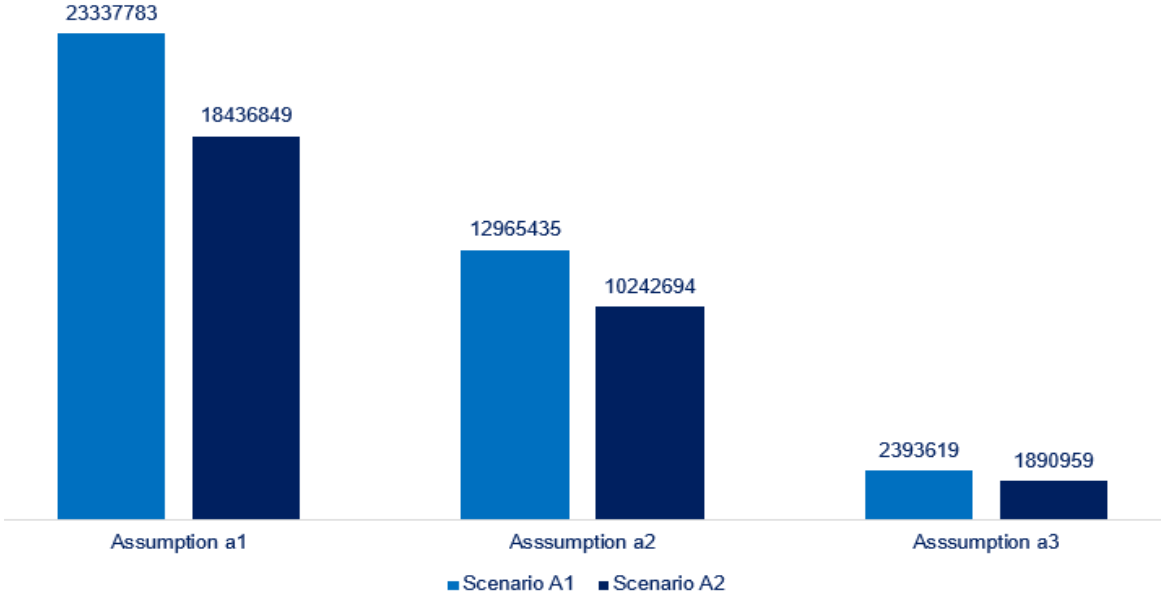


Figure 100: Total calculated tC sequestration in 10 years under two scenarios and three assumptions in Rajasthan

[335] GPG LULUCF table 3A.1.6 - for AGB only https://www.ipcc-nggip.iges.or.jp/public/gpglulucf/gpglulucf_files/Chp3/Anx_3A_1_Data_Tables.pdf

From 2011 to 2020, expressed as carbon, this corresponds to 12.97 million tonnes of carbon (tC) without factoring in mortality and 10.24 million tC when a mortality rate of 21%, was considered. An estimated 47.58 million tonnes of carbon dioxide (tCO_2e) were sequestered, excluding plantation mortality. When accounting for mortality, the sequestration was 37.59 million tCO_2e.[336]

Table 187: Carbon stock tC (per ha) in AGB and BGB carbon pools in area brought under restoration for different assumptions and scenarios in Rajasthan

Scenario	Assumption a1	Assumption a2	Assumption a3
Scenario A1	42.68	23.71	4.38
Scenario A2	33.72	18.73	3.46

4.28.3.3 Socio-economic impact

The socio-economic impact achieved has been measured in terms of man-days generated through FLR work in the state. According to SFD data for the period 2011 to 2020, a total of 87.79 million man-days of jobs were generated. This assessment accounts for the number of people involved in the implementation and maintenance of areas brought under restoration.

Table 188: Socio-economic impacts (man-days generated) in Rajasthan

Socio-economic impact											
Year	**2011-12**	**2012-13**	**2013-14**	**2014-15**	**2015-16**	**2016-17**	**2017-18**	**2018-19**	**2019-20**	**2020-21**	**Total**
Number of man-days generated (in million)	3.66	7.35	9.69	12.30	13	10.60	8.63	5.63	7.07	9.87	**87.79**

4.28.3.4 Financial flow

The total financial flow towards FLR in the state has been reported as INR 27,670 million (USD 339.13 million).[337] Domestic public expenditure is the primary source of funding, according to data provided by the SFD for the period 2011 to 2020.

Table 189: Financial outflow from 2011–2020 in Rajasthan

Financial outflow											
Year	**2011-12**	**2012-13**	**2013-14**	**2014-15**	**2015-16**	**2016-17**	**2017-18**	**2018-19**	**2019-20**	**2020-21**	**Total**
FLR Funding in INR (million)	890	1,910	2,680	3,410	4,120	3,560	2,890	2,000	2,510	3,700	**27,670**

Table 190: Fund utilisation for bringing area under restoration in Rajasthan

Description	**Fund utilisation** (2011-12 to 2020-21)
Total area brought under restoration (ha)	544,948
Total fund invested in FLR activities (million INR)	27,670
Funds invested per hectare (million INR/ha)	0.05
Area brought under restoration per million rupees (ha/million INR)	19.69

[336] Mortality rates was not available at the time of publication of this report. Hence, law of averages was applied assigning the average mortality rate derived from mortality rates provided by 13 other States and UTs

[337] Exchange Rate - 81.59 as assessed on 01 October 2022

4.29 Sikkim

4.29.1 Restoration Barometer

The following table summarises the key components of the Restoration Barometer:

Table 191: Highlights of Restoration Barometer for Sikkim

Highlights	
Area brought under restoration (in ha)	30,604.14
Financial flow (in million INR)	-
Socio-economic impacts (man-days generated) (in million)	2.28
Climate impacts: Estimated carbon sequestered (in million tC)	0.76 (0% Mortality)
	0.60 (21% Mortality)
Climate impacts: Estimated carbon dioxide sequestered (in million tCO_2e)	2.80 (0% Mortality)
	2.21 (21% Mortality)

4.29.2 Background

Sikkim, located in the northeastern part of India, borders West Bengal to the south. The state is known for its biodiversity and is home to Kanchenjunga, the highest peak in India and the third-highest on Earth. The total geographical area of the state is 7,096 sq km, which constitutes 0.22% of the country's TGA.[338] The state experiences a subtropical to high alpine climate. The annual temperature ranges from sub-zero during winter to 28°C during summer. The annual rainfall ranges from 2,700 mm to 3,200 mm.[339]

The state has a population of 0.61 million, which accounts for 0.05% of India's population. The rural and urban populations constitute 74.85% and 25.15%, respectively. The tribal population is 33.72%. The population density is 86 persons per sq km, which is much lower than the national average. The 19th Livestock Census of 2012 reported a total livestock population of 0.29 million in the state.[340]

Sikkim's economy is driven by the secondary sector, with hydroelectric power and handicrafts playing key roles. The tertiary sector, led by tourism and services, also contributes significantly. The primary sector, though smaller contribution, focuses on agriculture, including large cardamom and tea, along with forestry.[341] The total forest cover of the state is 3,341.03 sq km, which forms 47.08% of the state's area.[342]

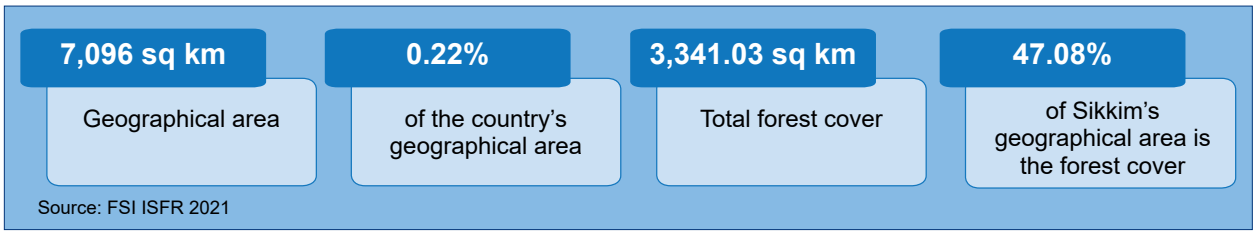


Figure 101: Geographical Area and Forest Cover of Sikkim

[338] ISFR 2021, https://fsi.nic.in/isfr-2021/chapter-13.pdf
[339] ISFR 2019, https://fsi.nic.in/isfr19/vol2/isfr-2019-vol-ii-sikkim.pdf
[340] ISFR 2019, https://fsi.nic.in/isfr19/vol2/isfr-2019-vol-ii-sikkim.pdf
[341] IBEF Infographics, https://www.ibef.org/states/sikkim-infographic
[342] ISFR 2021, https://fsi.nic.in/isfr-2021/chapter-13.pdf

As per ISFR 2011[343] and ISFR 2021[344], the following observations were made:

- In the last 10 years, from 2011 to 2020, there is an increase of 17.97 sq km, or 1,797 ha, in the forest cover.
- The tree cover of Sikkim constituted 0.55% of the state's TGA. In the last 10 years, there is an increase of 14 sq km, or 1,400 ha, in the tree cover area of the state.
- The average growing stock in Sikkim is 33.91 million cum in forest and 1.73 million cum in ToF. In the last 10 years, the average growing stock in the forest area increased by 15.08 million cum while decreased for ToF by 0.29 million cum.
- The total carbon stock of forest in the State, including the TOF patches which are more than one ha in size, is 55.54 million tonnes (203.65 $MtCO_2e$), which is 0.77% of the total forest carbon in the country.

As per the 2021 DLD Atlas of India, 84,610 ha of land, representing 11.92% of the state's TGA, is affected by various forms of desertification and land degradation. There has been an increase of 5,861 ha (0.82%) of degraded land from 2011–13 to 2018–19. The primary driver of land degradation is vegetation degradation (10.96%), followed by frost shattering (0.86%).[345]

Table 192: Status of desertification and land degradation from 2018–19 and 2011–13 (area in ha) in Sikkim

Year	Vegetation Degradation	Frost Shattering	Settlement
2018-19	77,794	6,116	700
2011-13	74,318	3,730	700

Source: ISRO 2021

4.29.3 Restoration Barometer: State Contribution

4.29.3.1 Area brought under restoration

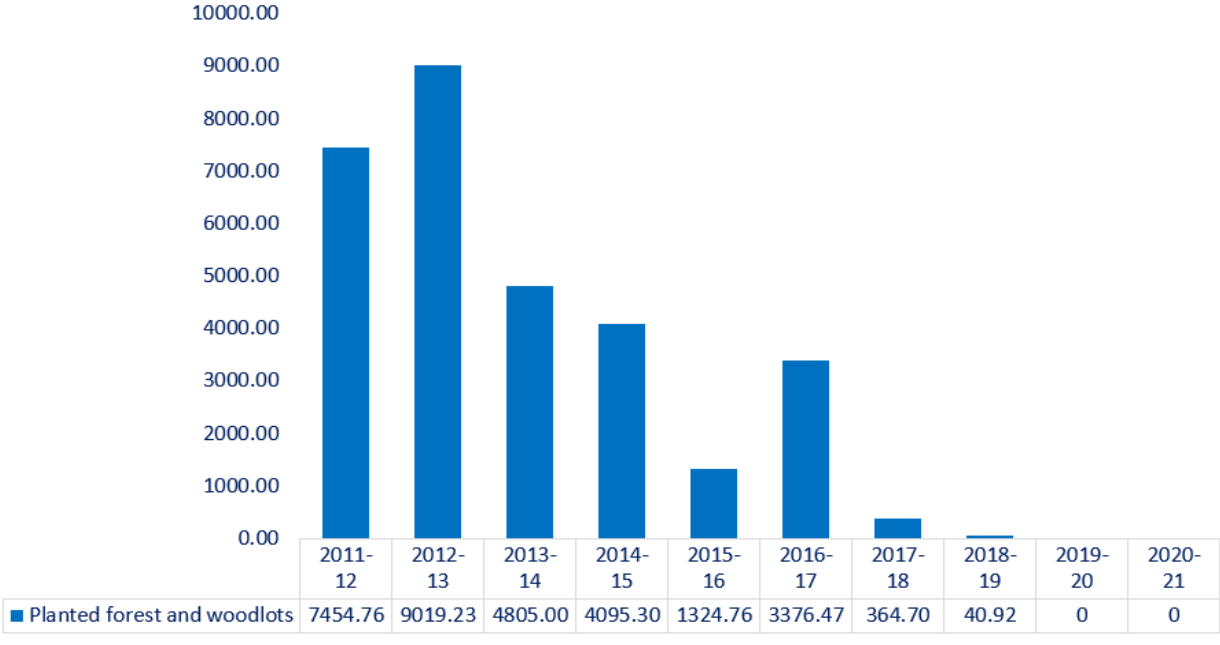


Figure 102: Area brought under restoration from 2011–2020 as reported by SFD of Sikkim

[343] ISFR 2011, https://fsi.nic.in/forest-report-2011

[344] ISFR 2021, https://fsi.nic.in/forest-report-2021-details

[345] DLD Atlas of India, 2021, https://vedas.sac.gov.in/static/atlas/dsm/DLD_Atlas_SAC_2021.pdf

As of 2020, a total of 30,481.14 ha of the state's area had been brought under restoration since 2011, according to data submitted by the State Forest Department. Additionally, data from the Department of Land Resources (DoLR) indicate that 123 ha were restored between 2018 and 2020 by the DoLR.

Table 193: Area brought under restoration based on FLR interventions by SFD of Sikkim

FLR interventions implemented	Area brought under restoration (in ha)
Planted forest and woodlots	30,481.14

4.29.3.2 Climate impacts

The carbon sequestration for Sikkim has been estimated for the restoration work carried out from 2011 to 2020 under different scenarios (A1 and A2) and assumptions (a1, a2, and a3). To estimate carbon sequestration, the IPCC GPG LULUCF 2003 methodology has been adopted. Sikkim is classified under the Wet Season category, with an annual average rainfall of >2,000 mm. According to the IPCC GPG LULUCF 2003, the following cases of average annual increment are applicable for this level of rainfall – best case (8 tdm/ha/yr), base case (5.2 tdm/ha/yr), and worst case (2.4 tdm/ha/yr), for the estimation of carbon sequestration.[346]

The detailed methodology for estimating carbon sequestration is outlined in Section 1.4.1(B) and Annex I of the report. Based on this methodology, the total carbon sequestered and the per-hectare carbon sequestration are presented in the following graph and table, respectively.

To report on carbon sequestration while accounting for mortality rates, the Base Case (a2) assumption under the two scenarios has been applied, as it represents a balanced middle ground with neither too high nor too low values (refer to the detailed methodology in Section 1.4.1(B) and Annex I).

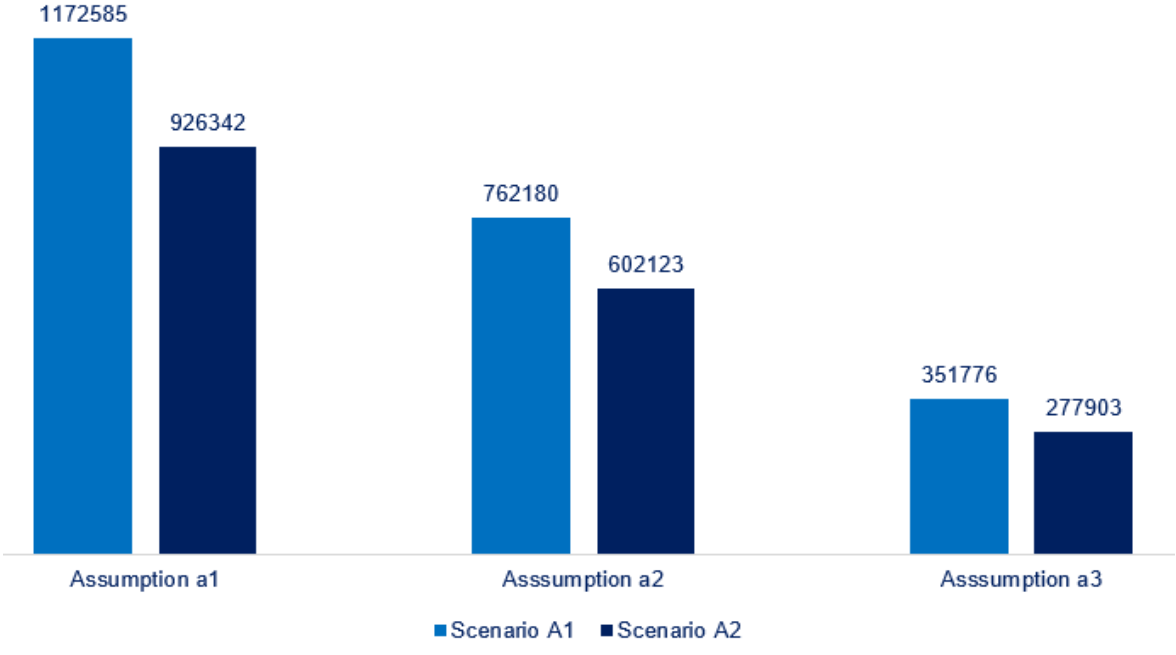


Figure 103: Total calculated tC sequestration in 10 years under two scenarios and three assumptions in Sikkim

[346] GPG LULUCF table 3A.1.6 - for AGB only https://www.ipcc-nggip.iges.or.jp/public/gpglulucf/gpglulucf_files/Chp3/Anx_3A_1_Data_Tables.pdf

From 2011 to 2020, expressed as carbon, this corresponds to 0.76 million tonnes of carbon (tC) without factoring in mortality and 0.60 million tC when a mortality rate of 21%, was considered. An estimated 2.80 million tonnes of carbon dioxide (tCO_2e) were sequestered, excluding plantation mortality. When accounting for mortality, the sequestration was 2.21 million tCO_2e.[347]

Table 194: Carbon stock tC (per ha) in AGB and BGB carbon pools in area brought under restoration for different assumptions and scenarios in Sikkim

Scenario	Assumption a1	Assumption a2	Assumption a3
Scenario A1	38.31	24.90	11.49
Scenario A2	30.27	19.67	9.08

4.29.3.3 Socio-economic impact

The socio-economic impact achieved has been measured in terms of man-days generated through FLR work in the state. According to SFD data for the period 2011 to 2020, a total of 2.28 million man-days of jobs were generated. This assessment accounts for the number of people involved in the implementation and maintenance of areas brought under restoration.

