CONTENTS

APFNet Workshop on

Degraded Forest Rehabilitation and Management in Asia-Pacific Region

18 - 27 August 2024 Yunnan Province, China

1. INTRODUCTION

APFNet's Thematic Workshops

Over the past decade, APFNet through its Kunming Training Center has organized thematic training workshops on two themes namely (a) Forest Resource Management and (b) Forestry and Rural Development and hitherto 23 such workshops have trained more than 350 professionals from 21 member economies in Asia-Pacific Region. These training workshops have become important platforms for knowledge sharing and strengthening inter-economy collaboration in promoting regional sustainable forest management.

APFNet Workshop on Degraded Forest Rehabilitation and Management in Asia-Pacific Region

Realizing the critical role of forests in enhancing human welfare through the provision of a wide range of goods and services, international, national and local efforts have been stepped up to counter deforestation and forest degradation and to manage forests sustainably. In the APEC region the 2020 Forest Cover Goal of adding 20 million ha has been achieved, however, negative trends of deforestation persist in several economies (APFNet & FAO 2023) and forest degradation still remains a challenging challenge issue in the Asia-Pacific Region. The urgency to scale up restoration efforts has prompted the United Nations to declare 2021-2030 as the decade of ecosystem restoration.

Over the last few decades, experience as regards degraded forest rehabilitation has been extremely varied between and within the Asia-Pacific economies. While some have made significant progress, many are far from scaling up efforts to a level to stabilize and reverse forest cover decline and degradation. Often wide gaps exist between what is envisioned in policy pronouncements and what is implemented/ accomplished at the ground level. Such varied experiences including successes and failures provide very valuable lessons, enabling improved design and implementation of forest restoration/ rehabilitation efforts. It is in this context that the present workshop is being organized under the training theme of Degraded Forest Rehabilitation and Management in Asia-Pacific Region.

In line with the mission of promoting sustainable forest management in the Asia-Pacific Region, Asia-Pacific Network for Sustainable Forest Management and Rehabilitation (APFNet) to help its member economies enhance a capacity and networking of forestry professionals through Capacity Building Programme particularly in the way of thematic training workshops. Since 2009, a total of 355 participants from 21 Asia-Pacific economies have benefited from those training workshops conducted by APFNet Kunming Training Center (APFNet-KTC). However, the outbreak of COVID 19 and consequent restrictions interrupted the conduct of the training workshops from 2020 to 2023. Now that regional economies have opened up and travel restrictions have been eased, APFNet intends to restart the training programme, beginning with a workshop in August 2024.

OBJECTIVES

The workshop aims to provide a better understanding of the complex issues relating to scaling up rehabilitation and sustainable management of degraded forest lands in Asia-Pacific, which enable allow the participants to craft more effective interventions on the ground and enhance the provision of forest goods and ecosystem services. Specifically, this workshop will:

- Provide an overview of the current state of forest rehabilitation and sustainable management of forest lands in the Asia-Pacific economies;
- Discuss the factors that contribute to successes and failures in forest rehabilitation efforts and the lessons learned from the experience hitherto;
- Assess the role of different players/stakeholders in forest rehabilitation efforts;
- Fulfill knowledge gap of how to make rehabilitation efforts more people and environment centric by sharing cross-economy experience, and enhance the capacity of participants to design more effective strategies, plans and programmes.

MAIN TOPICS/AREAS

Drawing upon the vast knowledge and experience of participants and resource persons, the workshop will cover the following topics and areas:

- General trends as regards the efforts to arrest and reverse forest degradation/ forest cover loss and where the different economies stand as regards accomplishing deforestation/ forest degradation neutrality;
- Improvement in forest governance that have contributed to the efforts to arrest/ reverse land degradation and to scale up rehabilitation and sustainable forest management;
- The relative role and importance of different players (in particular rural communities,

private investors, governments, civil society organizations and international organizations) in spearheading rehabilitation of degraded forest lands and their institutional capacities to undertake rehabilitation efforts;

- How forest and forestry can be a better role-playing in climate change;
- The future of forest rehabilitation and sustainable forest management in the regional economies and what needs to be done to craft a better path especially in the context of accomplishing SDGs and carbon neutrality.

WORKSHOP STRUCTURE AND APPROACH

The Workshop will have four interrelated components namely:

- **Keynote lectures** by experts outlining the critical issues pertaining to degraded forest rehabilitation and sustainable management.
- **Presentation by participants** outlining the experience of participating economies on the current state of degraded forest rehabilitation and the opportunities and challenges in bringing about quantitative and qualitative improvement in rehabilitation efforts,
- **Group work** helping to share knowledge of participants leading to the joint production of panel discussion on scaling up rehabilitation efforts under varied conditions; and
- **Field trip** will be conducted in Pu'er City and it intended to provide an opportunity to understand China's accomplishment as regards degraded forest rehabilitation and sustainable forest management.

WORKSHOP OUTPUTS

A synthesis report will be important workshop output with summarized key issues from workshop discussion and information shared by participants, then disseminate to a wider audience via both APFNet and APFNet-KTC websites.

Participation Requirements and Application Process

Eligibility

The workshop is open to senior policy makers and/or planners working for government organizations including research institutes and universities involved in the management of natural resources, in particular forest rehabilitation/restoration. The number of invited participants will be limited to 15 from the APFNet member economies in Asia-Pacific. Priority will be given to those involved in the formulation and implementation of forest policy, and the participation of women professionals is highly welcome.

For the invited participants, APFNet-KTC will cover their international travel costs in terms of a round-trip airfare (economy-class only), full-board accommodation and a certain amount of per diem. Participants/sponsoring agencies will have to bear other costs which are not mentioned as above, including costs of domestic travel, visa and other personal expenses.

WORKSHOP VENUE

Venue 1

Name: Golden Spring Hotel

Address: No. 93, Renmin Dong Road, Panlong District, Kunming City, Yunnan Province, P.R. China

Phone: (+86) 871 63192688

Venue 2

Name: Pu'er Sustainable Forest Management Demonstration and Training Base of Asia-Pacific Network for Sustainable Forest Management and Rehabilitation (APFNet Pu'er Base)

Address: Chahua Road, Simao District, Pu'er City, Yunnan Province, P.R. China

Phone: (+86) 879 3088885

CONTACT INFORMATION

For further details about the course and the various arrangements please contact:

Ms. PAN Yao

Programme Officer, APFNet Kunming Training Center

Southwest Forestry University

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Email: apfnetktc@apfnet.cn

Tel: (+86) 871 63862840 (office); (+86) 13629635716 (cell)

2. WORKSHOP PROGRAMME

Time	Agenda	Moderator/Presenter
DAY 1: (Sunday/August 18, 2024)	**Arrival of participants and registration**	
DAY 2: (Monday/ August 19, 2024)		
09:00 - 09:30	**Opening Ceremony** • Welcome remarks • Group Photo	APFNet; FGAYP; SWFU; APFNet-KTC
09:30 - 09:45	**Tea break**	APFNet - KTC
09:45 - 10:15	**Ice breaker – Getting to know each other**	Workshop facilitators
10:15 - 10:30	**Introduction to the course**	
10:30 - 11:10	**Check-out at a Hotel**	APFNet-KTC
11:10 - 12:00	**Lunch**	Gloden Spring Hotel
12:00-18:00	**Heading to Pu'er city**	APFNet-KTC
18:30-19:30	**Welcome dinner**	APFNet Pu'er base
DAY 3: (Tuesday/August 20, 2024)		
08:30 - 10:00	**Lecture 1:** Forest addressing climate change and actions in China --- Q & A	Prof. Jiang Chunqian
10:00 - 10:30	**Tea break**	APFNet Pu'er base
10:30 - 12:00	**Lecture 2:** Enhancing forest restoration through inclusive policies and effective implementation --- Q & A	Mr. Wasantha Tikiri Bandara Dissanayake
12:00 - 14:00	**Lunch**	APFNet Pu'er base

14:00 – 15:30	**Lecture 3:** Forest management towards to sustainable development --- Q & A	Prof. Jiang Chunqian
15:30 - 16:00	**Tea break**	APFNet Pu'er base
16:00 - 17:00	**Lecture 4:** An overview of forest management and forestry development in Pu'er City --- Q & A	Mr. Wang Yonggang
17:00 - 17:20	Wrap-up & Announcement by workshop secretariat	Workshop facilitators
17:30 - 18:30	**Dinner**	APFNet Pu'er base
DAY 4: (Wednesday/August 21, 2024)		
08:30 - 08:45	Overview of presentation and discussions on Day 3	Participant group 1
08:50 - 09:30	**Participant's presentation 1:** Bangladesh	Ms. Dipannita Bhattacherjee
09:30 - 10:10	**Participant's presentation 2:** Cambodia	Mr. Sien Teamhy
10:10 - 10:40	**Tea break**	APFNet Pu'er base
10:40 - 11:20	**Participant's presentation 3:** Lao PDR	Mr. Saykham Boutthavong
11:20 - 12:00	**Participant's presentation 4:** Malaysia	Ms. Nabilah Hamidah Binti Sabar
12:00 - 14:00	**Lunch**	APFNet Pu'er base
14:00 - 14:40	**Participant's presentation 5:** Myanmar	Mr. Maung Phyo
14:40 - 15:20	**Participant's Presentation 6:** Myanmar	Mr. Yan Myo Naing
15:20 - 15:50	**Tea break**	APFNet Pu'er base
15:50 - 16:30	**Participant's Presentation 7:** Nepal	Mr. Kushal Shrestha
16:30 - 17:10	**Participant's Presentation 8:** Sri Lanka	Mr. B.A.K.C. Bamunusinghe

17:10 - 17:30	Wrap-up & Announcement by workshop secretariat	Workshop facilitators
DAY 5: (Thursday/August 22, 2024)		
08:00 - 09:00	Heading to Ninger County	Forestry and Grassland Administration of Pu'er City; APFNet-KTC
09:00 - 12:00	Visit Pu'er Yunjing Feilin New Materials Co., Ltd.	
12:00 - 12:30	Heading to Nakeli	
12:30 - 13:30	**Lunch**	Nakeli
13:30 - 15:30	Visit Nakeli	Forestry and Grassland Administration of Pu'er City; APFNet-KTC
15:30 - 16:00	Heading to Huayu Household Goods Co., Ltd.	
16:00 - 17:00	Visit Huayu Household Goods Co., Ltd.	
17:00 - 17:30	Back to the APFNet Pu'er Base	
17:30 - 18:30	**Dinner**	APFNet Pu'er base
DAY 6: (Friday/August 23, 2024)		
08:30 - 08:50	Overview of presentations and discussions on Day 4 & Day 5	Participant Group 2 & 3
08:50 - 09:30	**Participant's Presentation 9:** Thailand	Ms. La-ongdao Thaopimai
09:30 - 10:10	**Participant's Presentation 10:** Thailand	Ms. Siriluck Thammanu
10:10 - 10:40	**Tea break**	APFNet Pu'er base
10:40 - 11:20	**Participant's Presentation 11:** Viet Nam	Mr. Nguyen Phuc Tho
11:20 - 12:00	**Participant's Presentation 12:** Viet Nam	Mr. Nguyen Trong Minh
12:00 - 14:00	**Lunch**	APFNet Pu'er base