Table 195: Socio-economic impact (man-days generated) in Sikkim

Socio-economic impact											
Year	**2011-12**	**2012-13**	**2013-14**	**2014-15**	**2015-16**	**2016-17**	**2017-18**	**2018-19**	**2019-20**	**2020-21**	**Total**
Number of man-days generated (in million)	0.56	0.67	0.36	0.31	0.10	0.25	0.03	0	0	0	**2.28**

4.29.3.4 Financial flow

The financial flow details achieved in terms of expenditure in the FLR work in the state was not received till the time of publication. Domestic public expenditure is the primary source of funding, according to data provided by the SFD for the period 2011 to 2020.

Table 196: Fund utilisation for bringing area under restoration in Sikkim

Description	**Fund utilisation** (2011-12 to 2020-21)
Total area brought under restoration (ha)	30,481.14
Total fund invested in FLR activities (million INR)	-
Funds invested per hectare (million INR/ha)	-
Area brought under restoration per million rupees (ha/million INR)	-

[347] Mortality rates was not available at the time of publication of this report. Hence, law of averages was applied assigning the average mortality rate derived from mortality rates provided by 13 other States and UTs

4.30 Tamil Nadu

4.30.1 Restoration Barometer

The following table summarises the key components of the Restoration Barometer:

Table 197: Highlights of Restoration Barometer for Tamil Nadu

Highlights	
Area brought under restoration (in ha)	226,152.56
Financial flow (in million INR)	5,626.51
Socio-economic impacts (man-days generated) (in million)	4.15
Climate impacts: Estimated carbon sequestered (in million tC)	5.74 (0% Mortality)
	4.53 (21% Mortality)
Climate impacts: Estimated carbon dioxide sequestered (in million tCO_2e)	21.05 (0% Mortality)
	16.63 (21% Mortality)

4.30.2 Background

Located in the southern part of the Indian peninsula, the state of Tamil Nadu consists of coastal plains, the Eastern Ghats, the central plateau, and higher-elevation mountains. The state is famous for its rich culture and traditions in literature, art, music, and dance. The total geographical area of the state is 130,060 sq km, which covers 3.96% of the country's TGA.[348] Tamil Nadu has a humid tropical climate, with annual temperatures ranging from 19°C to 37°C. The annual rainfall ranges from 900 mm to 1,200 mm.[349]

The state has a population of 72.15 million, which is 5.96% of India's population. The rural and urban populations are 51.60% and 48.40%, respectively. The tribal population is 1.10%. The population density is 555 persons per sq km, which is higher than the national average. The 19th Livestock Census of 2012 reported a total livestock population of 22.72 million in the state.[350]

Tamil Nadu's economy is primarily driven by the tertiary sector, with significant contributions from IT services, tourism, and healthcare. The secondary sector, including automobiles, manufacturing, textiles, and leather, also plays a key role. The primary sector, though contributing less, focuses on agriculture, particularly rice, bananas, and poultry.[351] The total forest cover of the state is 26,419.23 sq km, which forms 20.31% of the state's area.[352]

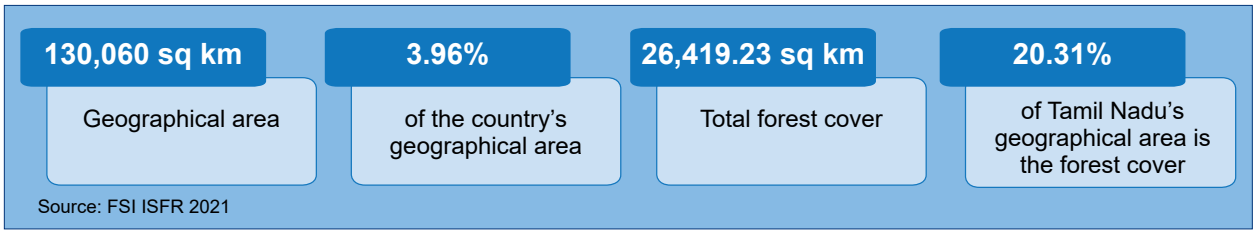


Figure 104: Geographical Area and Forest Cover of Tamil Nadu

[348] ISFR 2021, https://fsi.nic.in/isfr-2021/chapter-13.pdf
[349] ISFR 2019, https://fsi.nic.in/isfr19/vol2/isfr-2019-vol-ii-tamilnadu.pdf
[350] ISFR 2019, https://fsi.nic.in/isfr19/vol2/isfr-2019-vol-ii-tamilnadu.pdf
[351] IBEF Infographics, https://www.ibef.org/states/tamil-nadu-infographic
[352] ISFR 2021, https://fsi.nic.in/isfr-2021/chapter-13.pdf

As per ISFR 2011[353] and ISFR 2021[354], the following observations were made:

- In the last 10 years, from 2011 to 2020, there is an increase of 2,794.23 sq km, or 279,423 ha, in the forest cover.
- The tree cover of Tamil Nadu constituted 3.40% of the state's TGA. In the last 10 years, there is a decrease of 294 sq km, or 29,400 ha, in the tree cover area of the state.
- The average growing stock in Tamil Nadu is 92.27 million cum in forest and 82.21 million cum in ToF. In the last 10 years, the average growing stock in the forest area decreased by 52.13 million cum while increased for ToF by 11.88 million cum.
- The total carbon stock of forest in the State, including the TOF patches which are more than one ha in size, is 214.61 million tonnes (786.90 $MtCO_2e$), which is 2.98% of the total forest carbon in the country.

As per the 2021 DLD Atlas of India, 1,599,981 ha of land, representing 12.30% of the state's TGA, is affected by various forms of desertification and land degradation. There has been an increase of 56,083 ha (0.43%) of degraded land from 2011–13 to 2018–19. The primary driver of land degradation is vegetation degradation (10.88%), followed by settlement (0.92%).[355]

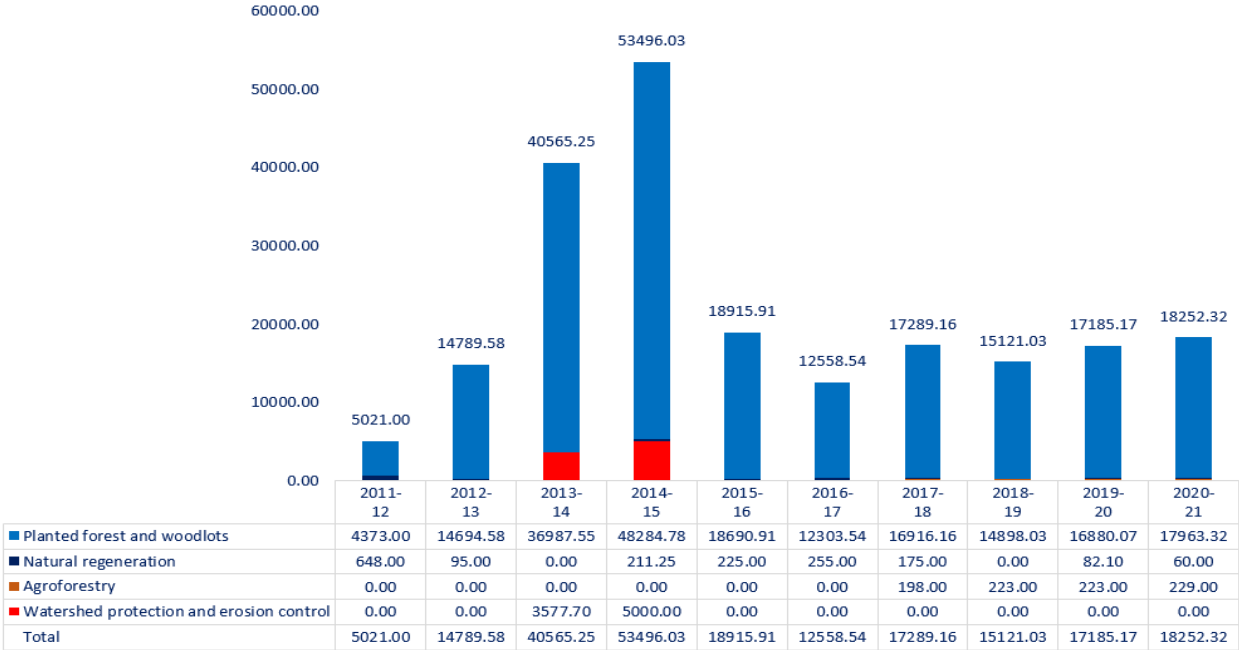
Table 198: Status of desertification and land degradation from 2018–19 and 2011–13 (area in ha) in Tamil Nadu

Year	Vegetation Degradation	Water Erosion	Wind Erosion	Salinity	Manmade	Barren/Rocky	Settlement
2018-19	1,414,888	6,411	30,429	10,500	18,036	515	119,203
2011-13	1,385,478	6,411	30,429	9,878	13,965	515	97,223

Source: ISRO 2021

4.30.3 Restoration Barometer: State Contribution

4.30.3.1 Area brought under restoration



	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20	2020-21
Planted forest and woodlots	4373.00	14694.58	36987.55	48284.78	18690.91	12303.54	16916.16	14898.03	16880.07	17963.32
Natural regeneration	648.00	95.00	0.00	211.25	225.00	255.00	175.00	0.00	82.10	60.00
Agroforestry	0.00	0.00	0.00	0.00	0.00	0.00	198.00	223.00	223.00	229.00
Watershed protection and erosion control	0.00	0.00	3577.70	5000.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	5021.00	14789.58	40565.25	53496.03	18915.91	12558.54	17289.16	15121.03	17185.17	18252.32

Figure 105: Area brought under restoration from 2011–2020 as reported by SFD of Tamil Nadu

[353] ISFR 2011, https://fsi.nic.in/forest-report-2011

[354] ISFR 2021, https://fsi.nic.in/forest-report-2021-details

[355] DLD Atlas of India, 2021, https://vedas.sac.gov.in/static/atlas/dsm/DLD_Atlas_SAC_2021.pdf

As of 2020, a total of 213,193.99 ha of the state's area had been brought under restoration since 2011, according to data submitted by the State Forest Department. Additionally, data from the Department of Land Resources (DoLR) indicate that 12,958.57 ha were restored between 2018 and 2020 by the DoLR.

Table 199: Area brought under restoration based on FLR interventions by SFD of Tamil Nadu

FLR interventions implemented	Area brought under restoration (in ha)
Planted forest and woodlots	201,991.94
Agroforestry	873
Mangrove restoration	1,751.35
Watershed protection and erosion control	8,577.70

4.30.3.2 Climate impacts

The carbon sequestration for Tamil Nadu has been estimated for the restoration work carried out from 2011 to 2020 under different scenarios (A1 and A2) and assumptions (a1, a2, and a3). To estimate carbon sequestration, the IPCC GPG LULUCF 2003 methodology has been adopted. Tamil Nadu is classified under the Moist with Short Dry Season category, with an annual average rainfall ranging from 1,000 mm – 2,000 mm. According to the IPCC GPG LULUCF 2003, the following cases of average annual increment are applicable for this level of rainfall – best case (13.5 tdm/ha/yr), base case (7.8 tdm/ha/yr), and worst case (2.0 tdm/ha/yr), for the estimation of carbon sequestration.[356] The detailed methodology for estimating carbon sequestration is outlined in Section 1.4.1(B) and Annex I of the report. Based on this methodology, the total carbon sequestered and the per-hectare carbon sequestration are presented in the following graph and table, respectively.

To report on carbon sequestration while accounting for mortality rates, the Base Case (a2) assumption under the two scenarios has been applied, as it represents a balanced middle ground with neither too high nor too low values (refer to the detailed methodology in Section 1.4.1(B) and Annex I).

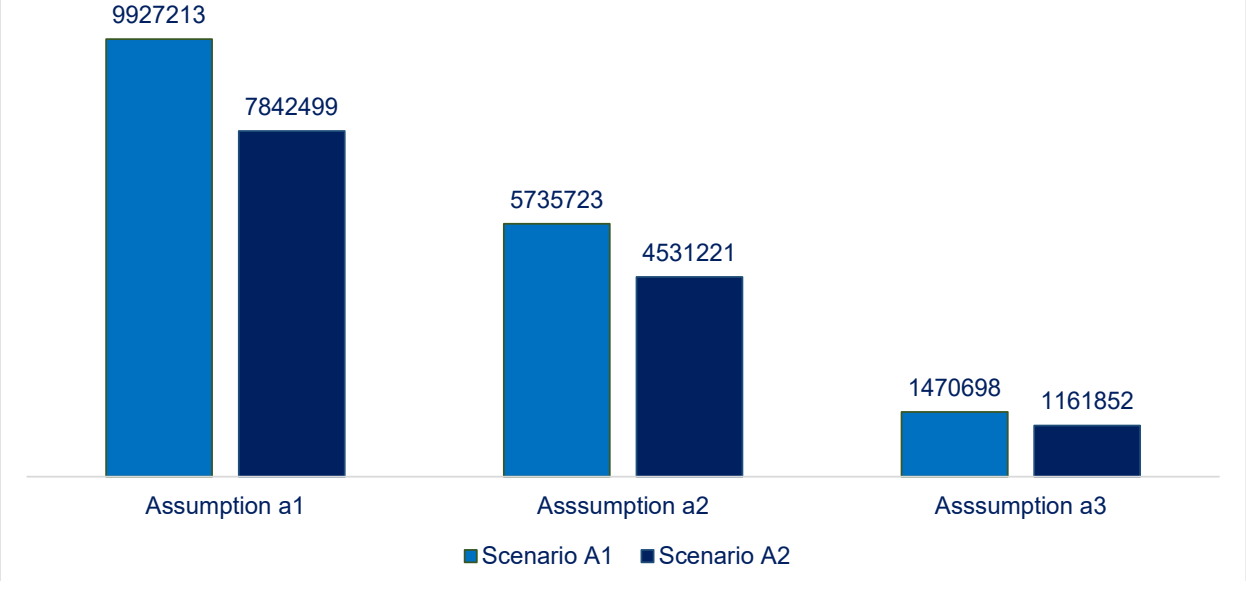


Figure 106: Total calculated tC sequestration in 10 years under two scenarios and three assumptions in Tamil Nadu

[356] GPG LULUCF table 3A.1.6 - for AGB only https://www.ipcc-nggip.iges.or.jp/public/gpglulucf/gpglulucf_files/Chp3/Anx_3A_1_Data_Tables.pdf

From 2011 to 2020, expressed as carbon, this corresponds to 5.74 million tonnes of carbon (tC) without factoring in mortality and 4.53 million tC when a mortality rate of 21%, was considered. An estimated 21.05 million tonnes of carbon dioxide (tCO_2e) were sequestered, excluding plantation mortality. When accounting for mortality, the sequestration was 16.63 million tCO_2e.[357]

Table 200: Carbon stock tC (per ha) in AGB and BGB carbon pools in area brought under restoration for different assumptions and scenarios in Tamil Nadu

Scenario	Assumption a1	Assumption a2	Assumption a3
Scenario A1	43.90	25.36	6.50
Scenario A2	34.68	20.04	5.14

4.30.3.3 Socio-economic impact

The socio-economic impact achieved has been measured in terms of man-days generated through FLR work in the state. According to SFD data for the period 2011 to 2020, a total of 4.15 million man-days of jobs were generated. This assessment accounts for the number of people involved in the implementation and maintenance of areas brought under restoration.

Table 201: Socio-economic impact (man-days generated) in Tamil Nadu

Socio-economic impact											
Year	**2011-12**	**2012-13**	**2013-14**	**2014-15**	**2015-16**	**2016-17**	**2017-18**	**2018-19**	**2019-20**	**2020-21**	**Total**
Number of man-days generated (in million)	0.10	0.44	0.92	0.87	0.54	0.18	0.30	0.41	0.23	0.16	**4.15**

4.30.3.4 Financial flow

The total financial flow towards FLR in the state has been reported as INR 5,626.51 million (USD 68.95 million).[358] Domestic public expenditure is the primary source of funding, according to data provided by the SFD for the period 2011 to 2020.

Table 202: Financial outflow from 2011–2020 in Tamil Nadu

Financial outflow											
Year	**2011-12**	**2012-13**	**2013-14**	**2014-15**	**2015-16**	**2016-17**	**2017-18**	**2018-19**	**2019-20**	**2020-21**	**Total**
FLR Funding in INR (million)	62.33	212.32	366.36	335.88	345.86	364.53	419.95	469.68	100.09	2,948.42	**5,626.51**

Table 203: Fund utilisation for bringing area under restoration in Tamil Nadu

Description	**Fund utilisation** (2011-12 to 2020-21)
Total area brought under restoration (ha)	213,193.99
Total fund invested in FLR activities (million INR)	5,626.51
Funds invested per hectare (million INR/ha)	0.03
Area brought under restoration per million rupees (ha/million INR)	37.89

[357] Mortality rates was not available at the time of publication of this report. Hence, law of averages was applied assigning the average mortality rate derived from mortality rates provided by 13 other States and UTs

[358] Exchange Rate - 81.59 as assessed on 01 October 2022

4.31 Telangana

4.31.1 Restoration Barometer

The following table summarises the key components of the Restoration Barometer:

Table 204: Highlights of Restoration Barometer for Telangana

Highlights	
Area brought under restoration (in ha)	4,176,409.22
Financial flow (in million INR)	52,079.40
Socio-economic impacts (man-days generated) (in million)	153.76
Climate impacts: Estimated carbon sequestered (in million tC)	64.13 (0% Mortality)
	50.66 (21% Mortality)
Climate impacts: Estimated carbon dioxide sequestered (in million tCO_2e)	235.35 (0% Mortality)
	185.92 (21% Mortality)

4.31.2 Background

Telangana is located in the southern part of India and is one of the newly formed states. It was part of Andhra Pradesh until 2nd June 2014. The total geographical area of the state is 112,077 sq km, which covers 3.41% of the country's TGA.[359] The state has a tropical climate and is located in a semi-arid area, primarily characterised by hot and dry weather. The annual temperature ranges from 15°C to 45°C, and the annual rainfall ranges from 1,100 mm to 1,200 mm.[360]

The state has a population of 35.19 million, which is 2.91% of India's population. The rural and urban populations comprise 61.12% and 38.88%, respectively. The tribal population is 9.35%. The population density is 306 persons per sq km, which is lower than the national average. The 19th Livestock Census of 2012 reported a total livestock population of 56.10 million in the state.[361]

The state's economy is primarily driven by the tertiary sector, with IT services playing a key role. The secondary sector, led by pharmaceuticals, contributes equally to the economy as the primary sector, which is supported by agriculture. Cotton and rice are the key contributors in the agricultural domain.[362] The total forest cover of the state is 21,213.98 sq km, which forms 18.93% of the state's area.[363]

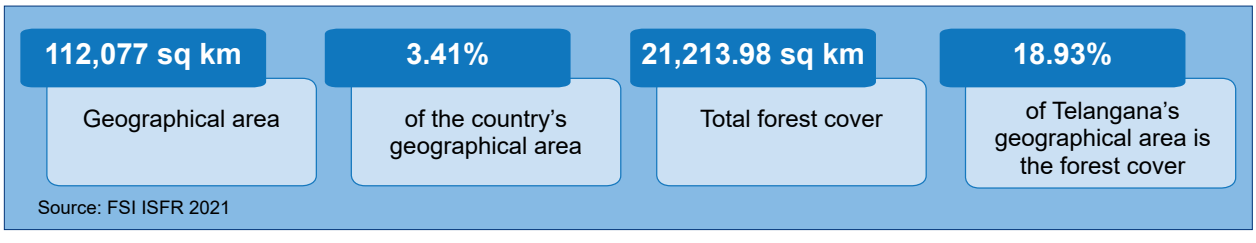


Figure 107: Geographical Area and Forest Cover of Telangana

[359] ISFR 2021, https://fsi.nic.in/isfr-2021/chapter-13.pdf
[360] ISFR 2019, https://fsi.nic.in/isfr19/vol2/isfr-2019-vol-ii-telangana.pdf
[361] ISFR 2019, https://fsi.nic.in/isfr19/vol2/isfr-2019-vol-ii-telangana.pdf
[362] IBEF Infographics, https://www.ibef.org/states/telangana-infographic
[363] ISFR 2021, https://fsi.nic.in/isfr-2021/chapter-13.pdf

As per ISFR 2015[364 and 365] and ISFR 2021[366], the following observations were made:

- In the five years from 2015 to 2020, there is an increase of 377.02 sq km, or 37,702 ha, in forest cover.
- The tree cover of Telangana constituted 2.54% of the state's TGA. In the last five years, there is an increase of 299 sq km, or 29,900 ha, in the tree cover area of the state.
- The average growing stock in Telangana is 80.20 million cum in forest and 43.76 million cum in ToF. In the last 10 years, the average growing stock in the forest area and ToF has increased by 123.96 million cum.
- The total carbon stock of forest in the State, including the TOF patches which are more than one ha in size, is 161.99 million tonnes (593.96 $MtCO_2e$), which is 2.25% of the total forest carbon in the country.

As per the 2021 DLD Atlas of India, 3,638,508 ha of land, representing 31.68% of the state's TGA, is affected by various forms of desertification and land degradation. There has been an increase of 39,652 ha (0.34%) of degraded land from 2011–13 to 2018–19. The primary driver of land degradation is water erosion (24.61%), followed by vegetation degradation (4.75%).[367]

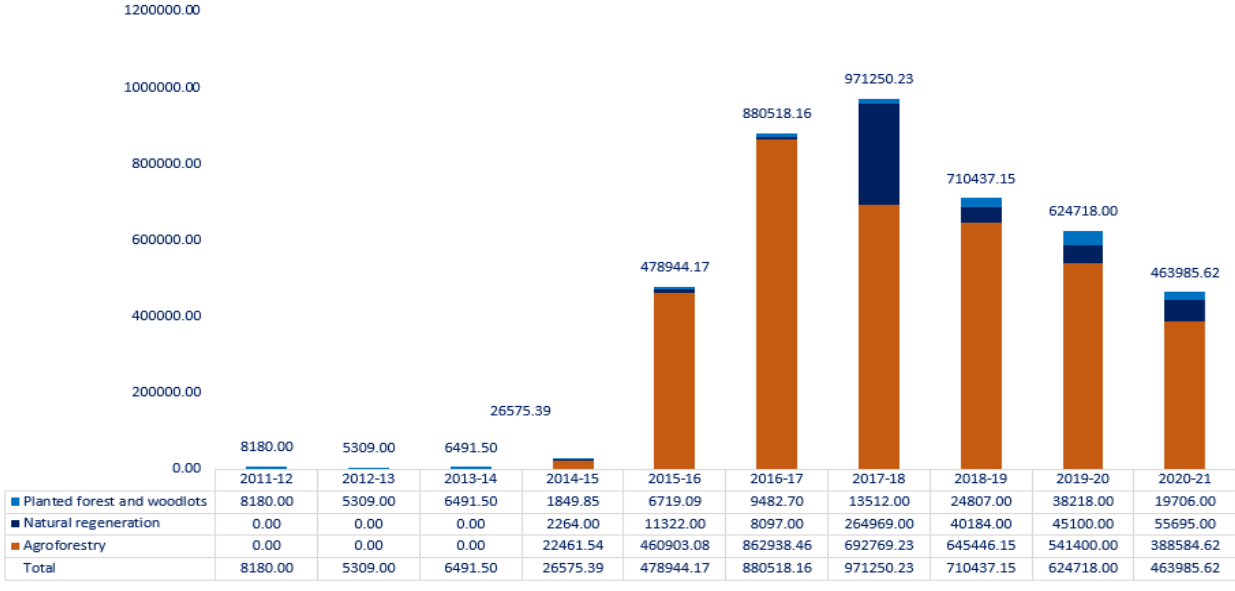
Table 205: Status of desertification and land degradation from 2018–19 and 2011–13 (area in ha) in Telangana

Year	Vegetation Degradation	Water Erosion	Salinity	Manmade	Barren/ Rocky	Settlement
2018-19	545,477	2,826,129	105,955	41,076	1,979	117,893
2011-13	541,145	2,854,285	86,514	16,982	1,979	97,951

Source: ISRO 2021

4.31.3 Restoration Barometer: State Contribution

4.31.3.1 Area brought under restoration



	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20	2020-21
Planted forest and woodlots	8180.00	5309.00	6491.50	1849.85	6719.09	9482.70	13512.00	24807.00	38218.00	19706.00
Natural regeneration	0.00	0.00	0.00	2264.00	11322.00	8097.00	264969.00	40184.00	45100.00	55695.00
Agroforestry	0.00	0.00	0.00	22461.54	460903.08	862938.46	692769.23	645446.15	541400.00	388584.62
Total	8180.00	5309.00	6491.50	26575.39	478944.17	880518.16	971250.23	710437.15	624718.00	463985.62

Figure 108: Area brought under restoration from 2011–2020 as reported by SFD of Telangana

[364] ISFR 2015, https://fsi.nic.in/isfr-2015/isfr-2015-forest-and-tree-resources-in-states-and-union-territories.pdf

[365] Before 2015 Andhra Pradesh and Telangana were together. Segregated values of the states are not available before 2015. Hence, the ISFR analysis is done from 2015 onwards to avoid any inconsistencies. https://fsi.nic.in/isfr-2021/chapter-13.pdf

[366] ISFR 2021, https://fsi.nic.in/isfr-2021/chapter-13.pdf

[367] DLD Atlas of India, 2021, https://vedas.sac.gov.in/static/atlas/dsm/DLD_Atlas_SAC_2021.pdf

As of 2020, a total of 4,176,409.22 ha of the state's area had been brought under restoration since 2011, according to data submitted by the State Forest Department.

Table 206: Area brought under restoration based on FLR interventions by SFD of Telangana

FLR interventions implemented	Area brought under restoration (in ha)
Planted forest and woodlots	134,275.14
Natural regeneration	427,631
Agroforestry	3,614,503.08

4.31.3.2 Climate impacts

The carbon sequestration for Telangana has been estimated for the restoration work carried out from 2011 to 2020 under different scenarios (A1 and A2) and assumptions (a1, a2, and a3). To estimate carbon sequestration, the IPCC GPG LULUCF 2003 methodology has been adopted. Telangana is classified under the Moist with Long Dry Season category, with an annual average rainfall ranging from 1,000 mm – 2,000 mm. According to the IPCC GPG LULUCF 2003, the following cases of average annual increment are applicable for this level of rainfall – best case (12.6 tdm/ha/yr), base case (7.1 tdm/ha/yr), and worst case (1.6 tdm/ha/yr), for the estimation of carbon sequestration.[368] The detailed methodology for estimating carbon sequestration is outlined in Section 1.4.1(B) and Annex I of the report. Based on this methodology, the total carbon sequestered and the per-hectare carbon sequestration are presented in the following graph and table, respectively.

To report on carbon sequestration while accounting for mortality rates, the Base Case (a2) assumption under the two scenarios has been applied, as it represents a balanced middle ground with neither too high nor too low values (refer to the detailed methodology in Section 1.4.1(B) and Annex I).

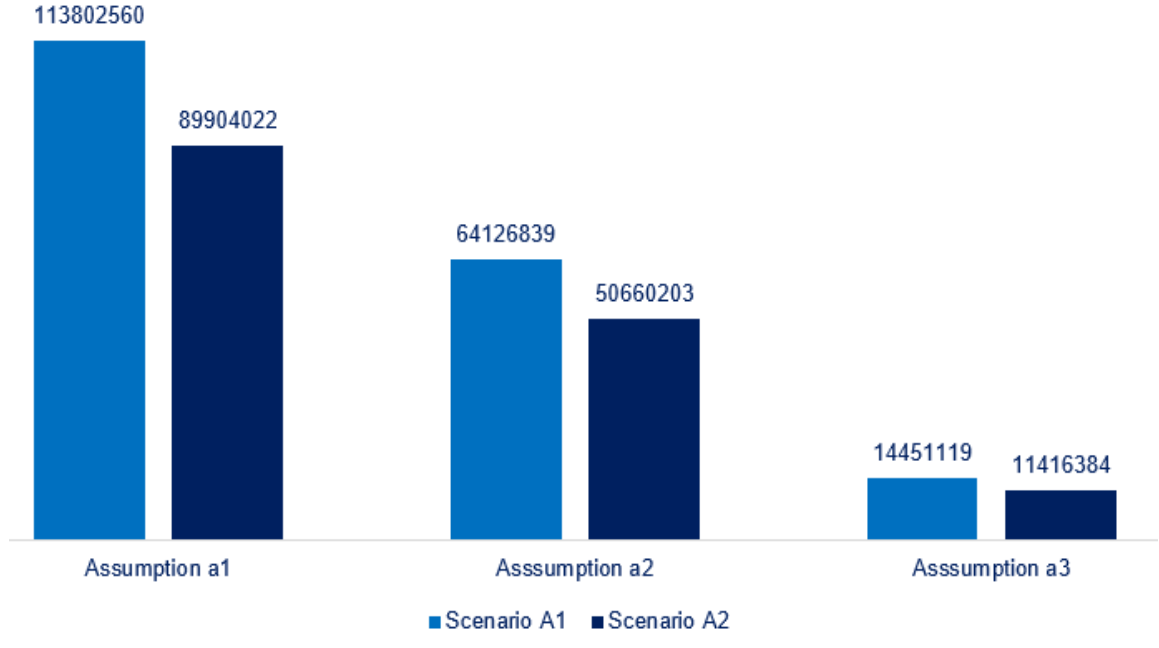


Figure 109: Total calculated tC sequestration in 10 years under two scenarios and three assumptions in Telangana

[368] GPG LULUCF table 3A.1.6 - for AGB only https://www.ipcc-nggip.iges.or.jp/public/gpglulucf/gpglulucf_files/Chp3/Anx_3A_1_Data_Tables.pdf

From 2011 to 2020, expressed as carbon, this corresponds to 64.13 million tonnes of carbon (tC) without factoring in mortality and 50.66 million tC when a mortality rate of 21%, was considered. An estimated 235.35 million tonnes of carbon dioxide (tCO_2e) were sequestered, excluding plantation mortality. When accounting for mortality, the sequestration was 185.92 million tCO_2e.[369]

Table 207: Carbon stock tC (per ha) in AGB and BGB carbon pools in area brought under restoration for different assumptions and scenarios in Telangana

Scenario	Assumption a1	Assumption a2	Assumption a3
Scenario A1	27.25	15.35	3.46
Scenario A2	21.53	12.13	2.73

4.31.3.3 Socio-economic impact

The socio-economic impact achieved has been measured in terms of man-days generated through FLR work in the state. According to SFD data for the period 2011 to 2020, a total of 153.76 million man-days of jobs were generated. This assessment accounts for the number of people involved in the implementation and maintenance of areas brought under restoration.

Table 208: Socio-economic impact (man-days generated) in Telangana

Socio-economic impact											
Year	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20	2020-21	Total
Number of man-days generated (in million)	1.27	0.99	1.07	10.24	16.98	15.35	19.51	28.76	28.50	31.09	**153.76**

4.31.3.4 Financial flow

The total financial flow towards FLR in the state has been reported as INR 52,079.40 million (USD 638.31 million).[370] Domestic public expenditure is the primary source of funding, according to data provided by the SFD for the period 2011 to 2020.

Table 209: Financial outflow from 2011–2020 in Telangana

Financial outflow											
Year	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20	2020-21	Total
FLR Funding in INR (million)	256.9	226.61	265.1	2,885.37	5,093.73	5,640.93	6,309.28	9,585.89	9,784.53	12,031.03	**52,079.40**

Table 210: Fund utilisation for bringing area under restoration in Telangana

Description	**Fund utilisation** (2011-12 to 2020-21)
Total area brought under restoration (ha)	4,176,409.22
Total fund invested in FLR activities (million INR)	52,079.40
Funds invested per hectare (million INR/ha)	0.01
Area brought under restoration per million rupees (ha/million INR)	80.19

[369] Mortality rates was not available at the time of publication of this report. Hence, law of averages was applied assigning the average mortality rate derived from mortality rates provided by 13 other States and UTs

[370] Exchange Rate - 81.59 as assessed on 01 October 2022

4.32 Tripura

4.32.1 Restoration Barometer

The following table summarises the key components of the Restoration Barometer:

Table 211: Highlights of Restoration Barometer for Tripura

Highlights	
Area brought under restoration (in ha)	115,323.36
Financial flow (in million INR)	5,156.47
Socio-economic impacts (man-days generated) (in million)	33.19
Climate impacts: Estimated carbon sequestered (in million tC)	2.58 (0% Mortality)
	2.04 (21% Mortality)
Climate impacts: Estimated carbon dioxide sequestered (in million tCO_2e)	9.47 (0% Mortality)
	7.48 (21% Mortality)

4.32.2 Background

Tripura is located in the northeastern part of India and shares its border on three sides with Bangladesh. The state is known for its handicrafts, bamboo products, and wood carvings. The total geographical area of the state is 10,486 sq km, which covers 0.32% of the country's TGA.[371] The state has a moist to humid climate, with an annual temperature range from 7°C to 36°C. The annual rainfall ranges from 2,250 mm to 2,500 mm.[372]

According to the 2011 Census, Tripura has a population of 3.67 million, which is 0.30% of India's population. The rural and urban population constitutes 73.83% and 26.17% respectively. The Tribal population is 31.76%. The average population density of the state is 350 persons per sq km, which is slightly lower than the national average. The livestock population of the state, as per the 19th Livestock Census of 2012, is 1.94 million.[373]

The tertiary and primary sectors play a significant role in driving Tripura's economy. The primary sector is led by natural gas, tea, bamboo, sericulture, and forestry. The tertiary sector, with tourism and services, further supports Tripura's economic landscape. Although the secondary sector contributes less, it is driven by food processing, rubber, and handloom and handicrafts.[374] The total forest cover of the state is 7,721.52 sq km, which forms 73.64% of the state's area.[375]

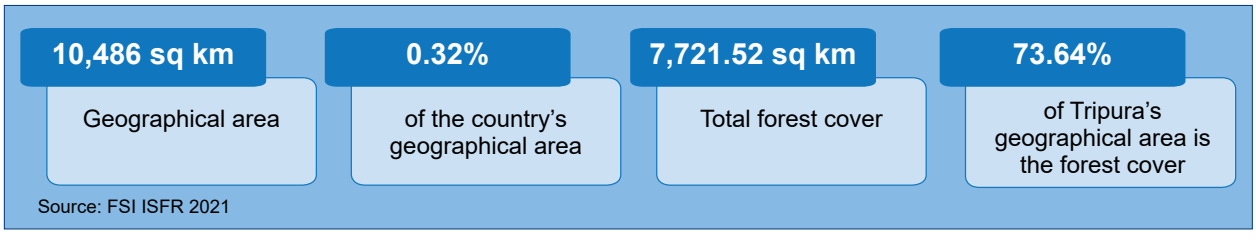


Figure 110: Geographical Area and Forest Cover of Tripura

[371] ISFR 2021, https://fsi.nic.in/isfr-2021/chapter-13.pdf
[372] ISFR 2019, https://fsi.nic.in/isfr19/vol2/isfr-2019-vol-ii-tripura.pdf
[373] ISFR 2019, https://fsi.nic.in/isfr19/vol2/isfr-2019-vol-ii-tripura.pdf
[374] IBEF Infographics, https://www.ibef.org/states/tripura-infographic
[375] ISFR 2021, https://fsi.nic.in/isfr-2021/chapter-13.pdf

As per ISFR 2011[376] and ISFR 2021[377], the following observations were made:

- In the last 10 years, from 2011 to 2020, there is an increase of 255.48 sq km, or 25,548 ha, in the forest cover.
- The tree cover of Tripura constituted 2.17% of the state's TGA. In the last 10 years, there is an increase of 44 sq km, or 4,400 ha, in the tree cover area of the state.
- The average growing stock in Tripura is 23.13 million cum in forest and 7.46 million cum in ToF. In the last 10 years, the average growing stock in the forest area and ToF has increased by 1.34 million cum.
- The total carbon stock of forest in the State, including the TOF patches which are more than one ha in size, is 74.97 million tonnes (274.89 $MtCO_2e$), which is 1.04% of the total forest carbon in the country.