14:00 - 15:30	**Group Work:** A SWOT analysis in institutional arrangement in forest rehabilitation and management	Workshop facilitators
15:30 - 16:00	**Tea break**	APFNet Pu'er base
16:00 - 17:30	**Group Work:** A SWOT analysis in institutional arrangement in forest rehabilitation and management	Workshop facilitators
17:30 - 18:30	**Dinner**	APFNet Pu'er base
DAY 7: (Saturday/August 24, 2024)		
09:00 - 09:15	Overview of presentations and discussions on Day 6	Participant group 4
09:20 - 10:00	**Participant's Presentation 13:** China	Ms. Wang Qing
10:0 - 10:20	**Tea break**	APFNet Pu'er base
10:20 - 10:30	Announcement by workshop secretariat	Workshop facilitators
10:30 - 12:00	Visit forest fire monitoring and early warning system at the APFNet Pu'er base	Wanzhangshan Forest Farm
12:00 - 13:00	**Lunch**	APFNet Pu'er base
13:00 - 14:00	Heading to Pu'er Sun River Forest Park	Forestry and Grassland Administration of Pu'er City; APFNet-KTC
14:00 - 17:00	Visit Heading to Pu'er Sun River Forest Park	
17:00 - 18:00	Back to the APFNet Pu'er base	
18:00 - 19:00	**Dinner**	APFNet Pu'er base
DAY 8: Sunday/August 25, 2024		
08:00 - 08:15	Heading to Mawangtang project site	Forestry and Grassland Administration of Pu'er City; Wanzhangshan Forest Farm; APFNet-KTC
08:15 - 09:00	Visit Mawangtang project site	
09:00 - 09:30	Heading to Pu'er Songmaogu Traditional Chinese Medicine Development Co., Ltd.	

09:30 - 11:30	Visit Pu'er Songmaogu Traditional Chinese Medicine Development Co., Ltd.	
11:30 - 12:00	Back to the APFNet Pu’er base	
12:00 - 14:00	**Lunch**	APFNet Pu’er base
14:00 - 14:30	Heading to Pu’er Forestry and Grassland Research Institute	Forestry and Grassland Administration of Pu’er City; Pu’er Forestry and Grassland Research Institute; APFNet-KTC
14:30 - 16:00	Visit Pu’er Forestry and Grassland Research Institute	
16:00 - 16:30	Heading to fine variety ecological tea garden	
16:30 - 17:30	Visit fine variety ecological tea garden	
17:30 - 18:30	**Dinner**	TBC
DAY 9: Monday/August 26, 2024		
09:00 - 09:20	Overview of presentations and discussions on Day 7 & Day 8	Participant group 5 & 6
09:20 - 09:40	An overview of the Workshop and Course evaluation	Workshop facilitators
09:40 - 10:00	**Tea break**	APFNet Pu’er base
10:00 - 10:30	**Closing Ceremony** • Vote of thanks • Group photo	APFNet-KTC
10:30 - 11:30	**Check-out at a Hotel**	
11:30 - 12:30	**Lunch**	APFNet Pu’er base
12:40 - 18:30	Return to Kunming city	APFNet-KTC
18:30 - 19:30	**Dinner**	Gloden Spring Hotel
DAY 10 (Tuesday/August 27, 2024) Participant departure		

3. LIST OF PARTICIPANTS

No.	Name	Economy	Title/Organization	E-mail
1	Dipannita Bhattacherjee	Bangladesh	Wildlife and Biodiversity Conservation Officer, Bangladesh Forest Department	dipannitacu10@gmail.com
2	Sien Teamhy	Cambodia	Lecturer and Researcher, Faculty of Forestry/Deputy Director, Center for Agricultural and Environmental Studies, Royal University of Agriculture	steamhy@rua.edu.kh
3	Wang Qing	China	Project Manager, Ecological Research Institute, China International Engineering Consulting Corporation	qing.wang@alumni.ubc.ca
4	Saykham Boutthavong	Lao PDR	Deputy Head, Department of Watershed and Land Management, Faculty of Forest Science, National University of Laos	boutthavong@nuol.edu.la
5	Nabilah Hamidah Binti Sabar	Malaysia	Assistant Director, Forestry Department of Peninsular Malaysia	nabilah@forestry.gov.my;
6	Maung Phyo	Myanmar	Ranger Officer, Forest Department	phyokokolwin2017@gmail.com
7	Yan Myo Naing	Myanmar	Registrar, University of Forestry and Environmental Science	yanmyonaing7@gmail.com
8	Kushal Shrestha	Nepal	Forest Officer, Ministry of Forests and Environment	kushal.dofsc@gmail.com
9	Bamunusinghe Arachchilage Kusala Channanath Bamunusinghe	Sri Lanka	Range Forest Officer, Department of Forest Conservation	rfohabarana@gmail.com
10	La-ongdao Thaopimai	Thailand	Researcher, Forestry Researcher Center, Faculty of Forestry, Kasetsart University	laongdao.t@ku.ac.th
11	Siriluck Thammanu	Thailand	Forestry Technical Officer (Professional level), Forest Protection and Forest Fire Control Office, Royal Forest Department	luckpp60@hotmail.com
12	Nguyen Phuc Tho	Viet Nam	Official, Department of Forestry	thodonc@gmail.com
13	Nguyen Trong Minh	Viet Nam	Lecturer, Faculty of Forestry, Vietnam National University of Forestry	minhnt@vnuf.edu.vn

4. PROFILES OF RESOURCE PERSONS

Prof. Jiang Chunqian (jiangchq@caf.ac.cn)

Dr. Jiang Chunqian is a Professor at Chinese Academy of Forestry. He did a PhD in silviculture, and has more than 25 years of experience in forestry programme design and implementation for China and for the Asia-Pacific Region. Prof. Jiang had published a number of books and more than 20 articles relating to forest management and policies, carbon stock accounting, ecotourism etc.

Mr. Wasantha Tikiri Bandara Dissanayake (dissaforest@yahoo.com)

Mr. Wasantha Tikiri Bandara Dissanayake is a freelance consultant specializing in environmental policy and planning, based in Sri Lanka. He currently serves as a forestry consultant for the Asia-Pacific Network for Sustainable Forest Management and Rehabilitation (APFNet) and has also been a Board Director for APFNet since 2018. His technical contributions to APFNet include analysing and summarizing project achievements, reviewing, monitoring, and evaluating projects for feasibility studies, mid-term evaluations, terminal evaluations, ex-post evaluations, and intermittent evaluations. Additionally, he provides technical support as a facilitator and resource person for APFNet events and workshops.

Mr. Wasantha Dissanayake has a multidisciplinary academic background. He holds a Bachelor's degree in Biological Science and a Master's degree in Forestry. Additionally, he earned a second Master's degree in Tropical Forestry, specializing in Social Forestry, from Wageningen Agricultural University in the Netherlands. He has also completed numerous international training programs covering various aspects of forestry and environmental science.

Mr. Wasantha Dissanayake has over 37 years of experience in various capacities across different organizations. He served in the Forest Department of Sri Lanka for over 28 years, holding positions such as Divisional Forest Officer, Regional Deputy Conservator of Forests, and Conservator of Forests. From 1998 to 2000, he was the Deputy Project Director for the Asian Development Bank-funded Upper Watershed Management Project. Between 2016 and 2022, Mr. Dissanayake worked at the Ministry of Environment of Sri Lanka as the Additional Secretary (Environment Policy and Planning). In this role, he oversaw environmental policies, including policy reforms and the development of new environmental policies and national action plans for Sri Lanka. He led the development of over ten environment related national policies during this period. Additionally, he served as the Chairman of the Central

Environmental Authority of Sri Lanka and the Marine Environment Protection Authority of Sri Lanka at certain periods and was also a governing board member of several institutes.

He has represented Sri Lanka at numerous international events as the head delegate. He has also served as a Vice President representing the Asia-Pacific Region at the Bureau of the Stockholm Convention on Persistent Organic Pollutants, and as a Governing Board Member of the Specific International Program of the Minamata Convention. Additionally, he held the position of Bureau Vice President of the Minamata Convention during 2019 – 2022, and also served as a panel member of the Voluntary Peer Review Panel for the UN Convention on Biological Diversity.

5. OUTLINES OF KEYNOTE LECTURES

Lecture 1: Forest addressing climate change and actions in China

--- Prof. Jiang Chunqian

"Climate change" has increasingly become a buzzword in the public mouth. To address climate change, IPCC (Intergovernmental Panel on Climate Change) convened experts to analyze the development of climate change, the Greenhouse Effect, the drivers of climate change, the impact of climate change on human beings, and the measures and actions to mitigate and adapt to climate change. We also talked about the Kyoto Protocol and the Paris Agreement.

Forest plays an important role in addressing climate change. We discussed the forest carbon stock change and how to estimate the carbon flux, REDD+ and CDM. Forest references (emissions) level is an important bar to accounting for forest carbon. We recognize that harvested wood product (HWP) is a significant carbon pool.

China is working hard to find solutions and take concrete actions to deal with the climate crisis. Chinese have been working on establishing as a reference standard, forest management reference levels, the carbon stock of HWP in China, the global mission trade system, China recorded methodologies on CCER (forest), Carbon trade market. Chinese have used different methods to assess the potential of China's terrestrial ecosystem carbon sink and forestry in coping with climate change, to provide Chinese solutions and contribute Chinese wisdom to the goal of mitigating and adapting to global climate change.

Lecture 2: Enhancing forest restoration through inclusive policies and effective implementation

--- Mr. Wasantha Tikiri Bandara Dissanayake

Asia-Pacific economies encompass approximately 18.5 percent of the global forest area. These forests host vast biodiversity reserves that are vital for the livelihoods of many, including Indigenous Peoples, local communities, and smallholders. They also significantly contribute to broader national economies by providing a wide range of products, such as timber and non-wood forest products (NWFPs). Additionally, they deliver essential ecosystem services that are vital for the well-being of human societies and the planet as a whole.

Forest restoration in the Asia-Pacific region is a critical endeavour due to the extensive deforestation and forest degradation that have occurred over the past few decades. Many economies in the region have established restoration goals within their national forest policies and strategies, Land Degradation Neutrality targets, Nationally Determined Contributions, and National Biodiversity Strategy and Action Plans. At least six economies in the region have committed to the Bonn Challenge, five to the New York Declaration on Forests, and seventeen to the Glasgow Leaders' Declaration on Forests and Land Use. The third Asia-Pacific Forest Sector Outlook Study emphasizes that significant investments are needed in forest and landscape restoration to achieve transformational change.