As per the 2021 DLD Atlas of India, 447,378 ha of land, representing 42.66% of the state's TGA, is affected by various forms of desertification and land degradation. There has been an increase of 10,250 ha (0.97%) of degraded land from 2011–13 to 2018–19. The primary driver of land degradation is vegetation degradation (23.40%), followed by water erosion (17.70%).[378]

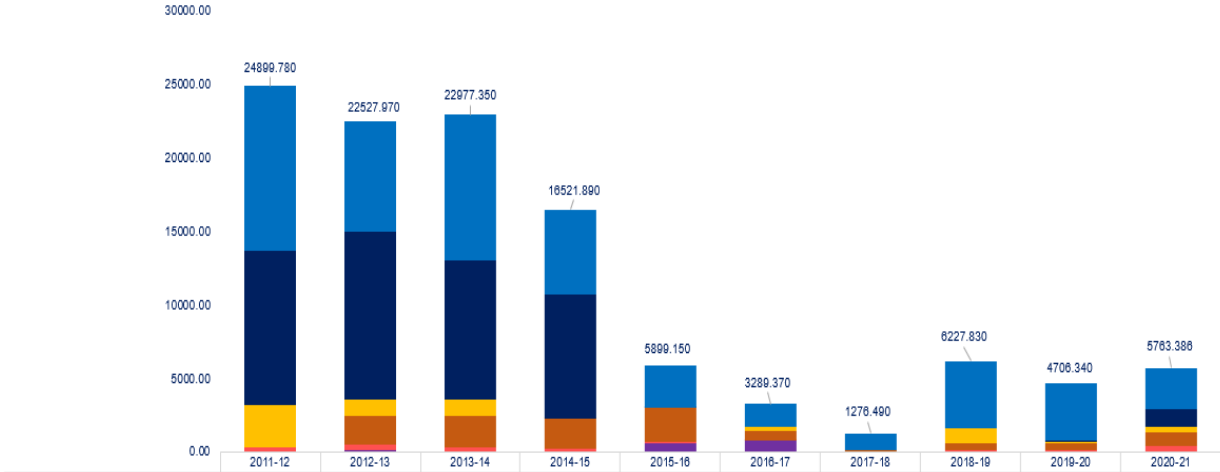
Table 212: Status of desertification and land degradation from 2018–19 and 2011–13 (area in ha) in Tripura

Year	Vegetation Degradation	Water Erosion	Settlement
2018-19	245,366	185,575	16,437
2011-13	236,374	186,900	13,854

Source: ISRO 2021

4.32.3 Restoration Barometer: State Contribution

4.32.3.1 Area brought under restoration



	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20	2020-21
Planted forests and woodlots	11177.93	7496.62	9923.23	5781.74	2857.62	1534.28	1127.49	4579.78	3947.21	2793.550
Natural Regeneration	10542.64	11441.31	9465.50	8442.93	58.10	0.00	0.00	0.00	40.50	1228.796
Silviculture	2829.36	1146.50	1091.65	41.50	0.00	333.50	0.00	1074.46	77.03	410.000
Agroforestry	0.00	1945.10	2206.16	1981.11	2307.78	639.50	133.00	432.00	500.60	939.560
Watershed protection and erosion control	315.01	357.67	241.14	209.35	89.38	10.00	16.00	141.59	141.00	391.480
Others	34.84	140.77	49.67	65.26	586.29	772.09	0.00	0.00	0.00	0.000
Total	24899.780	22527.970	22977.350	16521.890	5899.150	3289.370	1276.490	6227.830	4706.340	5763.386

Figure 111: Area brought under restoration from 2011–2020 as reported by SFD of Tripura

[376] ISFR 2011, https://fsi.nic.in/forest-report-2011

[377] ISFR 2021, https://fsi.nic.in/forest-report-2021-details

[378] DLD Atlas of India, 2021, https://vedas.sac.gov.in/static/atlas/dsm/DLD_Atlas_SAC_2021.pdf

As of 2020, a total of 114,089.56 ha of the state's area had been brought under restoration since 2011, according to data submitted by the State Forest Department. Additionally, data from the Department of Land Resources (DoLR) indicate that 1,233.80 ha were restored between 2018 and 2020 by the DoLR.

Table 213: Area brought under restoration based on FLR interventions by SFD of Tripura

FLR interventions implemented	Area brought under restoration (in ha)
Planted forest and woodlots	51,219.45
Natural regeneration	41,219.78
Silviculture	7,004
Agroforestry	11,084.81
Watershed protection and erosion control	1,912.60
Others	1,648.92

4.32.3.2 Climate impacts

The carbon sequestration for Tripura has been estimated for the restoration work carried out from 2011 to 2020 under different scenarios (A1 and A2) and assumptions (a1, a2, and a3). To estimate carbon sequestration, the IPCC GPG LULUCF 2003 methodology has been adopted. Tripura is classified under the Wet Season category, with an annual average rainfall of >2,000 mm. According to the IPCC GPG LULUCF 2003, the following cases of average annual increment are applicable for this level of rainfall – best case (8 tdm/ha/yr), base case (5.2 tdm/ha/yr), and worst case (2.4 tdm/ha/yr), for the estimation of carbon sequestration.[379] The detailed methodology for estimating carbon sequestration is outlined in Section 1.4.1(B) and Annex I of the report. Based on this methodology, the total carbon sequestered and the per-hectare carbon sequestration are presented in the following graph and table, respectively.

To report on carbon sequestration while accounting for mortality rates, the Base Case (a2) assumption under the two scenarios has been applied, as it represents a balanced middle ground with neither too high nor too low values (refer to the detailed methodology in Section 1.4.1(B) and Annex I).

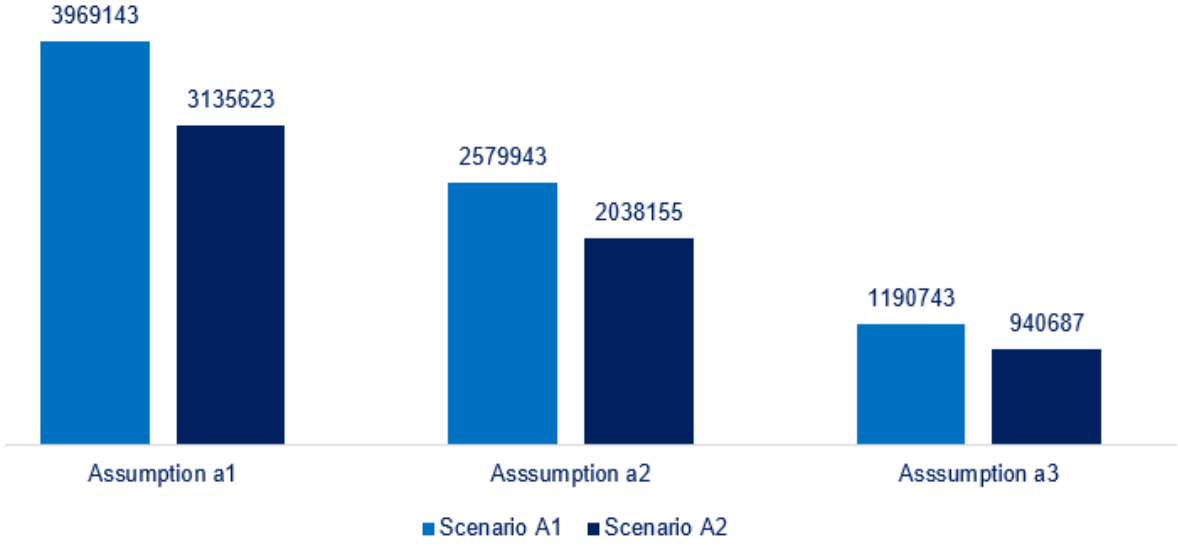


Figure 112: Total calculated tC sequestration in 10 years under two scenarios and three assumptions in Tripura

[379] GPG LULUCF table 3A.1.6 - for AGB only https://www.ipcc-nggip.iges.or.jp/public/gpglulucf/gpglulucf_files/Chp3/Anx_3A_1_Data_Tables.pdf

Therefore, from 2011 to 2020, when considering carbon in terms of tonnes, the sequestration is also 2.58 million tonnes of carbon (tC) without factoring in mortality, and 2.04 million tC considering 21% mortality. The sequestration of 9.47 million tonnes of carbon dioxide (tCO_2e) without accounting for plantation mortality, and 7.48 million tCO_2e when mortality is considered.[380]

Table 214: Carbon stock tC (per ha) in AGB and BGB carbon pools in area brought under restoration for different assumptions and scenarios in Tripura

Scenario	Assumption a1	Assumption a2	Assumption a3
Scenario A1	34.42	22.37	10.33
Scenario A2	27.19	17.67	8.16

4.32.3.3 Socio-economic impact

The socio-economic impact achieved has been measured in terms of man-days generated through FLR work in the state. According to SFD data for the period 2011 to 2020, a total of 33.19 million man-days of jobs were generated. This assessment accounts for the number of people involved in the implementation and maintenance of areas brought under restoration.

Table 215: Socio-economic impact (man-days generated) in Tripura

Socio-economic impact											
Year	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20	2020-21	Total
Number of man-days generated (in million)	6.63	5.05	5.28	3.45	3.57	2.90	0.50	2.20	1.74	1.85	**33.19**

4.32.3.4 Financial Flow

The total financial flow towards FLR in the state has been reported as INR 5,156.47 million (USD 63.20 million).[381] Domestic public expenditure is the primary source of funding, according to data provided by the SFD for the period 2011 to 2020.

Table 216: Financial outflow from 2011–2020 in Tripura

Financial outflow											
Year	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20	2020-21	Total
FLR Funding in INR (million)	939.20	775.70	816.90	549.50	285.95	464.55	94.44	372.80	419.40	438.03	**5,156.47**

Table 217: Fund utilisation for bringing area under restoration in Tripura

Description	**Fund utilisation** (2011-12 to 2020-21)
Total area brought under restoration (ha)	114,089.56
Total fund invested in FLR activities (million INR)	5,156.47
Funds invested per hectare (million INR/ha)	0.04
Area brought under restoration per million rupees (ha/million INR)	22.36

[380] Mortality rates was not available at the time of publication of this report. Hence, law of averages was applied assigning the average mortality rate derived from mortality rates provided by 13 other States and UTs

[381] Exchange Rate - 81.59 as assessed on 01 October 2022

4.33 Uttar Pradesh

4.33.1 Restoration Barometer

The following table summarises the key components of the Restoration Barometer:

Table 218: Highlights of Restoration Barometer for Uttar Pradesh

Highlights	
Area brought under restoration (in ha)	1,503,952.53
Financial flow (in million INR)	38,656.30
Socio-economic impacts (man-days generated) (in million)	74.86
Climate impacts: Estimated carbon sequestered (in million tC)	23.25 (0% Mortality)
	18.37 (21% Mortality)
Climate impacts: Estimated carbon dioxide sequestered (in million tCO_2e)	85.33 (0% Mortality)
	67.41 (21% Mortality)

4.33.2 Background

Uttar Pradesh is the fourth largest state in India, with an area of 240,928 sq km, which accounts for 7.33% of the country's total geographical area.[382] The state is situated in the northern part of India and is drained by several rivers originating either from the Himalayas in the north or the Vindhya Range in the south. Uttar Pradesh has a humid subtropical climate with dry winters. The annual temperature ranges from 5°C to 46°C, and the annual rainfall ranges from 1,000 mm to 1,200 mm.[383]

Uttar Pradesh is the most populous state in India, with a population of 199.81 million, which is 16.50% of India's total population. The rural and urban populations comprise 77.73% and 22.27%, respectively. The tribal population is 0.57%. The average population density of the state is 829 persons per sq km, which is more than twice the national average. According to the 19th Livestock Census of 2012, the total livestock population in the state is 68.71 million.[384]

Uttar Pradesh's economy is primarily driven by the tertiary sector, with services, IT, and tourism playing a major role. The secondary sector, including textiles, leather goods, handloom and handicrafts, and sports goods, also contributes significantly. Meanwhile, agriculture, particularly wheat, sugarcane, and potatoes, remains crucial in the primary sector.[385] The total forest cover of the state is 14,817.89 sq km, which forms 6.15% of the state's area.[386]

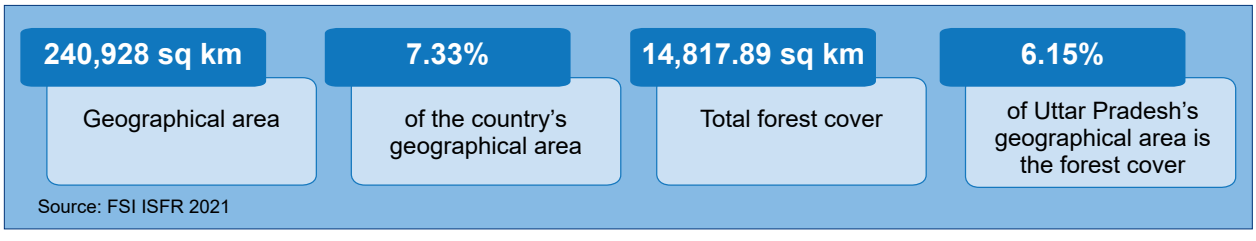


Figure 113: Geographical Area and Forest Cover of Uttar Pradesh

[382] ISFR 2021, https://fsi.nic.in/isfr-2021/chapter-13.pdf
[383] ISFR 2019, https://fsi.nic.in/isfr19/vol2/isfr-2019-vol-ii-uttar-pradesh.pdf
[384] ISFR 2019, https://fsi.nic.in/isfr19/vol2/isfr-2019-vol-ii-uttar-pradesh.pdf
[385] IBEF Infographics, https://www.ibef.org/states/uttar-pradesh-infographic
[386] ISFR 2021, https://fsi.nic.in/isfr-2021/chapter-13.pdf

As per ISFR 2011[387] and ISFR 2021[388], the following observations were made:

- In the last 10 years, from 2011 to 2020, there is an increase of 479.89 sq km, or 47,989 ha, in the forest cover.
- The tree cover of Uttar Pradesh constituted 3.08% of the state's TGA. In the last 10 years, there is an increase of 39 sq km, or 3,900 ha, in the tree cover area of the state.
- The average growing stock in Uttar Pradesh is 104.39 million cum in forest and 106.75 million cum in ToF. In the last 10 years, the average growing stock in the forest area decreased by 19.01 million cum while increased for ToF by 25.07 million cum.
- The total carbon stock of forest in the State, including the TOF patches which are more than one ha in size, is 117.24 million tonnes (429.88 $MtCO_2e$), which is 1.63% of the total forest carbon in the country.

As per the 2021 DLD Atlas of India, 1,549,608 ha of land, representing 6.43% of the state's TGA, is affected by various forms of desertification and land degradation. There has been an increase of 20,612 ha (0.08%) of degraded land from 2011–13 to 2018–19. The primary driver of land degradation is water erosion (2.42%), followed by vegetation degradation (1.74%).[389]

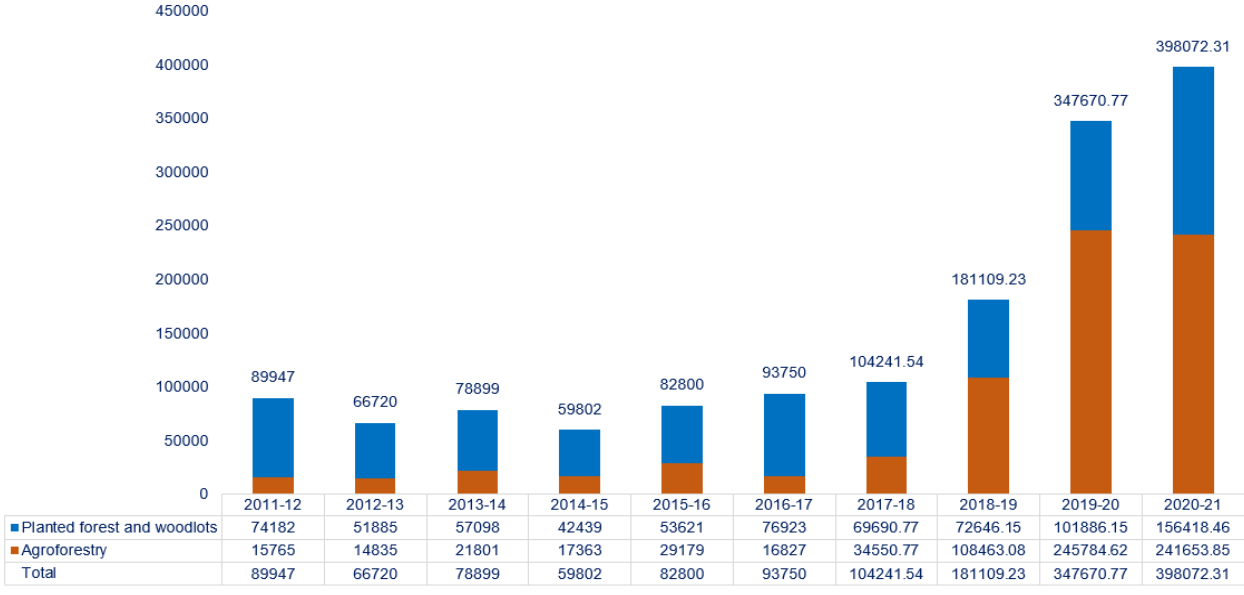
Table 219: Status of desertification and land degradation from 2018–19 and 2011–13 (area in ha) in Uttar Pradesh

Year	Vegetation Degradation	Water Erosion	Salinity	Water Logging	Manmade	Settlement
2018-19	419,538	584,188	282,913	34,505	9,836	218,628
2011-13	413,476	586,961	307,571	33,620	5,970	181,399

Source: ISRO 2021

4.33.3 Restoration barometer: State contribution

4.33.3.1 Area brought under restoration



	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20	2020-21
Planted forest and woodlots	74182	51885	57098	42439	53621	76923	69690.77	72646.15	101886.15	156418.46
Agroforestry	15765	14835	21801	17363	29179	16827	34550.77	108463.08	245784.62	241653.85
Total	89947	66720	78899	59802	82800	93750	104241.54	181109.23	347670.77	398072.31

Figure 114: Area brought under restoration from 2011–2020 as reported by SFD of Uttar Pradesh

[387] ISFR 2011, https://fsi.nic.in/forest-report-2011

[388] ISFR 2021, https://fsi.nic.in/forest-report-2021-details

[389] DLD Atlas of India, 2021, https://vedas.sac.gov.in/static/atlas/dsm/DLD_Atlas_SAC_2021.pdf

As of 2020, a total of 1,503,011.85 ha of the state's area had been brought under restoration since 2011, according to data submitted by the State Forest Department. Additionally, data from the Department of Land Resources (DoLR) indicate that 940.68 ha were restored between 2018 and 2020 by the DoLR.