The success of forest restoration largely depends on effective governance, specifically the policies and institutional arrangements in place for implementation. Establishing an optimal governance system that provides the right incentives for sustainable land and resource management will continue to be a significant challenge.

Forest policies are crucial for the rehabilitation and restoration of degraded forests as they provide the framework for sustainable forest management. However, significant gaps in the formulation and implementation of these policies hinder the effectiveness of restoration efforts, lead to unintended consequences, and undermine sustainable management goals. These gaps can slow down the progress of forest rehabilitation projects, making it difficult to meet targets and timelines. Inadequate policies and poor implementation restrict the scale at which restoration efforts can be carried out, limiting their overall impact.

The gaps in the formulation and implementation of forest policies can be broadly classified into several categories such as policy and legal gaps, governance and implementation gaps, financial and economic gaps, social and community engagement gaps, technological and knowledge gaps, and environmental and ecological gaps. This presentation will help

participants thoroughly analyse these gaps, aiming to develop more effective, inclusive, sustainable, and resilient strategies for forest restoration in their respective economies.

Lecture 3: Forest management towards to sustainable development

--- Prof. Jiang Chunqian

Sustainable forest management is an act involving administrative, economic, legal, social, technical and technological means, involving natural and planted forests, and it is a series of planned human interventions aimed at protecting and maintaining the various functions of forest ecosystems, while at the same time developing species with social, environmental and economic value. Great achievements of China's Forest Rehabilitation have been made in Degraded Karst, Northeast and Inner Mongolia (National Forest Area), southeast and south China. We provided an overview of the status of forest resource in China, key ecological programs, the achievements and experiences of China's forest rehabilitation, and forest rehabilitation and rural village development. And then discussed the case study about improving the forest ecosystem services. At the end, we introduced the rehabilitation direction in the future of China, which will focus on (1) Forest rehabilitation and restoration on landscape scales. (2) Forest ecosystem integrity and forest ecosystem services provided. (3) Mountains, rivers, forests, farmland, lakes, grasslands and deserts are part of the community of life. China has actively explored the concrete practice of sustainable forest management and achieved good results.

ATTACHED FILES:

1. PPT SLIDES OF KEYNOTE LECTURES

1) Forest addressing climate change and actions in China

   --- Prof. Jiang Chunqian

2) Enhancing forest restoration through inclusive policies and effective implementation

   --- Mr. Wasantha Tikiri Bandara Dissanayake

3) Forest management towards to sustainable development

   --- Prof. Jiang Chunqian

2. PPT SLIDES OF PARTICIPANT PRESENTATIONS

1) **Bangladesh:** Degraded forest rehabilitation: Embracing collaborative forest management approach in Bangladesh
2) **China:** Degraded forest rehabilitation and sustainable forest management in China
3) **Malaysia:** Restoration, reclamation and rehabilitation of degraded forest in Peninsular Malaysia
4) **Myanmar:** Degraded forest rehabilitation and sustainable forest management: Opportunities and challenges in scaling up forest rehabilitation efforts in Myanmar
5) **Nepal:** Degraded forest rehabilitation and management in Nepal
6) **Thailand:** Rehabilitation and management of a Thailand community forest
7) **Viet Nam:** Management and conservation of forestry in Viet Nam
8) **Viet Nam:** Assessing forest rehabilitation and solutions: A case study of Dong Nai biosphere reserve and Kon Chu Rang natural reserve in Vietnam

3. PARTICIPANT PAPERS

1) **Bangladesh:** Economy report on degraded forest rehabilitation: Embracing collaborative forest management approach in Bangladesh
2) **Cambodia:** Flooded forest restoration site carbon inventory survey: Case study at Tonle Sap Great Lake in Pursat Province
3) **China:** Degraded forest rehabilitation and sustainable forest management in China
4) **Malaysia:** Restoration, reclamation and rehabilitation of degraded forest areas in Peninsular Malaysia

5) **Myanmar:** Degraded forest rehabilitation and sustainable forest management: Opportunities and challenges in scaling up forest rehabilitation efforts in Myanmar

6) **Myanmar:** Degraded forest rehabilitation and management in Myanmar

7) **Nepal:** Degraded forest rehabilitation and management in Nepal

8) **Sri Lanka:** Degraded forest rehabilitation and sustainable forest management in Sri Lanka

9) **Thailand:** Degraded forest rehabilitation and sustainable forest management: A case study of highland reforestation program in northern Thailand

10) **Thailand**: Rehabilitation and management of a Thailand community forest

11) **Viet Nam:** Assessing forest rehabilitation and solutions: A case study of Dong Nai biosphere reserve and Kon Chu Rang natural reserve in Vietnam

APFNet Workshop on
Degraded Forest Rehabilitation and Management in Asia-Pacific Region
18-27 August, 2024 Yunnan Province, China

Introduction to the Workshop

Ms. Pan Yao
APFNet Kunming Training Center

Sponsored by:
Asia-Pacific Network for Sustainable Forest Management and Rehabilitation (APFNet)

Organized by:
- Forestry and Grassland Administration of Yunnan Province (FGAYP)
- Southwest Forestry University (SWFU)

Co-organized by:
- APFNet Kunming Training Center
- Forestry and Grassland Administration of Pu'er City
- Pu'er Forestry and Grassland Research Institute
- Pu'er Wanzhangshan Forest Farm

Outlines

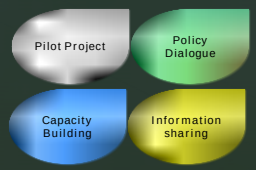
- **PART 1:**
  Introduction to APFNet Training Programme
- **PART 2:**
  Introduction to the Workshop

PART 1

Introduction to APFNet Training Programme

Asia-Pacific Network for Sustainable Forest Management and Rehabilitation

APFNet established in 2008, as the very name indicates is an international organization dedicated to advancing sustainable forest management and rehabilitation in the Asia-Pacific region.



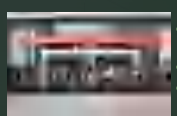
Asia-Pacific Network for Sustainable Forest Management and Rehabilitation

APFNet Capacity Building Initiative

- Capacity building – of people and institutions - is a thrust area of APFNet.
- An important component of the capacity building component is the thematic training workshops, which in addition to enabling sharing of knowledge and experience, helps to network forestry professionals in the Asia-Pacific region.

Asia-Pacific Network for Sustainable Forest Management and Rehabilitation

APFNet Kunming Training Center (APFNet-KTC)



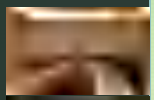
- Established on 12th November 2012 based at Southwest Forestry University (SWFU);
- Serves as an independent division of APFNet Secretariat;
- Its field visit base in Pu'er City, Yunnan Province, China

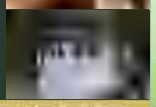
Asia-Pacific Network for Sustainable Forest Management and Rehabilitation

APFNet Thematic Training Workshops:

Prior to 2016, APFNet through its Kunming Training Centre (KTC) organized biannual thematic training workshops on the following themes:

1. Forest Resources Management;
2. Forestry and Rural Development.





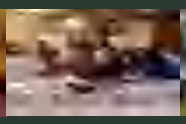
2016 onwards, the training themes have been fixed to:

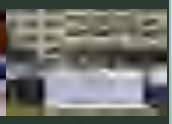
1. Degraded Forest Rehabilitation and Management;
2. Forestry and Rural Livelihood Development.

Asia-Pacific Network for Sustainable Forest Management and Rehabilitation

Objectives

- Create a platform for Asia-Pacific economies in enhancing forest rehabilitation and sustainable forest management
- Provide an in-depth understanding of urgent regional needs and promote SFM in the Asia-Pacific Region.





Asia-Pacific Network for Sustainable Forest Management and Rehabilitation

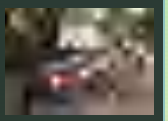
Target Group:

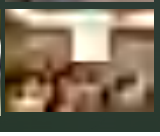
- Government officials from developing APFNet member economies across the Asia-Pacific region.
- Most participants, as senior officials from forestry authorities, nominated by the focal points of APFNet's member economies.

Asia-Pacific Network for Sustainable Forest Management and Rehabilitation

Workshop Design and Approach:

- Keynote lectures
- Presentations by participants
- Group work
- Field trip

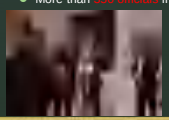


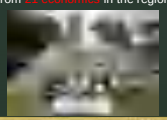


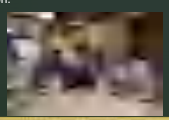
Asia-Pacific Network for Sustainable Forest Management and Rehabilitation

Overview of the previous training workshops:

- 23 training workshops run by APFNet-KTC since 2009, of which some of Some of these Workshops have been organized in APFNet member economies:
  - --- Chiang Mai, Thailand: November, 2015 ;
  - --- Negombo, Sri Lanka : November, 2016;
  - --- Siem Reap, Cambodia: July, 2017.
- More than 350 officials from 21 economies in the region.







Asia-Pacific Network for Sustainable Forest Management and Rehabilitation

Total of 21 Economies Involved from the Region			
Bangladesh	Bhutan	Brunei	Cambodia
Chile	China	Fiji	India
Indonesia	Lao PDR	Malaysia	Mexico
Mongolia	Myanmar	Nepal	Peru
Philippines	PNG	Sri Lanka	Thailand
Vietnam			

Asia-Pacific Network for Sustainable Forest Management and Rehabilitation

No.	Economy	No. of participants	No.	Economy	No. of participants
1	Bangladesh	21	12	Mexico	3
2	Brunei	10	13	Mongolia	13
3	Bhutan	2	14	Myanmar	26
4	Cambodia	30	15	Nepal	20
5	Chile	1	16	Peru	9
6	China	24	17	Philippines	20
7	Fiji	15	18	PNG	16
8	India	4	19	Sri Lanka	22
9	Indonesia	19	20	Thailand	30
10	Lao PDR	24	21	Viet Nam	23
11	Malaysia	23			
		TOTAL			355

APFNet-KTC website: https://apfnet-ktc.swfu.edu.cn/

E-mail: apfnetktc@apfnet.cn
Tel: (+86) 871 63862840 **Fax:** (+86) 871 63862531
Add: No. 300 Bailongsi, Southwest Forestry University , Kunming, China

PART 2

Introduction to the current Workshop

Outline of the Presentation

- Background
- Objectives of the workshop
- How the workshop is structured.

Background: Forest Rehabilitation

- Forest degradation and deforestation remain major problems reducing the forest's ability to provide goods and services, thereby directly and indirectly affecting human well-being.
- The Global Partnership on Forest Landscape Restoration estimates the extent of degraded forest lands worldwide as 2.0 billion hectares.
- As per ITTO estimates there are 500 million ha of degraded primary and secondary forests in the tropics.
- A number of restoration efforts at different levels have been made to address issues related to land degradation;
  (e.g. carbon neutrality, Goal 15 of SDGs, CBD's Aichi Target etc.)
- The outcome of these efforts are highly varied, and more successful stories occurred in Korea, Brazil, China and Vietnam;

APFNet's Effort to Forest Rehabilitation

- Giving due consideration to its establishment mission and the needs of the Asia-Pacific economies, APFNet has developed a Five-Year Strategic Plan for Thematic Training Programme from 2020 to 2025 and give clear focuses on:

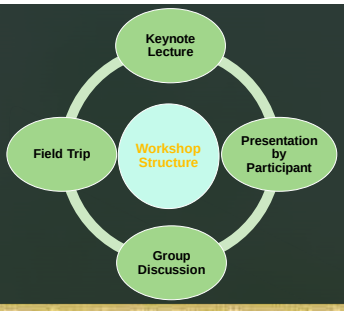
Rehabilitation **Livelihood**

- Through thematic training workshops under specific themes, it help establish a platform to share and learn knowledge and experience;
- It's in this context, the current training workshop on Degraded Forest Rehabilitation and Management in Asia-Pacific is being organized as the first APFNet training course after COVID-19.

Objectives of The Workshop

This workshop is being organized to:

- Provide an overview of the current state of forest rehabilitation and sustainable management of forest lands in the Asia-Pacific economies;
- Discuss the factors that contribute to successes and failures in forest rehabilitation efforts and the lessons learned from the experience hitherto;
- Assess the role of different players/stakeholders in forest rehabilitation efforts;
- Fulfill knowledge gap of how to make rehabilitation efforts more people and environment centric by sharing cross-economy experience, and enhance the capacity of participants to design more effective strategies, plans and programmes.



1. Thematic Lectures

Resource Person	Topic
Prof. Jiang Chunqian	➢ Forest Addressing Climate Change and Actions in China ➢ Forest Management towards to Sustainable Development
Mr. Wasantha Dissanayake	➢ Enhancing forest restoration through inclusive policies and effective implementation
Mr. Wang Yonggang	➢ Overview of forest management and forestry development in Pu'er City

2. Participant Presentation

No.	Economy	Participant Name
1	Bangladesh	Ms. Dipannita Bhattacherjee
2	Cambodia	Mr. Sien Teamhy
3	China	Ms. Wang Qing
4	Lao PDR	Mr. Saykham Boutthavong
5	Malaysia	Ms. Nabilah Hamidah Binti Sabar
6	Myanmar	Mr. Maung Phyo
7	Myanmar	Mr. Yan Myo Naing
8	Nepal	Mr. Kushal Shrestha
9	Sri Lanka	Mr. Bamunusinghe Arachchilage Kusala Channanath Bamunusinghe
10	Thailand	Ms. La-ongdao Thaopimai
11	Thailand	Ms. Siriluck Thammanu
12	Viet Nam	Mr. Nguyen Phuc Tho
13	Viet Nam	Mr. Nguyen Trong Minh

3. Group Discussion

- Discussion will be allocated in the afternoon of 23 August, 2024;
- Focus on a SWOT analysis in institutional arrangement in forest rehabilitation and management;
- Each group will select one role to play and then have an in-depth discussion.

4. Field Trip

- Conducted on 22nd, 24th and 25th August, 2024;
- Provide an opportunity for participants to observe rehabilitation-related work in Pu'er City of China;
- Field Visit include:
  - Forestry enterprise (e.g. household goods, particleboard)
  - Cultivation of rare and high value medical herbs under natural forests
  - Pu'er Forestry and Grassland Research Institute
  - Forest protected area
  - Forest fire monitoring system
  - …

Workshop Schedule

Timeline

- 18th August — Participant arrival and registration
- 19th August — Opening ceremony
- 20th - 26th August — Indoor learning session
  - Morning recaps
  - Keynote lectures
  - Presentations by participants
  - Group work

  Field trip in Pu'er City

  Closing ceremony
- 27th August — Participant departure

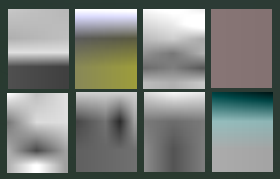
Morning recap

- Conduct in early morning session during indoor learning session;
- Morning recap please be presented in a Microsoft PowerPoint form.
- A total of 6 small groups will be formed, and group members of each group is suggested as followed:

Group No.	Date of presentation	Recap on	Group members
1	21 August	Day 3	Siriluck Thammanu, Nguyen Phuc Tho, Nguyen Trong Minh
2	23 August	Day 4	Wang Qing, Yan Myo Naing
3		Day 5	Sien Teamhy, Kushal Shrestha
4	24 August	Day 6	Dipannita Bhattacherjee, Saykham Bouttavong
5	26 August	Day 7	Nabilah Hamidah Binti Sabar, Maung Phyo
6		Day 8	B.A.K.C. Bamunusinghe, La-ongdao Thaopimai

Some Important Publications

- Restoration and rehabilitation have received widespread attention and several publications providing in-depth understanding of the diverse issues are available.



Summing Up

- Considerable progress has been made on forest rehabilitation and sustainable management during the last decades; but many gaps or obstacles need to be overcome;
- Enhance the opportunity for sharing knowledge and experience on best practices from the Asia-Pacific economies, and improve opportunities for increased collaboration;
- Adopt a highly interactive approach between resource persons and participants;
- We would like this workshop to be a highly productive and learning experience for everyone, and in some extent to make a contribution after our return.

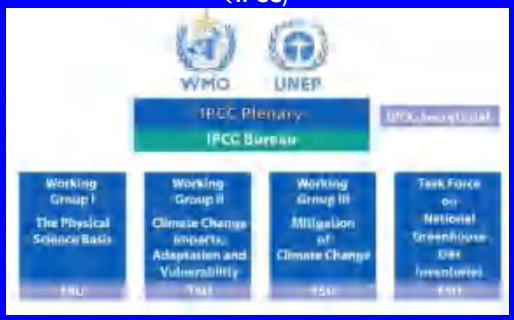
Thank you for your attention!

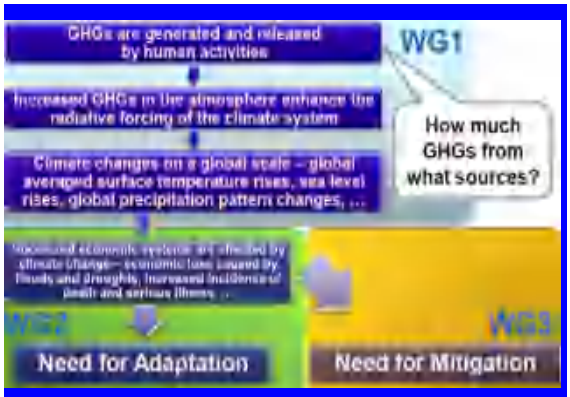
1. Climate Change and Internatioanl Negotiations

Intergovernmental Panel on Climate Change （IPCC)

- Established in 1988 by WMO and UNEP;
- Mission:
  - provide comprehensive scientific assessments of current scientific, technical and socio-economic information worldwide about the risk of climate change caused by human activity, its potential environmental and socio-economic consequences, and possible options for adapting to these consequences or mitigating the effects ;
  - Assessment reports, Special reports, Methodology reports, and Technical papers;
  - AR 1 to AR5，AR6

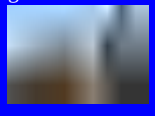
Intergovernmental Panel on Climate Change （IPCC)





United Nations Framework Convention on Climate Change（UNFCCC ）

- An international environmental treaty negotiated in 1992 and entered into force in 1994.
- Objective:
  - to “stabilize greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system“.
- National Greenhouse Gas Inventories
- Kyoto Protocol : GHG emission reductions
- Paris Agreement



International Negotiation on Climate Change

- **Conferences of the Parties（COP）： COP1 in 1995 in Belin**
- **the Conference of the Parties serving as the Meeting of the Parties to the Kyoto Protocol（CMP）： CMP 1 in 2005 in Montreal;**
- **The Subsidiary Body for Scientific and Technological Advice （SBSTA）**
- **The Subsidiary Body for Implementation （SBI）**
- **The Conference of the Parties serving as the meeting of the Parties to the Paris Agreement（CPA)**

Milestones in the international negotiation on climate change

- UNFCCC adopted in 1992.
- Kyoto Protocol was adopted at COP 3 in 1997
- The Marrakesh Accords at COP 7 in 2001: ways and means of making KP operational
- Bali Road Map at COP 13 in 2007
- Copenhagen Accord at COP 15 in 2009
- Cancun Agreements at COP 16 in 2010
- Durban Platform at COP 17 in 2011
- Doha packages at COP 18 in 2012
- Paris 2015, Climate change Agreement for post 2020
- The Paris Agreement entered into force on 4 November 2016

Kyoto Protocol

- Kyoto Protocol was adopted at COP 3 in 1997
- KP was ratified in 2005
  - Annex I Parties of UNFCCC are obligated to reduce overall the emissions of GHGs by 5.2% compared with 1990 levels by 2012.
- Greenhouse gases
  - Carbon dioxide (CO2), Methane (CH4), Nitrous oxide (N2O), Hydrofluorocarbons (HFCs), Perfluorocarbons (PFCs), Sulphur hexafluoride (SF6)
- Quantified emission limitation and reduction commitment
- KP (Doha amendment) 2013-2020

Paris Agreement

- Holding the increase in the global average temperature to well below 2 ° C above pre-industrial levels
- Pursuing efforts to limit the temperature increase to 1.5 ° C above pre-industrial levels;
- Intended Nationally Determined Contributions (INDC);
- Article 5: Forest (reservoirs and sinks), REDD+

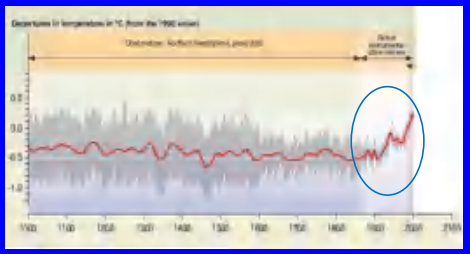
Climate change and CO_2 emission

- **Svante Arrhenius (1859-1927),** Stockholm University, *Philosophical Magazine* **41,** 237 (1896)
- **"On the Influence of Carbonic Acid in the Air upon the Temperature of the Ground"**
- Increased CO_2 in the air will increase ground temperatures
- Stronger influence near the poles than near the equator.
- Stronger impact in the northern hemisphere.
- Diminished difference in temperature between day and night

The Greenhouse Effect

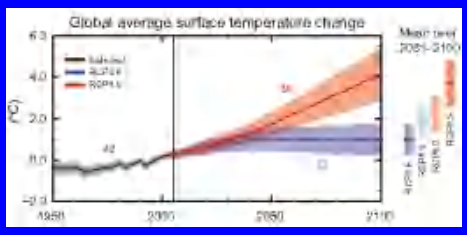
Climate Change

Temperature variations over the past 1000 years



Source：IPCC，2001

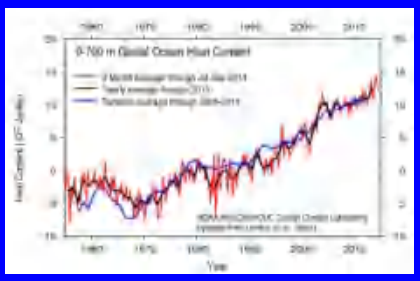
Climate Change



Global surface temperature change at the end of the 21st century is *likely* to exceed 1.5℃ relative to 1850 to 1900 for all RCP scenarios except RCP2.6. It is *likely* to exceed 2 ℃ for RCP6.0 and RCP8.5, and *more likely than not* to exceed 2 ℃ for RCP4.5. Warming will continue beyond 2100 under all RCP scenarios except RCP2.6.