Table 220: Area brought under restoration based on FLR interventions by SFD of Uttar Pradesh

FLR interventions implemented	Area brought under restoration (in ha)
Planted forest and woodlots	756,789.53
Agroforestry	746,222.32

4.33.3.2 Climate impacts

The carbon sequestration for Uttar Pradesh has been estimated for the restoration work carried out from 2011 to 2020 under different scenarios (A1 and A2) and assumptions (a1, a2, and a3). To estimate carbon sequestration, the IPCC GPG LULUCF 2003 methodology has been adopted. Uttar Pradesh is classified under the Moist with Long Dry Season category, with an annual average rainfall ranging from 1,000 mm – 2,000 mm. According to the IPCC GPG LULUCF 2003, the following cases of average annual increment are applicable for this level of rainfall – best case (12.6 tdm/ha/yr), base case (7.1 tdm/ha/yr), and worst case (1.6 tdm/ha/yr), for the estimation of carbon sequestration.[390] The detailed methodology for estimating carbon sequestration is outlined in Section 1.4.1(B) and Annex I of the report. Based on this methodology, the total carbon sequestered and the per-hectare carbon sequestration are presented in the following graph and table, respectively.

To report on carbon sequestration while accounting for mortality rates, the Base Case (a2) assumption under the two scenarios has been applied, as it represents a balanced middle ground with neither too high nor too low values (refer to the detailed methodology in Section 1.4.1(B) and Annex I).

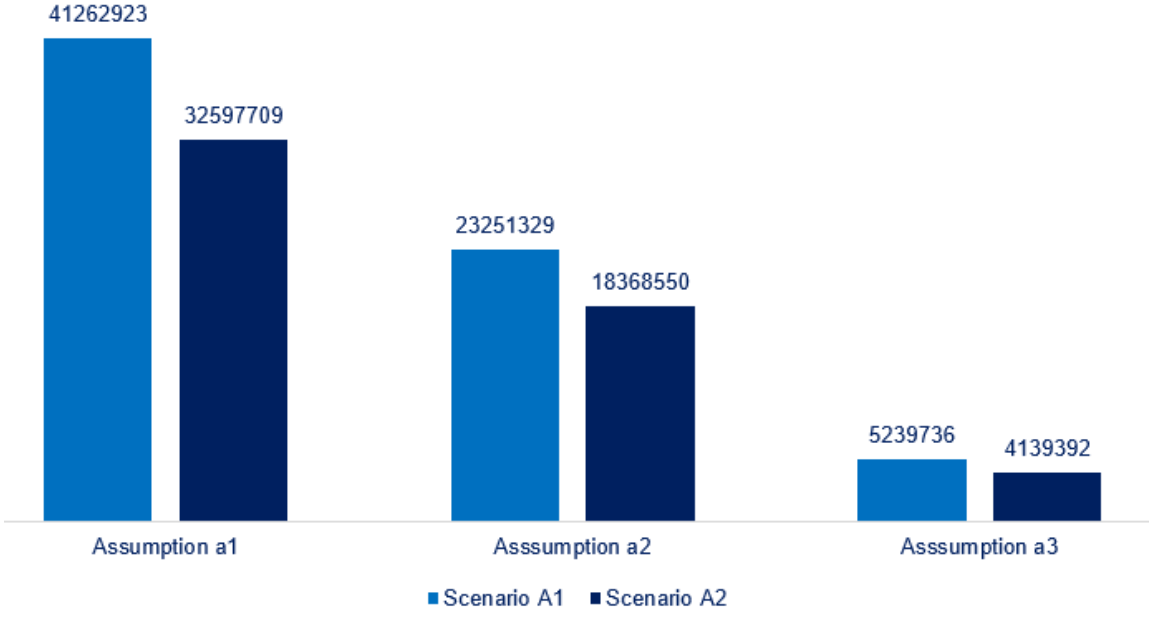


Figure 115: Total calculated tC sequestration in 10 years under two scenarios and three assumptions in Uttar Pradesh

[390] GPG LULUCF table 3A.1.6 - for AGB only https://www.ipcc-nggip.iges.or.jp/public/gpglulucf/gpglulucf_files/Chp3/Anx_3A_1_Data_Tables.pdf

From 2011 to 2020, expressed as carbon, this corresponds to 23.25 million tonnes of carbon (tC) without factoring in mortality and 18.37 million tC when a mortality rate of 21%, was considered. An estimated 85.33 million tonnes of carbon dioxide (tCO_2e) were sequestered, excluding plantation mortality. When accounting for mortality, the sequestration was 67.41 million tCO_2e.[391]

Table 221: Carbon stock tC (per ha) in AGB and BGB carbon pools in area brought under restoration for different assumptions and scenarios in Uttar Pradesh

Scenario	Assumption a1	Assumption a2	Assumption a3
Scenario A1	27.44	15.46	3.48
Scenario A2	21.67	12.21	2.75

4.33.3.3 Socio-economic impact

The socio-economic impact achieved has been measured in terms of man-days generated through FLR work in the state. According to SFD data for the period 2011 to 2020, a total of 74.86 million man-days of jobs were generated. This assessment accounts for the number of people involved in the implementation and maintenance of areas brought under restoration.

Table 222: Socio-economic impact (man-days generated) in Uttar Pradesh

Socio-economic impact											
Year	**2011-12**	**2012-13**	**2013-14**	**2014-15**	**2015-16**	**2016-17**	**2017-18**	**2018-19**	**2019-20**	**2020-21**	**Total**
Number of man-days generated (in million)	2.06	2.81	2.66	2.56	4.65	12.55	6.04	8.45	18.02	15.06	**74.86**

4.33.3.4 Financial Flow

The total financial flow towards FLR in the state has been reported as INR 38,656.30 million (USD 473.79 million).[392] Domestic public expenditure is the primary source of funding, according to data provided by the SFD for the period 2011 to 2020.

Table 223: Financial outflow from 2011–2020 in Uttar Pradesh

Financial outflow											
Year	**2011-12**	**2012-13**	**2013-14**	**2014-15**	**2015-16**	**2016-17**	**2017-18**	**2018-19**	**2019-20**	**2020-21**	**Total**
FLR Funding in INR (million)	1,506.4	1,881.3	2,570.8	3,247.7	3,606.7	7,312.6	2,519.2	3,279.2	7,177.7	5,554.7	**38,656.30**

Table 224: Fund utilisation for bringing area under restoration in Uttar Pradesh

Description	**Fund utilisation** (2011-12 to 2020-21)
Total area brought under restoration (ha)	1,503,011.85
Total fund invested in FLR activities (million INR)	38,656.30
Funds invested per hectare (million INR/ha)	0.03
Area brought under restoration per million rupees (ha/million INR)	38.88

[391] Mortality rates was not available at the time of publication of this report. Hence, law of averages was applied assigning the average mortality rate derived from mortality rates provided by 13 other States and UTs

[392] Exchange Rate - 81.59 as assessed on 01 October 2022

4.34 Uttarakhand

4.34.1 Restoration Barometer

The following table summarises the key components of the Restoration Barometer:

Table 225: Highlights of Restoration Barometer for Uttarakhand

Highlights	
Area brought under restoration (in ha)	217,975.87
Financial flow (in million INR)	51,176.50
Socio-economic impacts (man-days generated) (in million)	118.89
Climate impacts: Estimated carbon sequestered (in million tC)	5.24 (0% Mortality)
	4.72 (10% Mortality)
Climate impacts: Estimated carbon dioxide sequestered (in million tCO_2e)	19.23 (0% Mortality)
	17.31 (10% Mortality)

4.34.2 Background

Uttarakhand is situated in the northern part of India, bordering China and Nepal. It is home to the origin of the holy rivers Ganga and Yamuna. The state has three distinct regions: the Himalayas, the Shivaliks, and the Terai region. The total geographical area of the state is 53,483 sq km, which covers 1.63% of the TGA of the country.[393]

The state has a temperate climate, except in the plains, where the climate is tropical. The northern part experiences heavy snowfall during winter. The average annual temperature ranges from 0°C to 43°C, and the average annual rainfall is 1,500 mm.[394] The state has a population of 10.09 million, which is 0.83% of India's population. The rural and urban populations of the state constitute 69.77% and 30.23%, respectively. The tribal population is 2.89%. The population density of the state is 189 persons per sq km, which is lower than the national average. According to the 19th Livestock Census of 2012, the total livestock population is 4.79 million.[395]

Uttarakhand's economy is largely driven by the secondary sector, with pharmaceuticals and hydropower playing a major role. The tertiary sector, led by services and tourism, also contributes significantly to the state's economic growth. The primary sector, focused on agriculture, with key crops such as wheat and rice, remains important, though it contributes less to the overall economy.[396] The total forest cover of the state is 24,305.13 sq km, which forms 45.44% of the state's area.[397]

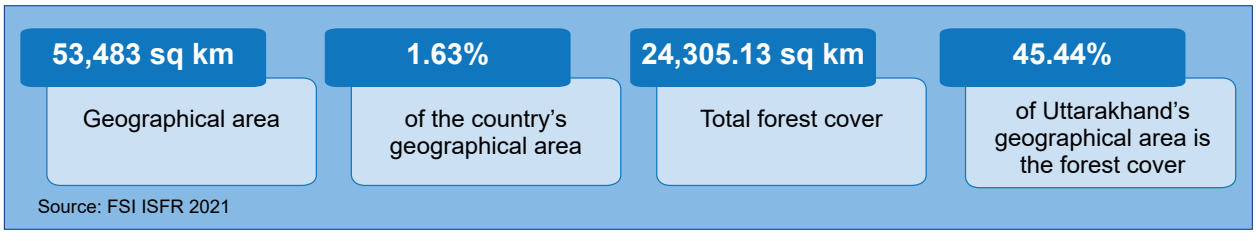


Figure 116: Geographical Area and Forest Cover of Uttarakhand

[393] ISFR 2021, https://fsi.nic.in/isfr-2021/chapter-13.pdf
[394] ISFR 2019, https://fsi.nic.in/isfr19/vol2/isfr-2019-vol-ii-uttarakhand.pdf
[395] ISFR 2019, https://fsi.nic.in/isfr19/vol2/isfr-2019-vol-ii-uttarakhand.pdf
[396] IBEF Infographics, https://www.ibef.org/states/uttrakhand-infographic
[397] ISFR 2021, https://fsi.nic.in/isfr-2021/chapter-13.pdf

As per ISFR 2011[398] and ISFR 2021[399], the following observations were made:

- In the last 10 years, from 2011 to 2020, there is an increase of 190.87 sq km, or 19,087 ha, in the forest cover.
- The tree cover of Uttarakhand constituted 1.87% of the state's TGA. In the last 10 years, there is an increase of 359 sq km, or 35,900 ha, in the tree cover area of the state.
- The average growing stock in Uttarakhand is 401.01 million cum in forest and 18.40 million cum in ToF. In the last 10 years, the average growing stock in the forest area and ToF has decreased by 61.60 million cum.
- The total carbon stock of forest in the State, including the TOF patches which are more than one ha in size, is 378.16 million tonnes (1,386.59 $MtCO_2e$), which is 5.25% of the total forest carbon in the country.

As per the 2021 DLD Atlas of India, 673,894 ha of land, representing 12.60% of the state's TGA, is affected by various forms of desertification and land degradation. There has been an increase of 25,642 ha (0.48%) of degraded land from 2011–13 to 2018–19. The primary driver of land degradation is vegetation degradation (11.79%), followed by settlement (0.92%).[400]

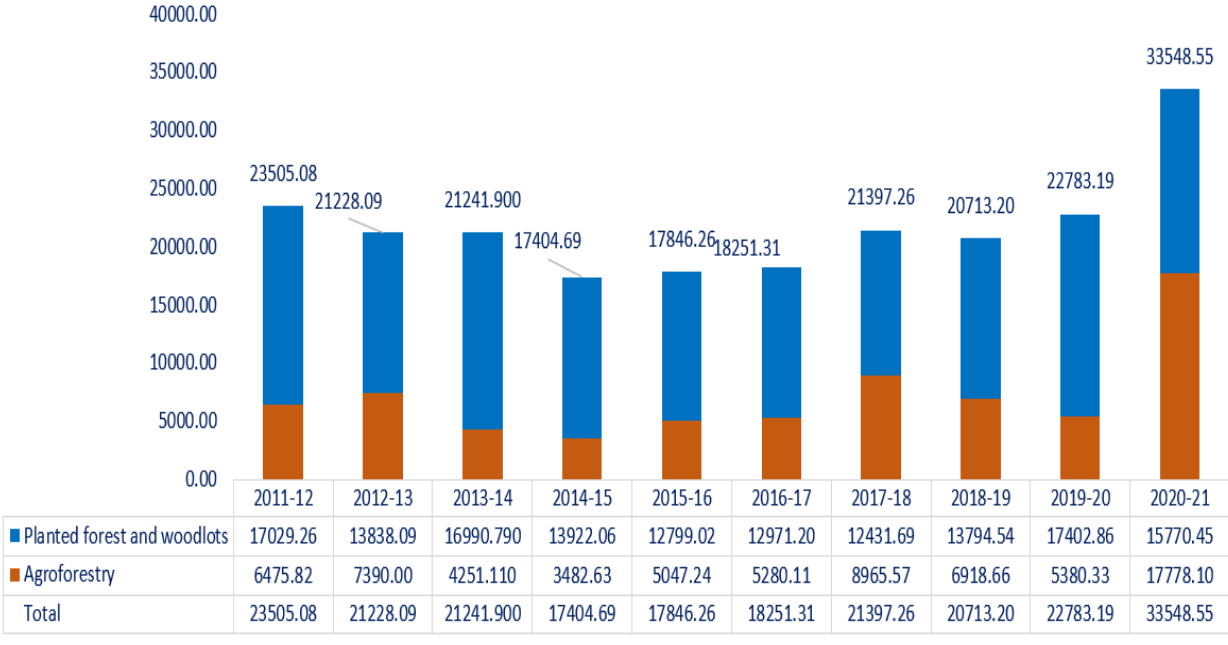
Table 226: Status of desertification and land degradation from 2018–19 and 2011–13 (area in ha) in Uttarakhand

Year	Vegetation Degradation	Water Erosion	Frost Shattering	Settlement
2018-19	630,308	11,943	13,786	17,858
2011-13	606,616	11,943	13,786	15,908

Source: ISRO 2021

4.34.3 Restoration Barometer: State Contribution

4.34.3.1 Area brought under restoration



	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20	2020-21
Planted forest and woodlots	17029.26	13838.09	16990.790	13922.06	12799.02	12971.20	12431.69	13794.54	17402.86	15770.45
Agroforestry	6475.82	7390.00	4251.110	3482.63	5047.24	5280.11	8965.57	6918.66	5380.33	17778.10
Total	23505.08	21228.09	21241.900	17404.69	17846.26	18251.31	21397.26	20713.20	22783.19	33548.55

Figure 117: Area brought under restoration from 2011–2020 as reported by SFD of Uttarakhand

[398] ISFR 2011, https://fsi.nic.in/forest-report-2011

[399] ISFR 2021, https://fsi.nic.in/forest-report-2021-details

[400] DLD Atlas of India, 2021, https://vedas.sac.gov.in/static/atlas/dsm/DLD_Atlas_SAC_2021.pdf

As of 2020, a total of 217,919.53 ha of the state's area had been brought under restoration since 2011, according to data submitted by the State Forest Department. Additionally, data from the Department of Land Resources (DoLR) indicate that 56.34 ha were restored between 2018 and 2020 by the DoLR.

Table 227: Area brought under restoration based on FLR interventions by SFD of Uttarakhand

FLR interventions implemented	Area brought under restoration (in ha)
Planted forest and woodlots	146,949.96
Agroforestry	70,969.57

4.34.3.2 Climate impacts

The carbon sequestration for Uttarakhand has been estimated for the restoration work carried out from 2011 to 2020 under different scenarios (A1 and A2) and assumptions (a1, a2, and a3). To estimate carbon sequestration, the IPCC GPG LULUCF 2003 methodology has been adopted. Uttarakhand is classified under the Moist with Short Dry Season category, with an annual average rainfall ranging from 1,000 mm – 2,000 mm. According to the IPCC GPG LULUCF 2003, the following cases of average annual increment are applicable for this level of rainfall – best case (13.5 tdm/ha/yr), base case (7.8 tdm/ha/yr), and worst case (2 tdm/ha/yr), for the estimation of carbon sequestration.[401] The detailed methodology for estimating carbon sequestration is outlined in Section 1.4.1(B) and Annex I of the report. Based on this methodology, the total carbon sequestered and the per-hectare carbon sequestration are presented in the following graph and table, respectively.

To report on carbon sequestration while accounting for mortality rates, the Base Case (a2) assumption under the two scenarios has been applied, as it represents a balanced middle ground with neither too high nor too low values (refer to the detailed methodology in Section 1.4.1(B) and Annex I).