- Representative Concentration Pathways (RCPs)

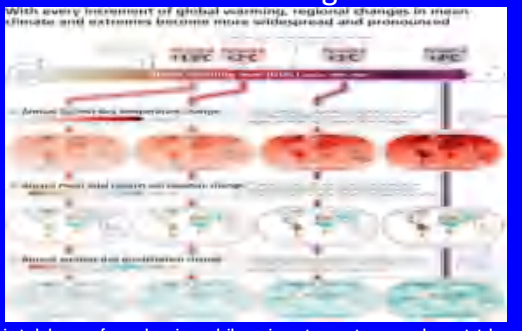
Climate Change



- Global ocean heat content

Source: NOAA/NESDIS/NODC,2014

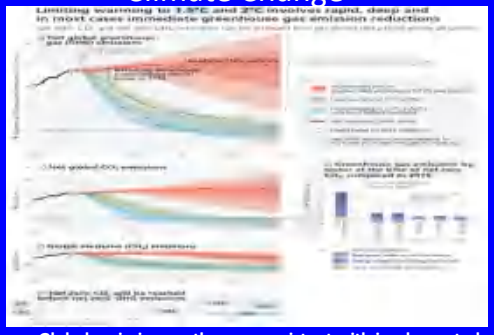
Climate Change



Projected changes of annual maximum daily maximum temperature, annual mean total column soil moisture and annual maximum 1-day precipitation at global warming levels of 1.5° C, 2° C, 3° C, and 4° C relative to 1850–1900.

Source：IPCC，2023

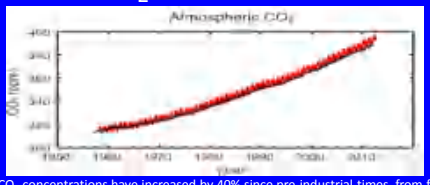
Climate Change



Global emissions pathways consistent with implemented policies and mitigation strategies

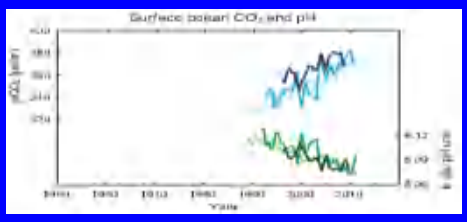
Source：IPCC，2023

CO_2 concentration



- CO_2 concentrations have increased by 40% since pre-industrial times, from fossil fuel emissions and secondarily from net emissions of land use change .
- Annual CO_2 emissions from fossil fuel combustion and cement production were 8.3 [7.6 to 9.0] GtC yr^{-1} averaged over 2002–2011 and were 9.5 [8.7 to 10.3] GtC yr^{-1} in 2011, 54% above the 1990 level. Annual net CO2 emissions from anthropogenic land use change were 0.9 [0.1 to 1.7] GtC yr^{-1} on average during 2002 to 2011.
- 1750 - 2011, CO_2 emissions from fossil fuel combustion and cement production have released 375 [345 to 405]GtC to the atmosphere, while deforestation and other land use change are estimated to have released 180 [100 to 260] GtC. This results in cumulative anthropogenic emissions of 555 [470 to 640] GtC.

CO_2 concentration



- **The ocean has absorbed about 30% of the emitted anthropogenic carbon dioxide, causing ocean acidification.**
- Ocean acidification is quantified by decreases in pH1.3. The pH of ocean surface water has decreased by 0.1 since the beginning of the industrial era (high confidence), corresponding to a 26% increase in hydrogen ion concentration

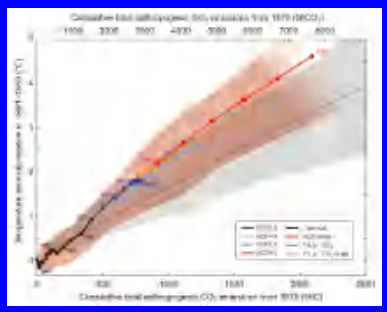
CO_2 Emissions

- **Cumulative CO_2 Emissions 2012 to 2100**

Scenario	GtC		GtCO2	
	Mean	Range	Mean	Range
RCP2.6	270	140 to 410	990	515 to 1505
RCP4.5	780	595 to 1005	2860	2180 to 3685
RCP6.0	1060	840 to 1250	3885	3080 to 4585
RCP8.5	1685	1415 to 1910	6170	5185 to 7005

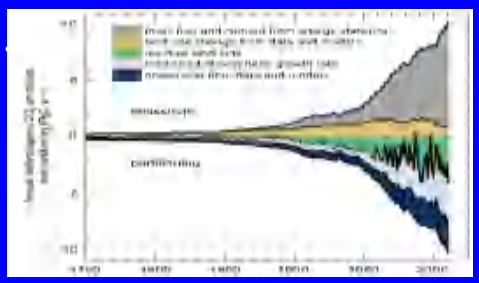
Cumulative CO_2 emissions from 2012 to 2100 period compatible with the RCP atmospheric CO_2 concentrations, as derived from 15 Earth System Models, range from 140 to 410 GtC for RCP2.6, 595 to 1005 GtC for RCP4.5, 840 to 1250 GtC for RCP6.0, and 1415 to 1910 GtC for RCP8.5.

CO_2 Emissions

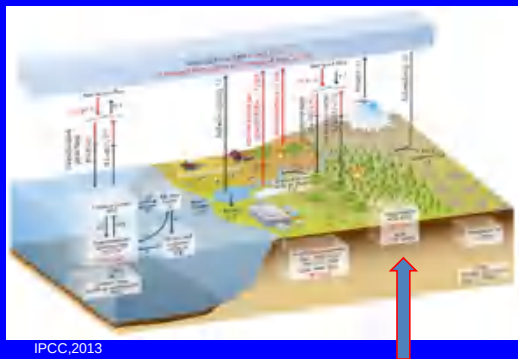


IPCC, 2013

CO_2 Emissions

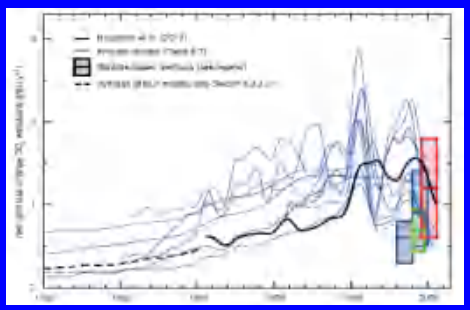


CO_2 Emissions



IPCC,2013

CO_2 Emissions from Land use



The Greenhouse Effect

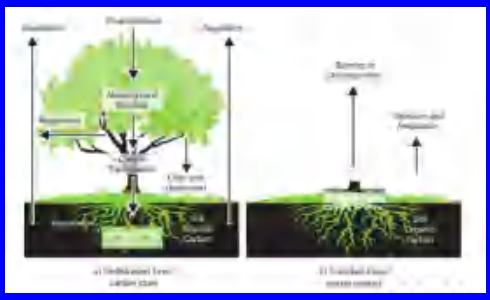
- UNEP released 2023 Emissions Gap report, **global greenhouse gas emissions in 2030 need to be reduced by 28 percent from current emissions to achieve the Paris Agreement goal of limiting global warming to 2 ° C, and 42 percent to achieve the goal of limiting global warming to 1.5 ° C.**

2. Forest carbon and accounting

Definitions

- "Reservoir": means a component or components of the climate system where a greenhouse gas or a precursor of a greenhouse gas is stored.
- "Sink": means any process, activity or mechanism which removes a greenhouse gas, an aerosol or a precursor of a greenhouse gas from the atmosphere.
- "Source": means any process or activity which releases a greenhouse gas, an aerosol or a precursor of a greenhouse gas into the atmosphere.

Effect of forest on the carbon cycle



Forestry's role in global carbon

- **Reservoirs** — **1650 GtC**
- **Sinks** — **2.6 GtC/yr**
- **Sources** — **1.6 GtC/yr**
- (from FAO)

Approach to increase forest C storage

- Expand forest area through restoration, planting forest.
- Forest conservation to increase C storage in the forest;
- Sustainable management of forest and improve forest quality and ability to sequestrate C;
- Strengthen the use of harvested wood products instead of energy intensive products ,such as cement and steel.

Forestry mitigation options

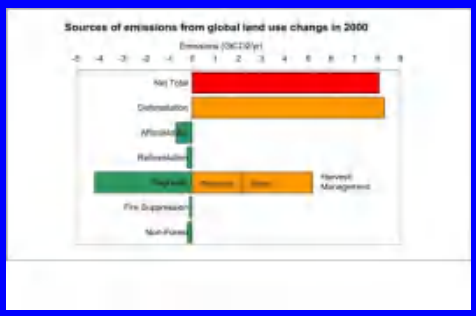
- **Maintain or increase forest area**
- **Reduce deforestation**
- **Increase afforestation and reforestation**
- **Maintain or increase forest carbon density**
  - » **Reduced forest degradation**
  - » **FM interventions; RIL, etc.**
  - » **Forest restoration**
  - » **Forest conservation**
  - » **Wild fire management**
- **Increase use of wood products for increased carbon stocks and fossil fuel substitution**

Forestry's role in global carbon

Forests cover some 30 per cent of our planet's land area and are home to 80 per cent of all terrestrial species.

Forests also act as important carbon sinks, absorbing about 2 billion tonnes of carbon dioxide annually. Sustainably managing forests is therefore critical for closing the emissions gap and limiting global temperature rise to 1.5° C from pre-industrial levels.