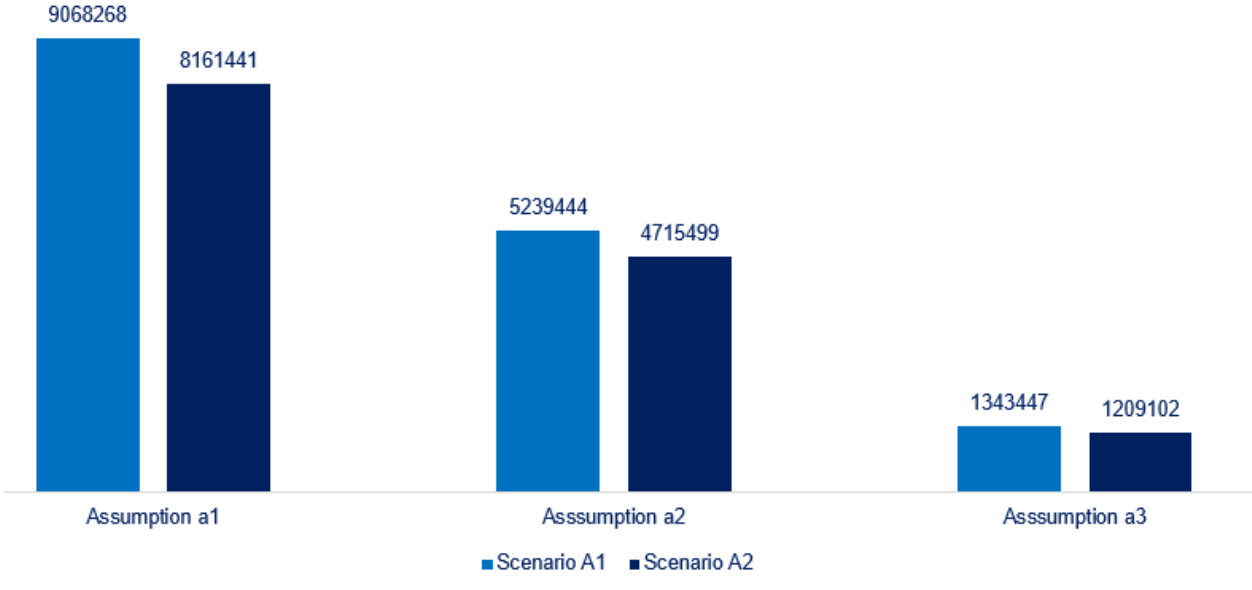


Figure 118: Total calculated tC sequestration in 10 years under two scenarios and three assumptions in Uttarakhand

[401] GPG LULUCF table 3A.1.6 - for AGB only https://www.ipcc-nggip.iges.or.jp/public/gpglulucf/gpglulucf_files/Chp3/Anx_3A_1_Data_Tables.pdf

From 2011 to 2020, expressed as carbon, this corresponds to 5.24 million tonnes of carbon (tC) without factoring in mortality and 4.72 million tC when a mortality rate of 10%, was considered. An estimated 19.23 million tonnes of carbon dioxide (tCO_2e) were sequestered, excluding plantation mortality. When accounting for mortality, the sequestration was 17.31 million tCO_2e.[402]

Table 228: Carbon stock tC (per ha) in AGB and BGB carbon pools in area brought under restoration for different assumptions and scenarios in Uttarakhand

Scenario	Assumption a1	Assumption a2	Assumption a3
Scenario A1	41.60	24.04	6.16
Scenario A2	37.44	21.63	5.55

4.34.3.3 Socio-economic impact

The socio-economic impact achieved has been measured in terms of man-days generated through FLR work in the state. According to SFD data for the period 2011 to 2020, a total of 118.89 million man-days of jobs were generated. This assessment accounts for the number of people involved in the implementation and maintenance of areas brought under restoration.

Table 229: Socio-economic impact (man-days generated) in Uttarakhand

Socio-economic impact											
Year	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20	2020-21	Total
Number of man-days generated (in million)	10.12	11.70	12.09	14.54	14.59	13.85	8.02	10	10.39	13.61	**118.89**

4.34.3.4 Financial Flow

The total financial flow towards FLR in the state has been reported as INR 51,176.50 million (USD 627.24 million).[403] Domestic public expenditure is the primary source of funding, according to data provided by the SFD for the period 2011 to 2020.

Table 230: Financial outflow from 2011–2020 in Uttarakhand

Financial outflow											
Year	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20	2020-21	Total
FLR Funding in INR (million)	3,204.2	3,915.5	4,231.4	5,332.2	5,594.4	5,769.1	6,609.6	7,243.3	7,200.3	2,076.5	**51,176.50**

Table 231: Fund utilisation for bringing area under restoration in Uttarakhand

Description	**Fund utilisation** (2011-12 to 2020-21)
Total area brought under restoration (ha)	217,919.53
Total fund invested in FLR activities (million INR)	51,176.50
Funds invested per hectare (million INR/ha)	0.23
Area brought under restoration per million rupees (ha/million INR)	4.26

[402] Mortality rates was not available at the time of publication of this report. Hence, law of averages was applied assigning the average mortality rate derived from mortality rates provided by 13 other States and UTs

[403] Exchange Rate - 81.59 as assessed on 01 October 2022

4.35 West Bengal

4.35.1 Restoration Barometer

The following table summarises the key components of the Restoration Barometer:

Table 232: Highlights of Restoration Barometer for West Bengal

Highlights	
Area brought under restoration (in ha)	105,397.15
Financial flow (in million INR)	4,876.82
Socio-economic impacts (man-days generated) (in million)	22.74
Climate impacts: Estimated carbon sequestered (in million tC)	2.77 (0% Mortality)
	1.97 (29% Mortality)
Climate impacts: Estimated carbon dioxide sequestered (in million tCO_2e)	10.18 (0% Mortality)
	7.23 (29% Mortality)

4.35.2 Background

West Bengal is a state located between the Himalayas and the Bay of Bengal in the eastern part of India. The state includes two broad natural regions: the Gangetic Plain in the south and the sub-Himalayan and Himalayan areas in the north.[404]

The state covers an area of 88,752 sq km, which equals 2.70% of the total geographical area of the country.[405] The climate varies from moist tropical in the southeast to dry tropical in the southwest and from subtropical to temperate in the mountains of the north. The annual temperature ranges from sub-zero in the hills during winter to about 46°C in the southern parts during summer. The annual rainfall ranges from 900 mm in the southwest to 5,000 mm in parts of the north.[406]

West Bengal has a population of 91.28 million, which is 7.54% of India's population. The rural and urban populations constitute 68.13% and 31.87%, respectively. The tribal population is 5.80%. The population density of the state is 1,028 persons per sq km, which is much higher than the national average. According to the 19th Livestock Census of 2012, the total livestock population is 30.35 million.[407]

West Bengal's economy is driven by the tertiary sector, with services, IT, and tourism leading. The secondary sector, including jute products, petrochemicals, and electronics, also contributes significantly, while the primary sector, focused on rice, jute, and tea, plays a smaller but important role.[408] The total forest cover of the state is 16,831.87 sq km, which forms 18.96% of the state's area.[409]

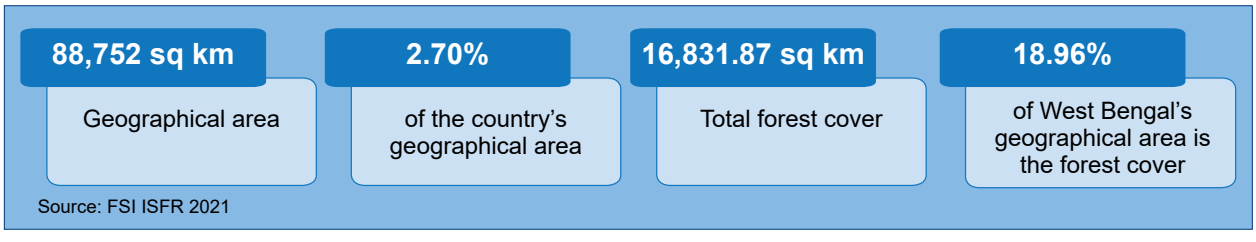


Figure 119: Geographical Area and Forest Cover of West Bengal

[404] State Profile, http://nriwestbengal.gov.in/nri/common/stateprofile.aspx
[405] ISFR 2021, https://fsi.nic.in/isfr-2021/chapter-13.pdf
[406] ISFR 2019, https://fsi.nic.in/isfr19/vol2/isfr-2019-vol-ii-west-bengal.pdf
[407] ISFR 2019, https://fsi.nic.in/isfr19/vol2/isfr-2019-vol-ii-west-bengal.pdf
[408] IBEF Infographics, https://www.ibef.org/states/west-bengal-infographic
[409] ISFR 2021, https://fsi.nic.in/isfr-2021/chapter-13.pdf

As per ISFR 2011[410] and ISFR 2021[411], the following observations were made:

- In the last 10 years, from 2011 to 2020, there is an increase of 3,836.87 sq km, or 383,687 ha, in the forest cover.
- The tree cover of West Bengal constituted 2.65% of the state's TGA. In the last 10 years, there is an increase of 14 sq km, or 1,400 ha, in the tree cover area of the state.
- The average growing stock in West Bengal is 61.19 million cum in forest and 38.70 million cum in ToF. In the last 10 years, the average growing stock in the forest area and ToF has decreased by 38.32 million cum.
- The total carbon stock of forest in the State, including the TOF patches which are more than one ha in size, is 155.26 million tonnes (569.29 $MtCO_2e$), which is 2.16% of the total forest carbon in the country.

As per the 2021 DLD Atlas of India, 1,784,345 ha of land, representing 20.10% of the state's TGA, is affected by various forms of desertification and land degradation. There has been an increase of 50,414 ha (0.56%) of degraded land from 2011–13 to 2018–19. The primary driver of land degradation is water erosion (14.91%), followed by vegetation degradation (3.03%).[412]

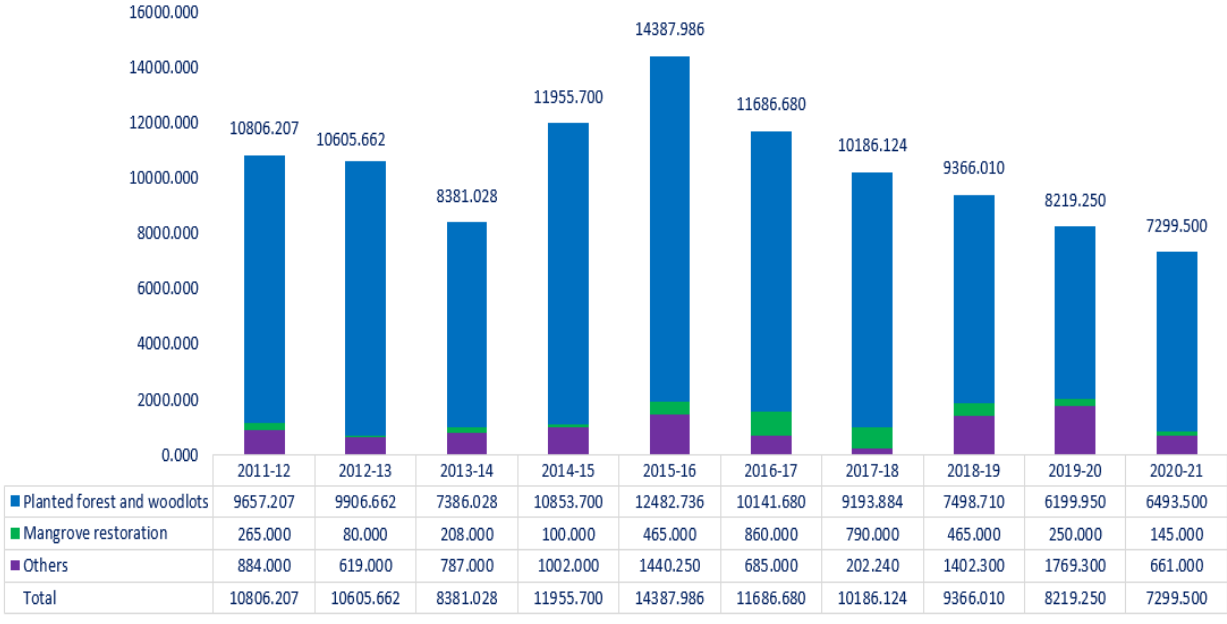
Table 233: Status of desertification and land degradation from 2018–19 and 2011–13 (area in ha) in West Bengal

Year	Vegetation Degradation	Water Erosion	Water Logging	Manmade	Settlement
2018-19	269,089	1,323,275	47,759	22,206	122,016
2011-13	265,277	1,329,539	17,627	15,102	106,386

Source: ISRO 2021

4.35.3 Restoration Barometer: State Contribution

4.35.3.1 Area brought under restoration



	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20	2020-21
Planted forest and woodlots	9657.207	9906.662	7386.028	10853.700	12482.736	10141.680	9193.884	7498.710	6199.950	6493.500
Mangrove restoration	265.000	80.000	208.000	100.000	465.000	860.000	790.000	465.000	250.000	145.000
Others	884.000	619.000	787.000	1002.000	1440.250	685.000	202.240	1402.300	1769.300	661.000
Total	10806.207	10605.662	8381.028	11955.700	14387.986	11686.680	10186.124	9366.010	8219.250	7299.500

Figure 120: Area brought under restoration from 2011–2020 as reported by SFD of West Bengal

[410] ISFR 2011, https://fsi.nic.in/forest-report-2011

[411] ISFR 2021, https://fsi.nic.in/forest-report-2021-details

[412] DLD Atlas of India, 2021, https://vedas.sac.gov.in/static/atlas/dsm/DLD_Atlas_SAC_2021.pdf

As of 2020, a total of 102,894.15 ha of the state's area had been brought under restoration since 2011, according to data submitted by the State Forest Department. Additionally, data from the Department of Land Resources (DoLR) indicate that 2,503 ha were restored between 2018 and 2020 by the DoLR.

Table 234: Area brought under restoration based on FLR interventions by SFD of West Bengal

FLR interventions implemented	Area brought under restoration (in ha)
Planted forest and woodlots	89,814.06
Mangrove restoration	3,628
Others	9,452.09

4.35.3.2 Climate impacts

The carbon sequestration for West Bengal has been estimated for the restoration work carried out from 2011 to 2020 under different scenarios (A1 and A2) and assumptions (a1, a2, and a3). To estimate carbon sequestration, the IPCC GPG LULUCF 2003 methodology has been adopted. West Bengal is classified under the Moist with Short Dry Season category, with an annual average rainfall ranging from 1,000 mm – 2,000 mm. According to the IPCC GPG LULUCF 2003, the following cases of average annual increment are applicable for this level of rainfall – best case (13.5 tdm/ha/yr), base case (7.8 tdm/ha/yr), and worst case (2 tdm/ha/yr), for the estimation of carbon sequestration.[413] The detailed methodology for estimating carbon sequestration is outlined in Section 1.4.1(B) and Annex I of the report. Based on this methodology, the total carbon sequestered and the per-hectare carbon sequestration are presented in the following graph and table, respectively.

To report on carbon sequestration while accounting for mortality rates, the Base Case (a2) assumption under the two scenarios has been applied, as it represents a balanced middle ground with neither too high nor too low values (refer to the detailed methodology in Section 1.4.1(B) and Annex I).

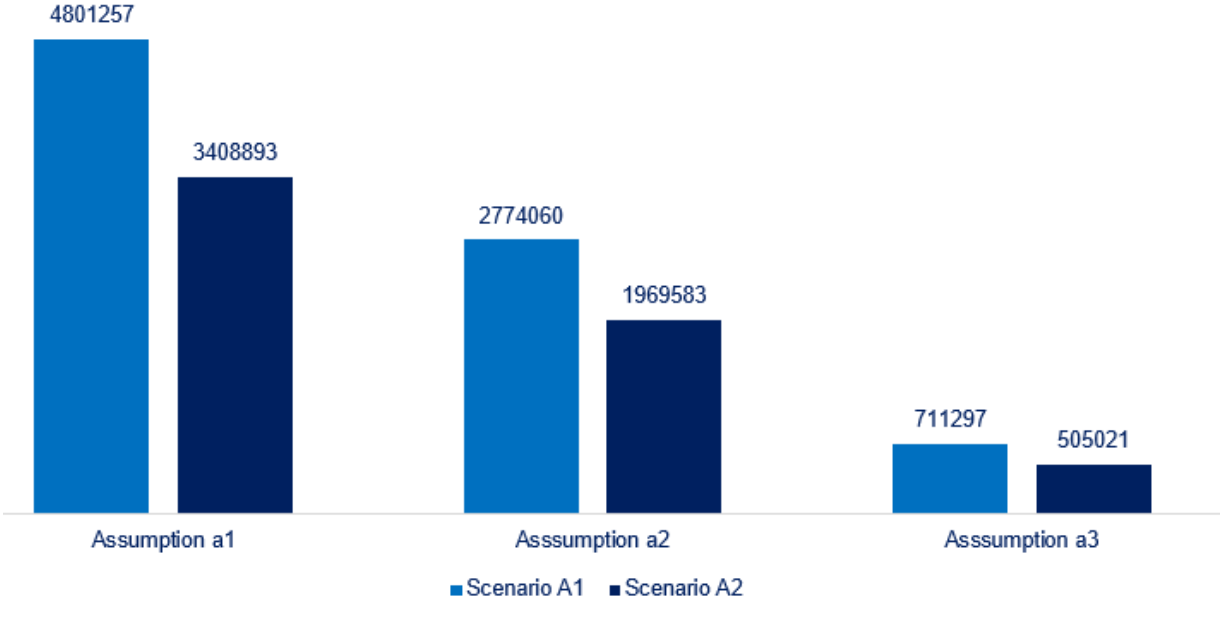


Figure 121: Total calculated tC sequestration in 10 years under two scenarios and three assumptions in West Bengal

[413] GPG LULUCF table 3A.1.6 - for AGB only https://www.ipcc-nggip.iges.or.jp/public/gpglulucf/gpglulucf_files/Chp3/Anx_3A_1_Data_Tables.pdf

From 2011 to 2020, expressed as carbon, this corresponds to 2.77 million tonnes of carbon (tC) without factoring in mortality and 1.97 million tC when a mortality rate of 29%, was considered. An estimated 10.18 million tonnes of carbon dioxide (tCO_2e) were sequestered, excluding plantation mortality. When accounting for mortality, the sequestration was 7.23 million tCO_2e.[414]

Table 235: Carbon stock tC (per ha) in AGB and BGB carbon pools in area brought under restoration for different assumptions and scenarios in West Bengal

Scenario	Assumption a1	Assumption a2	Assumption a3
Scenario A1	45.55	26.32	6.75
Scenario A2	32.34	18.69	4.79

4.35.3.3 Socio-economic impact

The socio-economic impact achieved has been measured in terms of man-days generated through FLR work in the state. According to SFD data for the period 2011 to 2020, a total of 22.74 million man-days of jobs were generated. This assessment accounts for the number of people involved in the implementation and maintenance of areas brought under restoration.

Table 236: Socio-economic impact (man-days generated) in West Bengal

Socio-economic impact											
Year	**2011-12**	**2012-13**	**2013-14**	**2014-15**	**2015-16**	**2016-17**	**2017-18**	**2018-19**	**2019-20**	**2020-21**	**Total**
Number of man-days generated (in million)	2.39	2.34	1.85	2.64	3.18	2.58	2.25	2.07	1.82	1.61	**22.74**

4.35.3.4 Financial flow

The total financial flow towards FLR in the state has been reported as INR 4,876.82 million (USD 59.77 million).[415] Domestic public expenditure is the primary source of funding, according to data provided by the SFD for the period 2011 to 2020.

Table 237: Financial outflow from 2011–2020 in West Bengal

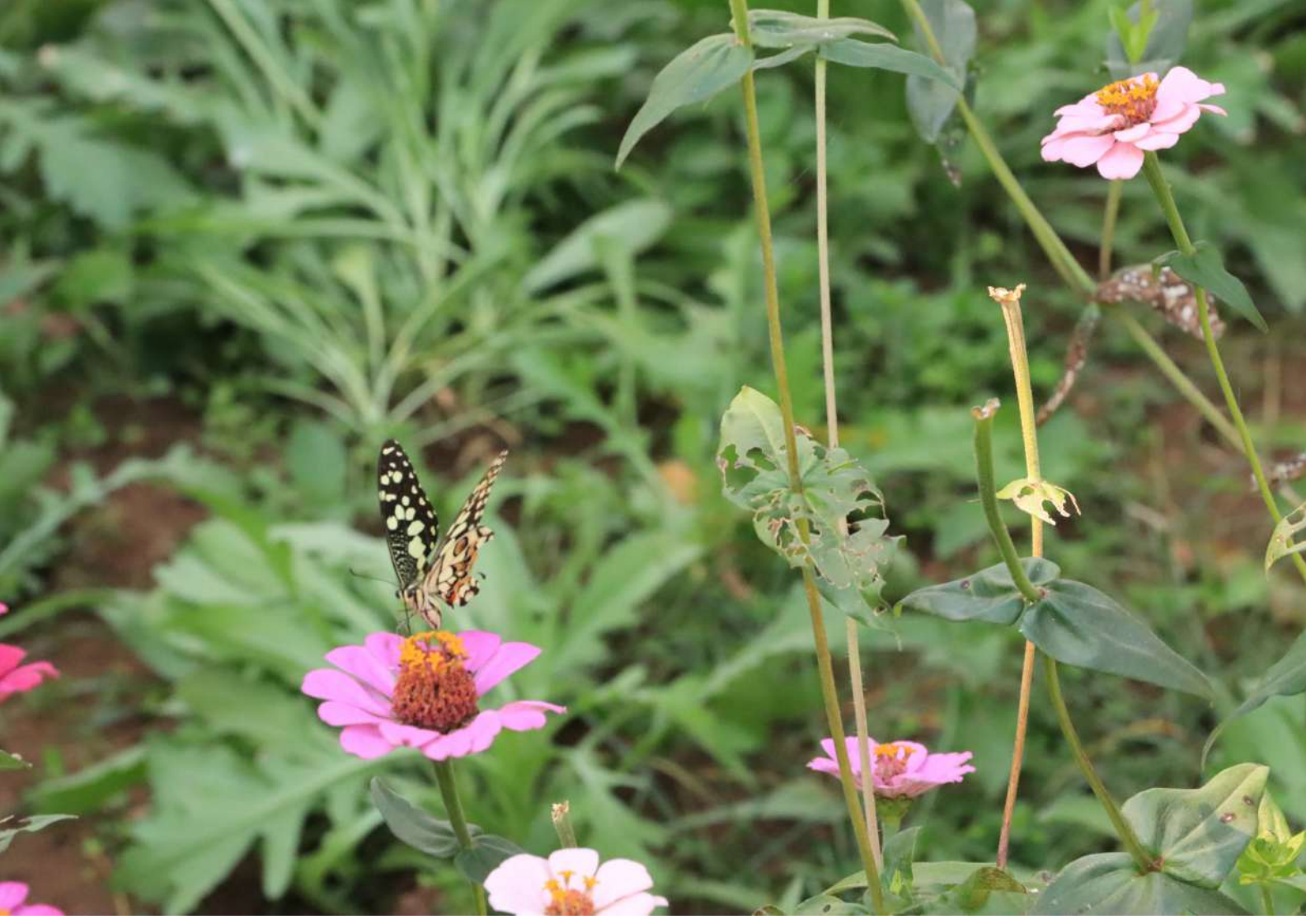
Financial outflow											
Year	**2011-12**	**2012-13**	**2013-14**	**2014-15**	**2015-16**	**2016-17**	**2017-18**	**2018-19**	**2019-20**	**2020-21**	**Total**
FLR Funding in INR (million)	175.64	220.8	238.8	413.27	595.18	645.74	686.14	755.33	658.9	487.01	**4,876.82**

Table 238: Fund utilisation for bringing area under restoration in West Bengal

Description	**Fund utilisation** (2011-12 to 2020-21)
Total area brought under restoration (ha)	102,894.15
Total fund invested in FLR activities (million INR)	4,876.82
Funds invested per hectare (million INR/ha)	0.05
Area brought under restoration per million rupees (ha/million INR)	21.10

[414] Mortality rates was not available at the time of publication of this report. Hence, law of averages was applied assigning the average mortality rate derived from mortality rates provided by 13 other States and UTs

[415] Exchange Rate - 81.59 as assessed on 01 October 2022



5.0 CASE STUDIES

5.1 Case Studies: India

Case study 1: Reducing forest degradation through sustainable fuelwood management in Assam

Introduction

The Forest Survey of India in 2019 reported that 85 million tonnes of fuelwood were extracted from forests nationwide. Furthermore, India accounts for 30% of the global reliance on solid biomass for cooking. Assam is one of the states with high dependency, where 72% of households (approximately 4.6 million) use fuelwood to meet their cooking energy requirements. Consequently, the state of Assam was chosen as the first to develop and implement a pilot Nationally Appropriate Mitigation Action (NAMA) in the forestry sector in India.

Problems

- Increased incidents of human-wildlife conflicts resulting from habitat fragmentation due to forest degradation in Assam.
- Forest degradation due to encroachments, shifting cultivation, and unsustainable extraction of fuelwood. In Assam, 81% (approximately 4.30 million) of rural households rely on fuelwood for their cooking needs.
- Significant biotic pressures on plantations in degraded areas, particularly in the Jhum areas. Cattle grazing and removal of saplings for fodder and fuel pose serious threats to natural and assisted regeneration in forest areas.
- Lack of interdepartmental coordination to address interdisciplinary aspects such as FLR and REDD+, etc.
- Assam faces significant environmental challenges due to adverse climatic conditions, resulting in annual floods and frequent droughts. The state's heavy rainfall exacerbates these issues.

Restoration efforts and policies

The project contributes to the State Action Plan on Climate Change (SAPCC) of Assam. The Assam SAPCC aims to:

- Reduce forest degradation by closing areas with promising regeneration and root-stock of natural species.
- Develop nurseries to provide quality plant material, including bamboo, indigenous fruit trees, medicinal plants, and other multi-utility trees.
- Develop skills among forest communities in emerging sectors to reduce pressure on forests. The project trained communities in income-generating activities such as making plates from areca nut sheaths.
- Promote alternative energy sources to substitute wood as fuel. Energy plantations were established as part of the project on 300 hectares.
- Provide Liquefied Petroleum Gas (LPG) connectivity and other clean cooking technologies to forest villagers and fringe dwellers to reduce dependence on fuelwood. 17,000 households have been provided with such technology under the project.

- Conduct pilot studies on carbon stock in forests to establish protocols for measuring, reporting, and verification systems for forest carbon. Carbon stock studies were carried out for six forest divisions under the project. A training manual was developed to build the capacity of forest officials on carbon stock assessment of the forest ecosystem of Assam.
- Pilot studies on carbon stock in forests have been conducted to establish protocols for measuring, reporting, and verification systems for forest carbon. These studies cover six forest divisions, and a training manual has been developed to build the capacity of forest officials to assess the carbon stock of Assam's forest ecosystems.

Figure 122: Women using improved cooking stove in villages

Figure 123: Training Manual for Forest Carbon Stock Assessment

Solutions

- **Enhancing capacities for carbon stock assessment:** The project has developed a training manual on 'Carbon Stock Assessment of Forest Ecosystems,' tailored for the frontline staff of the Assam Forest Department.
- **Planted woodlots:** As part of the project, the Assam Forest Department has planted 422 ha in the forest divisions of Biswanath Chariali, Sonitpur East, Nagaon South, and Sonitpur West. Additionally, the Eco Task Force has conducted plantation efforts across 300 ha in Biswanath Chariali.
- **Assisted natural regeneration:** The project supports forest villages, forest fringe villages, and tea estate labourers in reducing their dependence on forests for fuelwood by promoting the deployment and sustained use of cleaner cooking technology.

Benefits

- **Economic benefits**: Time saved from collecting fuelwood can now be used for livelihood generation activities. The project has created employment and income generation opportunities in technology research and development (R&D), manufacturing, vending, operations and maintenance, and monitoring. It has also reduced health-related costs due to decreased indoor air pollution. Furthermore, the project has enhanced the value of ecosystem services, enabling ecotourism and reducing damages from natural hazards, and has created new and green jobs.
- **Environmental benefits**: The pilot implementation phase is estimated to reduce and sequester approximately 117,000 tCO_2eq. The introduction and use of improved cookstoves have reduced fuelwood consumption by 20%-50%, addressing the drivers of deforestation and

forest degradation. Additionally, efforts have been made for soil protection and enhancement of soil fertility and moisture, alongside initiatives for biodiversity conservation. The project has also led to improvements in the water table and groundwater recharge.

- **Social impacts**: The project has raised awareness among 120,000 individuals through continuous community engagement on the benefits of shifting to cleaner cooking technology and reducing dependence on forests. It has provided health benefits for women and children due to reduced exposure to indoor air pollution and reduced the drudgery of collecting fuelwood, allowing more time for other activities. Access to cleaner fuel has led to an improved standard of living. Additionally, the project supports capacity building and skill development initiatives within the community, enhancing participation and ownership of local communities in forest conservation efforts.

Case study 2: Himachal Pradesh Forest Ecosystem Services (HP-FES) project

Introduction

The HP-FES project, commissioned by the German Federal Ministry for Economic Cooperation and Development (BMZ) in collaboration with the Himachal Pradesh State Forest Department (SFD), employs a Forest Ecosystem Services (FES) approach. It focuses on sustainable forest management to provide prioritised ecosystem services based on stakeholders' choices.

Problems

Himachal Pradesh faces several problems leading to the degradation of forest land. The most notable is climate change, which has been linked to unfavourable weather patterns, including an increase in forest fires and extended periods of dry weather. There is a high impact of human interference and infrastructure development on forests. Economically marginalised communities in the state rely heavily on forest resources for their survival and means of subsistence.

A part of the state's land (20,511 sq km) is both uncultivable and cannot sustain forests because it comprises barren land, alpine pastures, snow-covered peaks, and areas above the tree line, although such areas fall within the legally classified forest land (Source: Himachal Pradesh Forest Sector Review).

The relationship between primary stakeholders and forests has mostly been one-sided, with stakeholders enjoying their rights and benefits. However, the increase in pressure on forest-based resources necessitates sustainable forest management practices to address the apparent problems leading to depleted forest land cover.

Solutions

The Forest Survey of India reported in 2021 that forest cover in Himachal Pradesh has increased compared to assessments over the last decade. The project has implemented several components and principles of the FLR approach in the following ways:

1. **Contributing to the New National Working Plan Code 2014**: The project integrates the FES approach into the Solan Forest Divisional Working Plan in line with the National Working Plan Code, 2014. Recommendations for incorporating the FES approach have been formulated and are under review by the Himachal Pradesh Forest Department (HPFD).
2. **Maintaining and enhancing natural ecosystems within landscapes**: The project interventions in nine demonstration sites across the state directly contribute to enhancing the conservation, recovery, and sustainable management of forests and other ecosystems.

Figure 124: Dependence of local communities on forest resources

3. **Engaging stakeholders and supporting participatory governance**: The interventions are carried out at the project sites in collaboration with Village Forest Development Societies (VFDS) and HPFD. These interventions for a sustainable flow of prioritised ecosystem services were planned using a participatory approach. Women formed a major part of the VFDS and played a prominent role in the planning and implementation of the project activities.

Benefits

Environmental benefits: As a result of the project, a total of 53.85 sq km of forest area is now being sustainably managed. The project interventions have ensured basic provisioning and regulatory services for village communities. There has been an improvement in drinking water security, irrigation water security, and livelihood security for communities residing in the project sites.

Economic benefits: The project has created increased employment opportunities, with 283 people, including 133 women, gaining additional work hours as wage labourers at the demonstration sites. Furthermore, 327 individuals, of whom 283 are women, are expected to see an increase in income due to the project's initiatives based on non-agricultural activities.

Social benefits: A key aspect of the project is building the capacity of community members, particularly women's Self-Help Groups (SHGs), to explore alternative livelihood possibilities and reduce the financial burden of obtaining water, fodder, and fuelwood. Given the communities' high dependency on forest resources, people have actively participated in preserving and protecting the forests.

Pine-needle weaving was chosen as an initial application of the FES strategy for micro-planning. The project encouraged village communities to use pine needles as a resource for crafting artefacts, thereby generating cash income.

Figure 125: Handmade products from pine-needle weaving

Case study 3: Roadside Beautification and Plantation in Tripura (RBPT)

Introduction

Tripura boasts a substantial 73.64% of its total geographical area under forest cover.[416] However, the roadside areas in the state are notably lacking in trees. To address this, the State Government of Tripura prioritised the planting of tree saplings and ornamental plants on both sides of the National Highway 44 (renamed NH 8), stretching from the state capital, Agartala, to Sabroom, the southernmost town in the state. The government ensured full and effective participation from local communities, the private sector, and other governmental agencies. Accordingly, the Tripura SFD initiated a plan to plant tall saplings along the newly widened section of the national highway in the first phase, passing through four districts namely, West Tripura, Sepahijala, Gomati, and South Tripura. This roadside plantation project was successfully developed in a remarkably short span of time during the year 2019.

The programme met with significant success, attributed to the following measures:

- Use of tall seedlings.
- Mobilisation of local people's support and intensive monitoring.
- Leadership by the Tripura SFD.
- Keen interest by the hon'ble Chief Minister of Tripura[417]

Problems

- Major stretches of the State's National Highway were dusty, and devoid of shade-giving trees, making travelling a tedious exercise and unpleasant for the road users, especially in summers.
- Both sides of the national highway were vacant and had scope for beautification; the vacant areas were available in scattered patterns as the sides of the national highway were either occupied by habitation or markets.
- People's participation in this noble cause was the biggest challenge, which was overcome by continuous discussion and dialogue to convince the people about the benefits of the roadside plantation.

Solutions

- The project focused on creating roadside greenery by planting tall seedlings of various indigenous species, ensuring ecological compatibility and sustainability.
- Mobilisation and effective participation of the field staff. Moreover, 6,500 seedlings were planted in one minute in Udaipur by mobilising school children, parents, teachers, and locals.
- The implementation of the new Green Highways Policy 2015 can help bridge this gap. Emphasis is not only on the number of trees planted but also on how many survive and are useful to the local communities.

[416] FSI ISFR 2021

[417] Chief Minister of Tripura in 2019 was Mr. Biplab Kumar Deb

Benefits

Environmental benefits: Reducing the impact of air pollution and dust by planting trees and shrubs along the national highways. The plantation acts as a natural sink for air pollutants and arrests soil erosion at the embankment slopes. Providing much-needed shade on blazingly hot summer highways. Additionally, it improves animal habitat and biodiversity.

Economic benefits: The initiative has facilitated livelihood opportunities for local communities. The usufruct rights from these plantations, such as fruits, fuelwood, and fodder, are granted to residents, allowing them to earn revenue by selling these products.

Social benefits: The initiative helps improve the well-being of local people by providing clean air, livelihood opportunities, and awareness about plantation and biodiversity conservation.

Case study 4: Ecological restoration of targeted degraded land in the red lateritic belt of West Bengal through orchard plantation under the West Bengal Accelerated Development of Minor Irrigation Project (WBADMIP)

Introduction

The West Bengal Accelerated Development of Minor Irrigation Project (WBADMIP), initially supported by the World Bank from 2012 to 2019 and later continued by the Government of West Bengal. The project focuses on restoring degraded land in the west lateritic zone. The Government of India has approved the proposal for the project's second phase with further support from the World Bank. The project aims to boost the income of small and marginal farmers by providing assured irrigation facilities and support services in agriculture, horticulture, and fishery through Water Users Associations (WUAs) and Farmer Producer Organisations (FPOs). Notably, four WUAs under the project have received the National Water Award from the Government of India.

The project comprises three major components includes,strengthening community-based institutions, developing irrigation infrastructures using spatial technologies, and providing agricultural support services to promote crop diversification and sustainable farm technologies. As part of this framework, an orchard plantation initiative has been undertaken to restore degraded land.

Problems

- The greater Chotanagpur plateau in Bengal faces significant environmental challenges, including soil erosion, water pollution, and biodiversity loss due to unsustainable land-use practices. Water scarcity is exacerbated by erratic rainfall patterns, impacting primarily marginalised local subsistence farming farmers.
- The area spans 2.4 million ha, with over 0.3 million ha of uncultivable dry uplands, contributing to the challenges faced by a large impoverished tribal community. The effects of climate change worsen the situation, leading to high crop losses and economic migration.

Solutions

- In 2018-19, the project introduced orchard plantation initiatives in the degraded lateritic belt after recognising that the mere availability of irrigation was insufficient to improve the living conditions of the local community.
- These orchard initiatives aim to enhance the degraded landscape through mechanical and biological approaches, engaging the community and empowering them as custodians of restoration in buffer zones.

5.2 Case Studies: Bangladesh

Introduction

The People's Republic of Bangladesh, located to the east of India on the Bay of Bengal, is a South Asian country known for its rich biodiversity, lush greenery, and numerous waterways. Although Bangladesh is small in size, it is densely populated, with a population of 144,043,697 according to the 2011 census. The total forest land area of the country is 2,298,904 ha, accounting for less than 15.5% of the total land area.

Problems

Despite having substantial forest cover, Bangladesh faces severe deforestation and forest degradation due to increasing population and poverty. The direct drivers of deforestation and forest degradation include illegal fuelwood collection, timber harvesting, and encroachment for agriculture and settlement. The indirect drivers include poverty, population growth, inadequate forest management capacity, and ineffective governance.

Restoration efforts and policies

The afforestation programmes in coastal areas are crucial for ensuring the stability of newly accreted land and protecting communities from storm surges. Forest sector policy in Bangladesh promotes the conservation of forests through the engagement of local people. Social forestry programmes have been highly successful over decades, contributing to increasing forest and tree cover and improving the livelihoods of poor communities. Reforestation and enrichment plantation programmes have played a key role in maintaining forest cover and ensuring the flow of non-carbon benefits to society.

In Bangladesh, most long-term strategic documents emphasise forest improvement, notably the Seventh Five Year Plan, the Bangladesh Climate Change Strategy and Action Plan 2009, the National Forest Policy 2016 (draft), the Country Investment Plan (CIP 2016–2021), and the Forestry sub-program. These key policy documents include common actions that support the reduction of deforestation and forest degradation, the enhancement of forest carbon stock, and afforestation/reforestation and enrichment of degraded forests. Common actions include the moratorium on felling in natural forests (till 2022), the creation of livelihood opportunities, the promotion of social forestry activities, the completion of forest land surveys and records, and the development of a monitoring, reporting, and verification system. The Country Investment Plan Forestry sub-program (CIP 2016-2021) also supports small and medium forest enterprises, value chain development, and the enhancement of the Bangladesh Forest Department's planting capacity.