Mitigation options



Increasing C Sink and Storage in Forestry Sector

- Cheap approach
- Estimation from scientists: if reducing 1% coal in energy use, the emission of CO_2 will be reduced 0.74%. GDP and employment will decrease 0.64% and 4.7 million respectively.
- Multiple benefits: social and ecological benefits.
- From 1981-2000, the C absorbed by terrestrial vegetation is 14.6%-16.1% of total C emission.

The impacts of climate change on forest

Climate changes will affect many processes (growth, decay, disturbances) with large differences between ecosystems and regions.

Currently not able to predict net impacts.

Forestry issues of International negotiation on climate change

- LULUCF
- REDD+
- CDM-A/R
- FM
- HWP

LULUCF

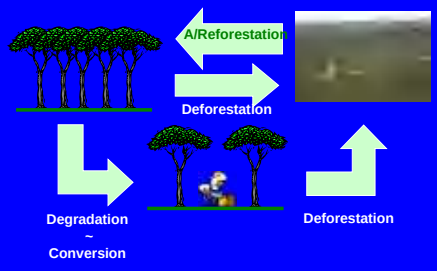
Human activities impact terrestrial sinks, through land use, land-use change and forestry (LULUCF) activities, consequently, the exchange of CO_2 (C cycle) between the terrestrial biosphere system and the atmosphere is altered.

Marrakesh Accords

- Forest Land
- Cropland
- Grassland
- Wetland
- Settlement
- Other lands

- Activity-based approach
- Land-based approach

Forest land use change



- Above-ground biomass
- Below-ground biomass
- Litters
- Dead wood
- Soil organic carbon

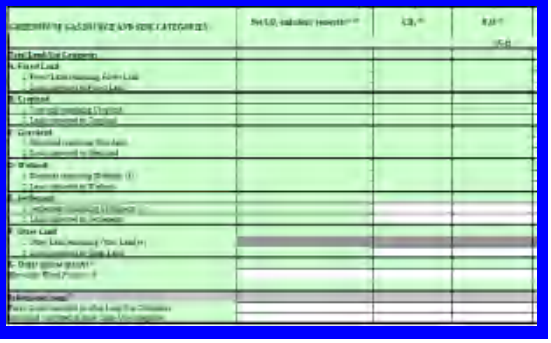
Tiers of estimation:
Tier 1
Tier 2
Tier 3

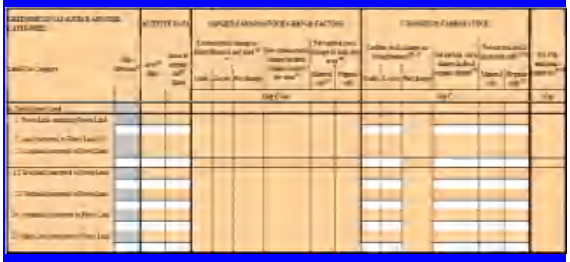
Carbon pools

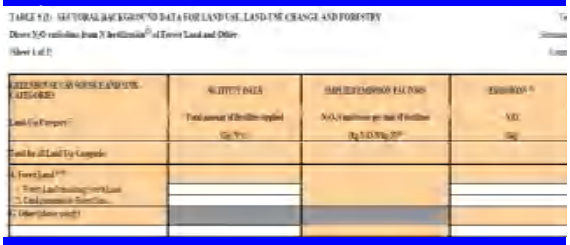
1.AGB
2.BGB
3.Litter
4.Dead Wood
5. Soil Organic
6.Wood Products

Living Biomass=
(AGB + BGB)

- LULUCF: Marrakesh Accords (Decision 11/CP7 and decision 16/CMP.1 of COP/MOP1
- Article 3.3: the accounting on the emissions by sources and removals by sinks in the LULUCF activities of afforestation, reforestation and deforestation (mandatory)
- Article 3.4: the accounting on the activities of forest management, cropland management, grassing land management etc .
- Meet Parties' emission reduction commitments
- Second commitment period: (Forest management - mandatory,, cropland management, grass land management, revegetation, wetland drainage and rewetting - elective activities)







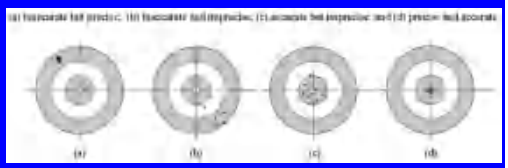
Uncertainty assessment

- *Uncertainty*: Lack of knowledge of the true value of a variable that can be described as a probability density function (PDF) characterizing the range and likelihood of possible values.
- Uncertainty depends on the analyst's state of knowledge, which in turn depends on the quality and quantity of applicable data as well as knowledge of underlying processes and inference methods.

IPCC,2006

Uncertainty assessment

- **Illustration of accuracy and precision**

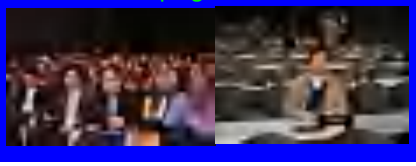


- Inventories should be accurate in the sense that they are neither over- nor underestimated as far as can be judged, and precise in the sense that uncertainties are reduced as far as practicable.

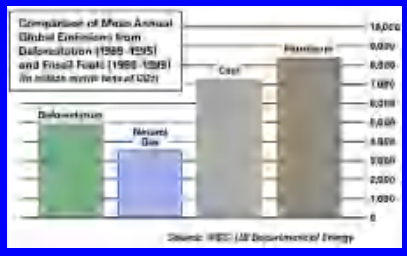
- Marrakesh Accords (11./CP7) :deforestation was not the eligible CDM activity because of the baseline and methodology issues.
- 2005, PNG and Costa Rica proposed to add "reducing emissions from deforestation in developing countries : incentive mechanism" in provisional agenda of COP11 (UNFCCC,2005).
- Workshops on incentive mechanism ,methodology and policy approaches of deforestation topic.
- COP13 also continued to discuss the material action to reduce the emissions from deforestation in developing countries
- REDD is becoming one of the significant topics in climate change negotiation.

Concept

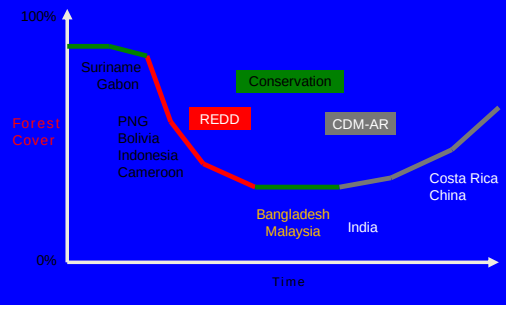
- Policy approaches and positive incentives on issues relating to reducing emissions from deforestation and forest degradation in developing countries; and the role of conservation, sustainable management of forest and enhancement of forest carbon stocks in developing countries.



Emissions from deforestation approx. 17% of total GHG's (12% in AR5)



Forest transition



Ten countries with largest annual change in forest area

Definition of Deforestation

- UNFCCC 2001 COP7 (11/CP.7):
  - The direct human –induced conversion of forested land to non-forested land.
- FAO 2001:
  - The conversion of forest to another land use or the long-term reduction of the tree canopy cover below the minimum 10 percent threshold.

Activities involved in REDD +

- Deforestation
- Degradation
- Conservation
- Sustainable Management of Forest
- Enhancement C stocks

A National Strategy or Plan

How to develop the strategy or plan?
The structure, composition and contents of the strategy or plan?
Experience from the ongoing readiness processes or programme

A National Reference Level

Reference level/ Reference emission level
How to establish it?

A Forest Monitoring System

- Provide information on the progress of the activities of REDD+, and information on how the safeguards are addressed.

Phased Approach

- **Phase 1**: Development of national plan, policies and measures and capacity building
- **Phase 2**: Implementation of national plan, policies and measures, technology development and transfer, and results based demonstration activities
- **Phase 3**: Results-based actions with full measurement reporting and verification

Drivers of Deforestation

- Identify land use, land-use change and forestry activities in developing countries, in particular those that are linked to the drivers of deforestation and forest degradation
- Fails to address the role that *developed countries* play in driving tropical deforestation
- Drivers link to the opportunity cost?

Indigenous People and Local Community

- Respect for the knowledge and rights
- Full and effective participation in REDD-plus design, implementation and MRV
- Consent of indigenous peoples

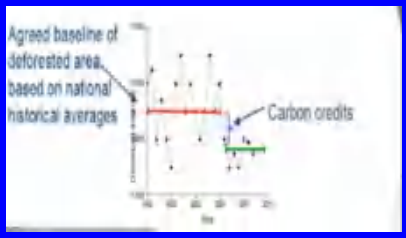
Building MRV

- Modalities for MRV.
- Implement national-level MRV system supplemented by sub-national MRV.
- MRV for financial mechanism.

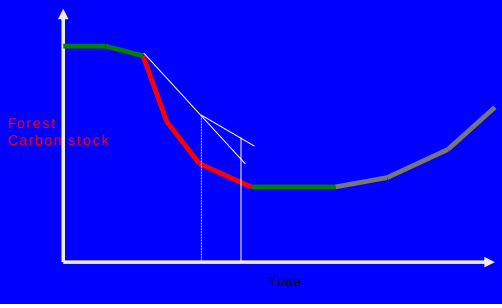
National and Sub-national Approach

- Assess existing capacities, available data and future requirements for MRV.
- Implement national-level MRV system supplemented by sub-national MRV.
- Establish MRV system to review REDD-plus related policies and processes.

National approach



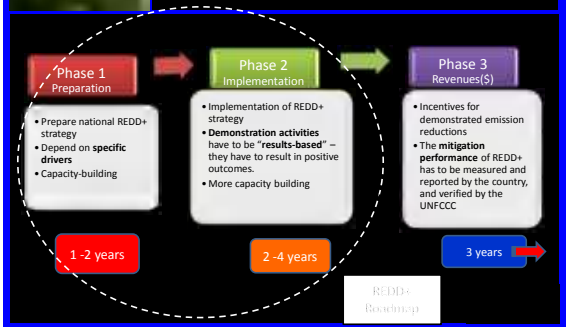
Reference emission level/Reference level



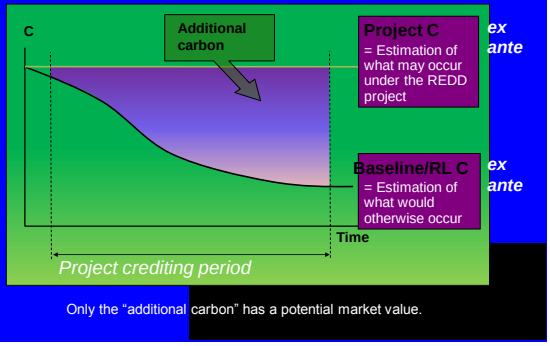
FRL/FREL

- The Cancun Agreements request developing country parties that are aiming to participate in a REDD+ mechanism to develop a national forest REL/RL.
- Credible and transparent forest REL/RL will be an important component of results-based actions for phase three REDD+ activities.
- Construction of forest REL/RL should be a key priority including:
  - ✓ clarity of definitions, terminology
  - ✓ carbon pools
  - ✓ GHG
  - ✓ Flexibility of approach during the different phases of REDD+
  - ✓ Think national circumstances

Three phases of REDD+



REDD



Only the "additional carbon" has a potential market value.