The Bonn Challenge Pledge

The total forest land area of Bangladesh is 2,298,904 ha, accounting for less than 15.50% of the total land area. Of this, 1,603,678 ha of forests are managed by the Bangladesh Forest Department (BFD), and the remaining 695,226 ha are managed by the Ministry of Land, represented by the Deputy Commissioners of the Chittagong Hill Tracts (CHT).

The Government of Bangladesh aims to increase its forest cover to 16%, up from the current 14.50%, to meet the country's SDG target (16%) by 2030. This corresponds to the afforestation/reforestation of 637,259 ha of forest lands. Additionally, 173,498 ha of degraded forest require enrichment planting, and 1,269,070 ha need strengthened conservation and protection measures. Approximately 86,000 ha will be reforested by 2023 under the Sustainable Forests & Livelihoods (SUFAL) programme.

Case study 1: Balancing forest conservation and community livelihoods in Bangladesh

Background

Since 25 August 2017, the Government and the people of Bangladesh have demonstrated remarkable international solidarity by providing support to an additional 735,116 refugees.

Problems

Refugees often turn to nearby forests to obtain food and shelter, which significantly damages the forest. These forests contain traditional routes and corridors for Asian Elephants. Elephants use these corridors to migrate between forests. When elephants encounter obstacles, they attempt to break through them, leading to human-elephant conflict.

Solutions

IUCN Bangladesh, with support from the United Nations High Commissioner for Refugees (UNHCR), has been implementing a programme since 2018 to minimise human-elephant conflict, improve the degraded environment, enhance the livelihoods of refugees and host communities, and contribute to the peaceful coexistence of refugees and the host community. To engage the Rohingyas and the host community, IUCN Bangladesh initiated the camp restoration programme in 2018. To date, 50 hectares have been restored with native mixed species inside the Rohingya camps. IUCN engaged 200 Rohingya people, including 10% women, as plantation watchers for the maintenance of the plantation. The restoration programme was highly successful, with a 97% survival rate after two years of planting.

Minimised human-elephant conflict: Since January 2018, IUCN Bangladesh, in partnership with UNHCR, has implemented the project. Guarding by the Elephant Rescue

Team (ERT) has significantly reduced elephant attacks and increased the safety of approximately 450,000 people in the camps who were vulnerable to elephant attacks. Along with mitigating human-elephant conflict, the ERTs also rescued several wild animals captured by Rohingya people and released them into the forest with support from the BFD.

Raising awareness among beneficiaries: IUCN organised interaction sessions with more than 10,000 students in 200 schools and engaged students in making elephant puppets, composing, and staging puppet shows. In addition to the school programme, activities such as drills, rallies, and puppet shows were organised in different locations of Kutupalong and Teknaf camp areas in Cox's Bazar. These activities provided information on the importance of nature, forests, and wildlife and strategies to avoid conflicts with elephants.

Restoration of degraded forest: ERT members, along with community people, participated in planting 50 hectares of degraded lands. The plantation was community-based, with local people taking care of and managing the plants. A total of 200 plantation watchers worked regularly to protect this 50-hectare plantation.

Provision of financial support to the community: Under the project, total of 824 volunteers from both the host and refugee communities participated. Among these volunteers, 624 individuals served as ERT members and 200 as plantation watchers, collectively representing 824 families. The volunteers were employed every month and were compensated by the project according to a standard rate set by the Refugee Relief and Repatriation Commissioner (RRRC).

Distribution of LPG to reduce pressure on firewood: To alleviate pressure on forest resources, UNHCR and IOM distributed LPG to families in and around forest area, reducing the reliance on firewood collection from the nearby forests. IUCN assisted UNHCR in analysing the impact of LPG distribution, finding that it reduced firewood consumption by 80%.

Figure 126: Plantation activity by local communities

Case Study 2: Building resilience through mangrove rehabilitation in Shyamnagar, Bangladesh

Shyamnagar, a sub-district in the southwest corner of Bangladesh, is prone to natural hazards such as cyclonic surges and salinity ingress. Under the Mangroves for the Future (MFF) initiative, a resilience analysis was conducted to assist local communities in identifying priority strategies to reduce their vulnerability and enhance their resilience.

MFF supported a Geographic Information System (GIS) mapping to identify suitable areas for mangrove rehabilitation and assess the tenure system to support the vision of a resilient Shyamnagar. The MFF grantee CNRS facilitated dialogues among village communities, the local Union Parishad (UP), and the Forest Department, leading to an agreement on a shared governance structure and benefit-sharing mechanism. A 35-member Village Conservation Forum (VCF) was established, agreeing that the community would receive 40% of the benefits (from fruits, honey, fuelwood, and mangrove nurseries), the UP would receive 40%, and the remaining 20% would be used to maintain the forest. This model was initially piloted on 25 ha, and MFF subsequently scaled it up by allocating a medium grant to Sushilan.

Planting mangrove trees has become a replicable model of mangrove rehabilitation in Shyamnagar and beyond. MFF supported the rehabilitation of 100 ha through its small and medium grant projects. Furthermore, the Climate Resilient Ecosystems and Livelihoods (CREL) project, funded by USAID and managed by the Forest Department, rehabilitated more than 300 ha by leveraging their investment. The mangroves now resemble a natural forest, providing shelter to fish and birds.

Transformation Facilitated by MFF

Figure 127: Transformation of the land between 2013 and 2017

6.0 DISCUSSION AND RECOMMENDATIONS

Restoring degraded land through FLR provides numerous environmental, social, and economic benefits. However, in a diverse, large, and densely populated country like India, a one-size-fits-all approach is not feasible for the successful implementation of FLR. India's complex socio-ecological and biophysical systems present unique challenges. These challenges can only be addressed through a structured framework for designing, planning, managing, and monitoring FLR activities to meet diverse needs. This framework could be modelled on the lines of the Restoration Barometer. While compiling data for the Restoration Barometer to report on India's progress on the Bonn Challenge, several key insights were gained. The following are some of these findings and potential recommendations:

- An important opportunity for improving data management related to the Bonn Challenge is the potential standardisation of data collection and input processes across States and Union Territories. Aligning these procedures with the requirements of the Restoration Barometer tool could improve consistency and accuracy in data reporting.
- FLR extends beyond forestry and covers various land uses within a landscape. It involves multiple line departments, each responsible for collecting data within their jurisdiction. Improved coordination among these departments is crucial. It helps mitigate data duplication and prevents overlaps in information reported by different departments. This would result in more accurate and reliable data reporting.
- While states and While states and UTs have reported the areas they have attempted to restore, effective monitoring of these areas has proven challenging. Monitoring plantations involves assessing the survival rates of different species at various intervals and across different sites. This requires additional human resources and capital. Improved monitoring will lead to more accurate reporting of restoration achievements. It will also support better decision-making and continuous improvement.
- To ensure the success of FLR initiatives in India, it is essential to establish a common understanding of FLR. States, Union Territories, and relevant stakeholders are working towards fostering this collective understanding. This effort targets both high-level decision-makers and grassroots communities. It reflects a strong commitment to achieving a shared vision for FLR. It also ensures successful implementation across all levels of engagement.

Recommendations

- There is a need for a unified, online, and user-friendly platform, similar to the Restoration Barometer tool. This platform should allow all entities involved in FLR in India (domestic, international,

private, public, CSOs, etc.) to report their contributions. The data provided by each entity must be validated to ensure relevance, completeness, and accuracy.

- Public-Private Partnerships (PPP) can be explored to overcome barriers related to financing the development, implementation, and monitoring of FLR activities on the ground.
- Strengthening the capacities of line department officials and their frontline staff is crucial for the effective planning and implementation of FLR approaches and measures on the ground. This presents a significant opportunity to achieve restoration and contribute to fulfilling various national and international commitments.
- Establishing a robust Monitoring, Reporting, and Verification (MRV) system is essential. It will enhance data accuracy and accountability by systematically monitoring and reporting on the progress of activities.

ANNEXURES

Annexure I: Methodology Used to Estimate Climate Benefits

Most States and Union Territories reported increasing biomass carbon stock through planted forests and woodlots. Only a few States and UTs reported other FLR interventions. The IPCC methodology was applied to sustainable production models, such as planted forests, agroforestry, and silvopastoral systems. This was done to estimate the amount of CO_2 sequestered. The report considers two scenarios for calculating carbon sequestration, based on different mortality rates:

Scenario A1	0% Mortality
Scenario A2	Mortality rate (the mortality rate, reported by the forest department of each State and UT, was used. In cases where data on mortality rates was unavailable, average rates were applied)

Under each scenario, three assumptions are considered in terms of annual average increment:

Scenario A1	**0% Mortality**		
	Assumption a1 - Best Case Scenario - i.e., best growth potential and having high annual increment of AGB based on the area's average annual rainfall.	**Assumption a2** – Base Case Scenario - i.e., average growth potential and having average annual increment of AGB based on the area's average annual rainfall.	**Assumption a3** - Worst Case Scenario - i.e., very low growth potential and having low annual increment of AGB based on the area's average annual rainfall.
Scenario A2	**Considering Mortality Rate**		
	Assumption a1 - Best Case Scenario - i.e., best growth potential and having high annual increment of AGB based on the area's average annual rainfall.	**Assumption a2** - Base Case Scenario - i.e., average growth potential and having average annual increment of AGB based on the area's average annual rainfall.	**Assumption a3** - Worst Case Scenario - i.e., very low growth potential and having low annual increment of AGB based on the area's average annual rainfall.

To assess the carbon sequestration potential of areas brought under restoration in different States and UTs of India, the IPCC Good Practice Guidance, 2003 is used. Carbon sequestration for plantations is calculated based on the average annual aboveground biomass increment at the Tier-1 level. The average annual increment in biomass for saplings is represented using the following equations.

$$G_{total} = G_w^{*} (1 + R)$$

Where,

G_{total} = Average annual biomass increments above and belowground, tonnes d.m. ha^{-1} yr^{-1}

G_w = Average annual aboveground biomass increment, tonnes d.m. ha^{-1} yr^{-1}

R = root-to-shoot ratio appropriate to increments, dimensionless.

The AGB (tonnes dry matter/ha/year) increment was taken from Tier-1 default values of the average annual increment in aboveground biomass (GW) which are provided in "Table 3A.1.6 in Chapter 3: LUCF Sector Good Practice Guidance (IPCC, 2003), concerning plantations by broad category."

Table 239: Annual average aboveground biomass increment in plantations based on annual rainfall (mm/yr)

Tropical and subtropical plantations						
	Wet	Moist with Short Dry Season	Moist with Long Dry Season	Dry	Montane	Montane Dry
R= annual rainfall in mm/yr	R>2000	2000>R>1000		R<1000	R>1000	R<1000
Biomass increment (tonnes dry matter/ ha/year)	5.2 (2.4-8.0)	7.8 (2.0-13.5)	7.1 (1.6-12.6)	6.45 (1.2-11.7)	5.0 (1.3-10.0)	-

Default values for Root-To-Shoot Ratios from Table 3A.1.8 in Chapter 3: LUCF Sector Good Practice Guidance (IPCC, 2003) is used to estimate the BGB increment.

Figure 128: Methodology followed for carbon sequestration estimation

The carbon sequestration (tCO_2e) was estimated using the AGB increments, default values for R (root to shoot ratio), carbon fraction (CF) and CO_2 conversion.

$$B = AGB \times (1 + R) \times 44/12 \times {}^{CF}TREE$$

B = Annual above and belowground carbon stock increment in new plantations, tCO_2e

AGB = Average annual aboveground biomass increment in new plantations, tonnes d.m. ha-1 yr-1; (average value of 7.45 t d.m./ha/yr. was used)

R = Root-to-shoot ratio appropriate to increments, dimensionless; (average value of 0.27 was used)

CF = Carbon fraction of tree biomass; tC t d.m-1. A default value of 0.47 was used (unless transparent and verifiable information can be provided to justify a different value)

Annexure II: Restoration Opportunities Assessment Methodology (ROAM)

Halting land degradation and promoting landscape-based restoration require interaction between stakeholders and multiple land users by integrating them into a joint management process (Global Landscapes Forum [GLF], 2014).

IUCN India adopted the Restoration Opportunities Assessment Methodology (ROAM), developed by IUCN and the World Resources Institute (WRI), to identify specific priority areas for restoration across five Indian states: Haryana, Maharashtra, Madhya Pradesh, Karnataka, and Nagaland. This was done to meet the FLR objectives through interactive stakeholder engagement processes. The ROAM assessment for these five states was undertaken in 2020, during which the states were divided into sub-regions based on agro-ecological zones and district boundaries. A comprehensive literature review, alongside spatial analysis, was conducted to identify key issues of land degradation, followed by an analysis of the degradation status in these states using the publicly available Land Degradation Atlas of India (2015–16). The major drivers of degradation were identified in each state based on a classification system consisting of land degradation processes and classes.

Within each sub-region of a state, the ten largest degraded patches were identified as priority landscapes for restoration activities. FLR interventions were shortlisted based on an extensive literature review and spatial analysis. A list of FLR opportunities was compiled, along with broad intervention strategies that could be employed to restore the identified opportunities. This was followed by stakeholder consultations and expert interviews to validate the district-wise list of degradation classes, drivers, and interventions identified. As part of the assessment, a Cost-Benefit Analysis (CBA) was also undertaken, utilising Benefits Transfer, Avoided Costs, and Direct Value from Market Costs methods, along with secondary literature sources. Four separate state-level reports have also been developed as part of this project.

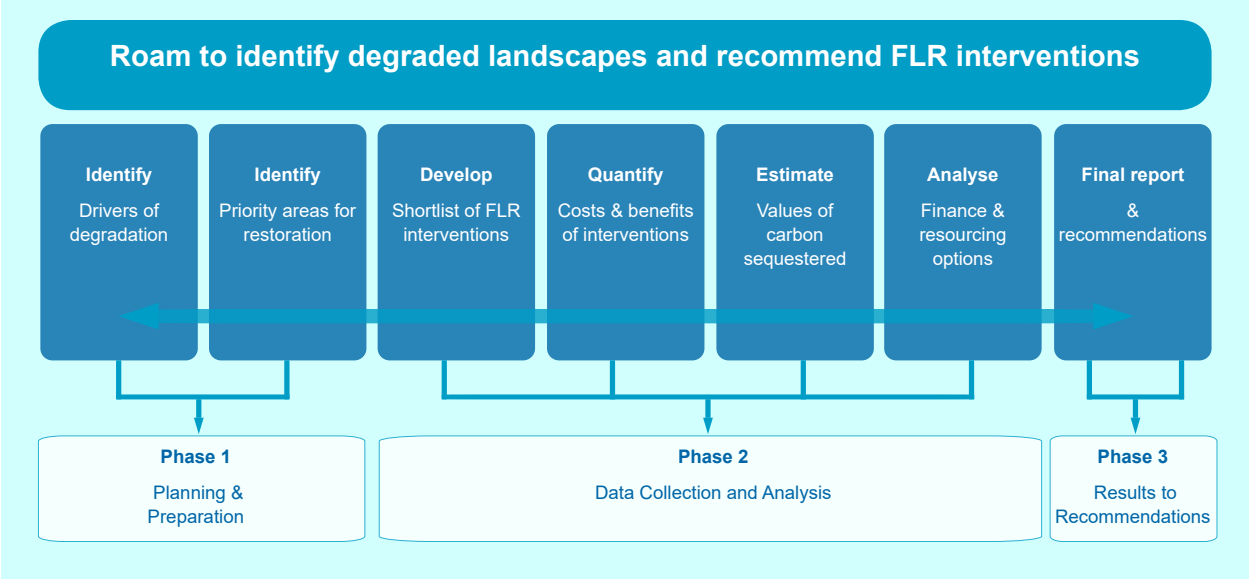


Figure 129: Outline of ROAM process

Annexure III: Strengthening Capacities on FLR

It has been recognised that multiple line departments need to work together to effectively implement FLR. However, this has remained a gap area. Working on this, IUCN India worked towards strengthening the capacities of the five focus states on identifying, prioritising, and operationalising FLR-based interventions through capacity building workshops with the support of MoEFCC.

These workshops attempted at strengthening the capacities of government officials from different line departments, whose work has the potential to contribute to FLR, and develop synergies between the different stakeholders in the process. Additionally, the workshops provided an opportunity for participants to share their experiences with FLR approaches. In each of the five States (Madhya Pradesh, Maharashtra, Karnataka, Nagaland and Haryana), the three-day consultations facilitated knowledge sharing on FLR between governments and NGOs, focusing on the technical, financing and policy aspects. Agencies and governments were also given an opportunity to showcase their work using landscape-based approaches and share experiences on restoration during the interactive session. IUCN India organised these workshops in collaboration with the state forest departments on the following dates.

On average, about 30-40 participants attended each workshop. Several experts attended the meeting, including Principal Chief Conservator of Forests (PCCF) and Additional Principal Chief Conservator of Forests (APCCF) of the respective States, forest and other line department officials, research organisations, and environmental organisations. The resource persons possessed understanding of the local context and belonged to organisations of national and international repute, including government institutes, such as the Wildlife Institute of India, Indian Institute of Forest Management, Forest Research Institute, state governments, and non-government institutes, such as GIZ, the Nature Conservancy, Ashoka Trust for Research in Ecology and the Environment (ATREE), Foundation for Ecological Security (FES), IORA Ecological Solutions, Indian Environment Law Organization, among others.

These workshops yielded productive recommendations for stakeholders, such as taking stock of FLR-supportive policy and institutional frameworks, adopting people-centric FLR approaches, understanding and accounting for the local context, practising restoration at a landscape level, and designing a suitable FLR monitoring framework. The workshops have already provided a platform for different line departments, including Forest, Water Resources, Tribal Welfare, Rural Development, Panchayati Raj (system of rural local self-government), among others, to come together and start discussing FLR in a common language. Proceedings for all the four workshops have also been prepared.

INTERNATIONAL UNION
FOR CONSERVATION OF NATURE

H-4, Green Park Extension
New Delhi - 110016, India
Telefax - +91 11 2616 7742
Email: india@iucn.org
www.iucn.org/india