UN-REDD Partner countries

UN-REDD Partner countries and support provided through various delivery mechanisms of the Programme, 30 June 2014

MRV institution in Indonesia

CDM

- CDM was derived from Brazil proposal ---*clean development fund* and established in the article 12 of KP;
- The *CDM* allows emission-reduction projects in developing countries to earn certified emission reduction (CER) credits, each equivalent to one tonne of CO_2. These CERs can be traded and sold, and used by industrialized countries to a meet a part of their emission reduction targets under the Kyoto Protocol.
- The mechanism stimulates sustainable development and emission reductions, while giving industrialized countries some flexibility in how they meet their emission reduction limitation targets.
- The Adaptation Fund is financed by a 2% levy on CERs issued by the CDM

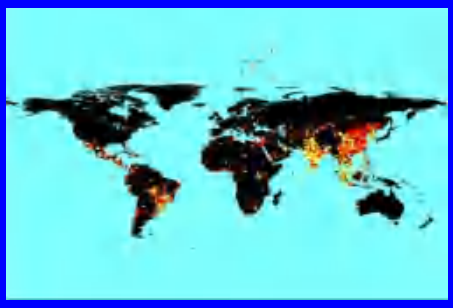
CDM:A/R

- A/R carbon sequestration projects are eligible under CDM for the first commitment period (2008-2012)
- Under Kyoto Protocol, afforestation and reforestation refer to afforest/reforest the land that had not been forested by Past 50 Years or December 31st, 1989
- First forestry CDM project in China: Guangxi

Small-scale A/R CDM

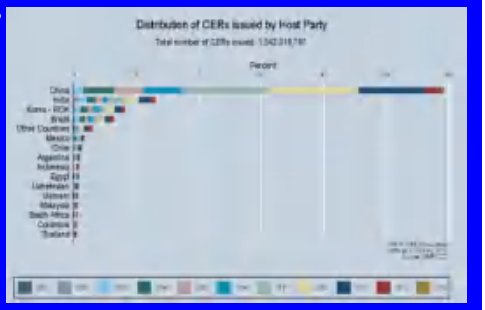
- "Small-scale afforestation and reforestation project activities under the CDM" are those that are expected to result in net anthropogenic greenhouse gas removals by sinks of less than 16,000t of CO_2 /yr and are developed or implemented by low-income communities and individuals as determined by the host Party. If a small-scale AR project activity under the CDM results in net anthropogenic GHG removals by sinks greater than 16,000t of CO_2 /yr , the excess removals will not be eligible for the issuance of tCERs or lCERs.

Distribution of CDM project

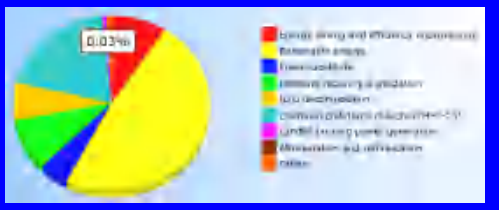


Global：5157 ;China：2676; (FAO,2012)

CDM： Distribution of CERs issued

- 

CDM： Number of CERs issued by scope



- Average Annual Reductions from A/R：90,272 $CO_{2\text{-eq}}$（0.03%）

Key Point of CDM project Design

- Project boundary
- Baseline
- Additionality
- Leakage
- Credit period

Key Point of CDM project

Carbon pools

Mandatory: AGB and BGB

Optional: Dead wood, Litter and SOC

Emissions: CH_4 and N_2O emissions from burning of woody biomass

Baseline and additionality:

Stratification

Baseline stratification: land use, vegetation type and/or crown cover

Project stratification:

Ex ante: planting (time & species) and management plan

Ex post: actual planting (time & species) and management, climate, soil, disturbance, etc.

Key concepts in C Accounting

- *Baseline: Business as Usual*
- *Reference level:* Established as a reference standard (statically or dynamical)
- *Additionality: New stored carbon.* Practices that exceed BAU, in anticipation of future C credits

Key concepts in C Accounting

- *Leakage: Gains not lost elsewhere*
- *Permanence: Ensure Net C remains stored over time (Kyoto: 100 year standard)*
- *Validation:* 3rd Party Certification (similar to FSC)
  - *Yr. 1, then every five years to certify emissions reductions*

G. Donald Bain, Courtesy of the Geo-Images Project/UC Berkeley

Baseline / Reference Level

Caculation

Net Anthropogenic GHG Removals by Sinks (or just Amount of Carbon Offsets)

$$Cn = Cp - LB - L$$

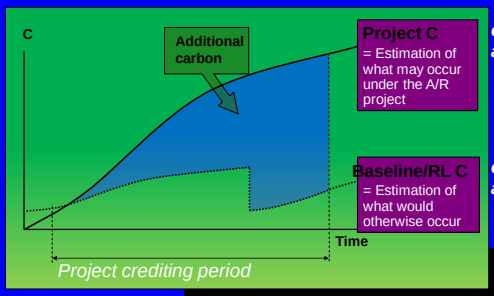
Cn = Net anthropogenic greenhouse gas removals by sinks

Cp = Actual net greenhouse gas removals by sinks (PROJECT)

LB = Baseline net greenhouse gas removals by sinks

L = Total GHG emissions due to leakage

Additionality



Only the "additional carbon" has a potential market value.

PEDRONI (2005)

Treatment of FM in the different commitment periods of KP

First（Dec.16/ CMP.1	Second（DEC.2/CMP.7）
FM is an alternative activity under Article 3.4.	Accounting for FM shall be mandatory, along with Article 3.3 activities, and Article 3.4 activities elected in the first commitment period. Accounting for FM shall be done on the basis of the FMRL inscribed in the appendix to Decision 2/CMP.7
Accounting for FM is on a gross-net basis.	Parties shall demonstrate methodological consistency between the FMRL and reporting for FM during the second commitment period, including in the area accounted for; in the treatment of Harvested Wood Products; and in the accounting of any emissions from natural disturbances
	Parties shall make technical corrections, if necessary, to ensure methodological consistency between the FMRL and reporting for FM during the commitment period, including applying IPCC methods for ensuring time-series consistency
	Technical corrections shall be applied after adoption of the FMRL if the reported data used to establish it are subject to recalculations, to include in the accounting the impact of the recalculations on the reported data that have been used by the Party to set the FMRL

Forest management reference levels

Construction of reference levels

- (a) Area under forest management;
- (b) The relationship between FM and GHG inventories and relevant historical data, including information
- (c) Forest characteristics, including age-class structure, increments, rotation length and other relevant information, including information on FM activities under 'BAU';

Forest management reference levels

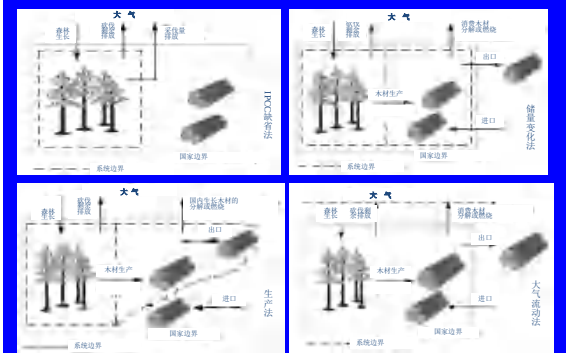
Construction of reference levels

- (d) Historical and assumed harvesting rates;
- (e) Harvested wood products;
- (f) Disturbances in the context of force majeure;
- (g) Factoring out in accordance with paragraph 1 (h) (i) and (ii) of decision16/CMP.1.

- Provide a description of any other relevant elements considered or treated in the construction of the FMRL

HWP

Accounting approachs



Method

- **Tier 1: "Instantaneous oxidation"**
  （many developing countries）
- **Tier II: First order decay （general）**
- **Tier III: Country-specific methods**

Method

- Default parameters:

IPCC,2014

Method

- Default half-lives:

IPCC,2014

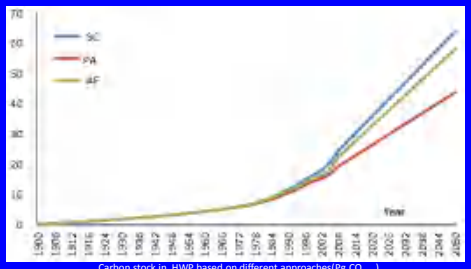
Method

$$C(i+1) = e^{-k} \cdot C(i) + \left[\frac{\left(1-e^{-k}\right)}{k}\right] \cdot Inflow(i)$$

$$\Delta C(i) = C(i+1) - C(i)$$

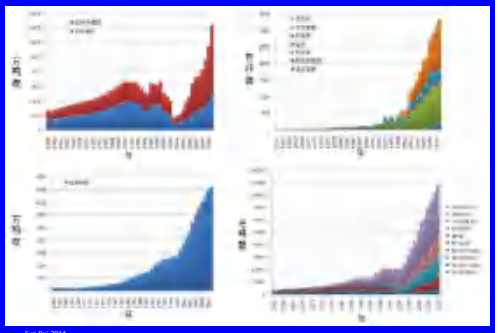
- i = year
- $C(i)$ = the carbon stock of the HWP pool in the beginning of year i, Gg C
- k = decay constant of first-order decay given in units, yr^{-1} ($k = \ln(2) / HL$, where HL is half-life of the HWP pool in years. A half-life is the number of years it takes to lose one-half of the material currently in the pool.)
- $Inflow(i)$ = the inflow to the HWP pool during year i, Gg C yr^{-1}
- $\Delta C(i)$ = carbon stock change of the HWP pool during year i, Gg C yr^{-1}

Carbon stock of HWP in China



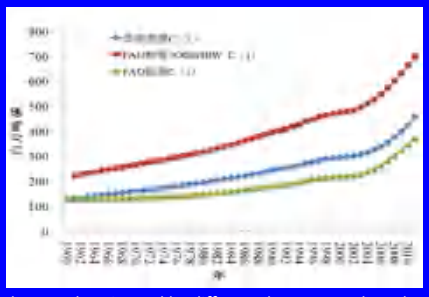
Carbon stock in HWP based on different approaches(Pg CO_{2eq})

Carbon stock of HWP in China



Sun Rui,2014

Carbon stock of HWP in China



Carbon stock estimated by different data sources based on PA and default parameters

Treatment of HWP in the different commitment periods of KP

First（Dec.16/CMP.1）	Second（DEC.2/CMP.7）
Harvested Wood Products not accounted for, or equivalently assumed to be instantaneously oxidized.	Emissions from Harvested Wood Products removed from a Party's forests which are accounted for under Article 3.3 and Article 3.4 shall be accounted for by that Party only; imported Harvested Wood Products, irrespective of their origin, shall not be accounted by the importing Party (Production approach). Accounting of Harvested Wood Products shall be on the basis of instantaneous oxidation , unless other provisions set out in Dec.2/CMP.7 apply. The treatment of Harvested Wood Products in the construction of a projected FMRL shall not be on the basis of instantaneous oxidation.
	If transparent and verifiable activity data for the specified categories (paper, wood panels and sawn wood) are available, accounting of Harvested Wood Products shall be on the basis of the change in the Harvested Wood Products pool during the second and subsequent commitment periods, estimated using the first-order decay function with default half-lives provided in the Dec. 2/CMP.7 (based on *GPG-LULUCF*)

Treatment of HWP in the different commitment periods of KP

First（Dec.16/CMP.1）	Second（DEC.2/CMP.7）
	Parties may use country-specific half-lives as an alternative to those specified in Dec. 2/CMP.7, or to account for HWP in accordance with the definitions and estimation methodologies in the most recently adopted IPCC guidelines, and any subsequent clarifications agreed by the COP, if verifiable and transparent activity data are available and the methodologies used are at least as detailed or accurate as those specified in the Dec.21.
	HWP resulting from Deforestation; solid waste disposal sites (where carbon dioxide emissions are separately accounted for); and wood harvested for energy purposes shall be accounted for on the basis of instantaneous oxidation.
	Emissions that occur in the second commitment period from HWP removed from forests prior to the start of the second commitment period shall also be accounted for. Emissions from HWP already accounted for during the first commitment period on the basis of instantaneous oxidation shall be excluded.
	Parties may choose not to account for the emissions from H WP from forests prior to the start of the second commitment period if the FMRL is based on a projection and shall ensure consistency in the treatment of the HWP pool in the 2nd commitment period.

Global Emission Trade System

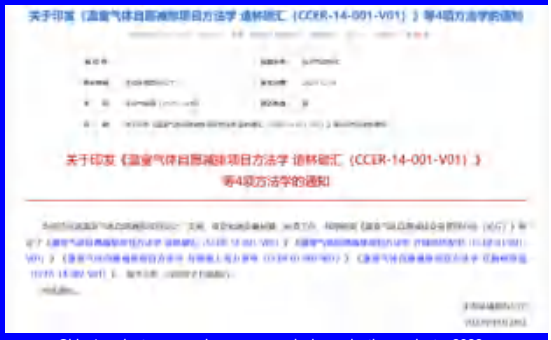
CCX	emission allowance based		Project based	
Emission trade system	(EU ETS)	Chicago Climate Exchange (CCX)、Australian Climate Exchange (ACX)	JI	CDM
Trade Unit	EU carbon emission allowance (EUA)	Volutary Emission ReductionVER)	Emission Reduction Unit (ERU)	CER

China Recorded Methodologies on CCER (Forest)

1	A/Refforestation	AR- CM-001-V01	（2013-ongoing）
2	A/Refforestation for Bamboo	AR- CM-002-V01	（2013）
3	Forest Management	AR-CM-003-V01	（2014）
4	Ecological Restoration	CM-099-V01	（2015）
5	Bamboo Management	AR- CM-005-V01	（2016）

- 15 forest CCER projects were registrated

China Recorded Methodologies on CCER (Forest)


关于印发《温室气体自愿减排项目方法学 造林碳汇（CCER-14-001-V01）》等4项方法学的通知

China's voluntary greenhouse gas emission reduction project---2023

AFOLU-VCS

- Voluntary Carbon Standard for Agriculture, Forestry and Other Land Use Projects
- AFOLU-VCS2007

Type of Project:

（1）A/Refforestation and Revegetation（ARR）
（2）Agriculture Land Management（ALM）
（3）Improved Forest Management（IFM）
（4）REDD

AFOLU-VCS

6 Forest related projects registrated under AFOLU-VCS

Project ID	Project Name	Project Proponent	Country	Sectoral Scope	Estimated Annual Emission Reductions	Active CCB Status
1718	Inner Mongolia Keyihe IFM (conversion of logged to protected forest) Project	MULTIPLE PROJECT PROPONENTS	China	14. Agriculture, Forestry, Land Use	128563	
1577	Fujian Yong'an Improved Forest Management Project	Yong'an Forestry Bureau of Fujian province, P.R.China	China	14. Agriculture, Forestry, Land Use	70082	
1542	Yunnan Kunming Lianggu Improved Forest Management Project	Kunming Yuming Investment Development Co., Ltd.	China	14. Agriculture, Forestry, Land Use	54734	
1529	Inner Mongolia Chao'er Improved Forest Management Project	Chao'er Forest Bureau of Inner Mongolia Autonomous Region, P.R.China	China	14. Agriculture, Forestry, Land Use	90035	
1361	Reforestation Project in Qinghai Province 2012	MULTIPLE PROJECT PROPONENTS	China	14. Agriculture, Forestry, Land Use	6708	
1332	Reforestation Project in Yingjing County, Sichuan Province	MULTIPLE PROJECT PROPONENTS	China	14. Agriculture, Forestry, Land Use	3365	Verification approved
1162	Jiangxi Province Le'an County Forest Farm Carbon Sink Project	Beijing Shengdahuitang Carbon Management Co.,Ltd.	China	14. Agriculture, Forestry, Land Use	86680	

Political Commitment

President Xi Jinping annouced on 75th UN Conference in September 22, 2020: Carbon dioxide emission peak in 2030, and Carbon neutrality in 2060

Comparing to 2005, Forest Stock Volume will increase 6 billion Cubic meters.

China's terrestrial ecosystem carbon sink

the potential of the carbon sink in China's terrestrial ecosystems to mitigate anthropogenic carbon emissions has attracted unprecedented attention from scientific communities, policy makers and the public.

（Piao S, et al., 2022）

China's terrestrial ecosystem carbon sink

China, with approximately 6.5% of the world's land area, contributed 10–31% of the global land carbon sink

the total carbon sink of China's terrestrial ecosystems was comparable to Europe (0.14–0.23 Pg C yr−1) but less than the United States(0.30–0.58 Pg C yr−1) In terms of carbon sink intensity,

(Piao S, He Y, Wang X, Chen F. 2022

Methods of terrestrial ecosystem carbon sink estimates

Inventory method

The inventory method is based on the comparison of ecosystem carbon stock inventory (mainly vegetation and soil) in different time periods to estimate the carbon budgets of terrestrial ecosystems (Dixon et al., 1994; Fang et al., 2001; Piao et al., 2009; Pan et al., 2011).

Methods of terrestrial ecosystem carbon sink estimates

Eddy covariance method

Eddy covariance directly measures the net CO2 exchange between terrestrial ecosystems and the atmosphere within its footprint area (usually several square meters to several square kilometers), based on the principle of micrometeorology. These measurements were then scaled-up to regional net ecosystem productivity (NEP) (Jung et al., 2011; Yu et al., 2014a; Wang et al., 2015; Yao et al., 2018a).

Methods of terrestrial ecosystem carbon sink estimates

Ecosystem process modeling method

Process-based ecosystem models provide gridded carbon flux estimates by simulating the processes and mechanisms of the terrestrial ecosystem carbon cycle. These models have become an important tool for many global and regional terrestrial ecosystem carbon sink assessments, including the Global Carbon Project (Friedlingstein et al., 2020).

Methods of terrestrial ecosystem carbon sink estimates

Atmospheric inversion method

Atmospheric inversion estimates the land carbon sink based on atmospheric transport model and measurements of atmospheric CO2 mole fraction, combined with anthropogenic CO2 emission inventory (Bousquet et al., 2000; Gurney et al., 2002).

China's terrestrial ecosystem carbon sink

The inventory method

estimated that China' terrestrial carbon sink was 0.21–0.33 Pg C yr−1

the estimates of ecosystem process models (0.12–0.26 Pg C yr−1)

Paris Agreement

Art. 4.13 : Nationally determined contributions

Art. 5.1: Conserve and enhance sinks and reservoirs of GHGs

Art. 5.2: REDD+

CHINA' S Nationally Determined Contributions

China has nationally determined its actions by 2030 as follows:

- To achieve the peaking of carbon dioxide emissions around 2030 and making best efforts to peak early;
- To lower carbon dioxide emissions per unit of GDP by 60% to 65% from the 2005 level;
- To increase the share of non-fossil fuels in primary energy consumption to around 20%;
- To increase the forest stock volume by around 4.5 billion cubic meters on the 2005 level.

CHINA' S INDC Increasing Carbon Sinks

- Enhance afforestation, promoting voluntary tree planting by all citizens, continuing the implementation of key ecological programs, including protecting natural forests, restoring forest and grassland from farmland, planting shelter belt, controlling stone desertification, conserving water and soil, strengthening forest tending and management and increasing the forest carbon sink;
- To strengthen forest disaster prevention and forest resource protection and to reduce deforestation-related emissions

Progress in estimating China's land carbon sink:FOREST

China Carbon Trade Market

- "Workplan on GHG emission control"; "Interim Procedures on Carbon Emission Rights"
- 2012-2017 Pilot trade market on carbon emission rights;
- 2017 National carbon trade
- 2021 China Carbon Emission Trade Exchange (CCETE)

China Carbon Trade Market

- **Emission Allowance**
- **Voluntary emission reduction**
- National CCER registration system

Thank you !

普洱市现代林产业发展情况

An overview of forestry development in Pu'er City

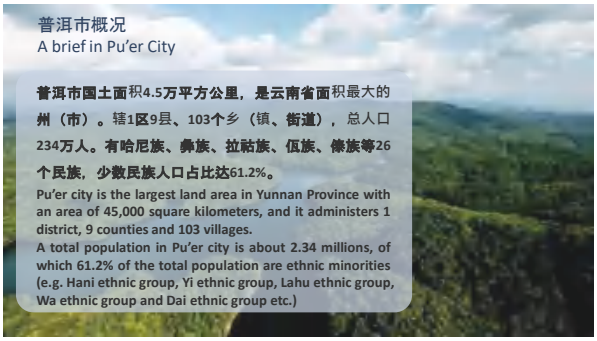
汇报人：王永刚

Presented by Mr. Wang Yonggang

01

普洱市概况

A Brief in Pu'er City



普洱市概况

A brief in Pu'er City

普洱市国土面积4.5万平方公里，是云南省面积最大的州（市）。辖1区9县、103个乡（镇、街道），总人口234万人。有哈尼族、彝族、拉祜族、佤族、傣族等26个民族，少数民族人口占比达61.2%。

Pu'er city is the largest land area in Yunnan Province with an area of 45,000 square kilometers, and it administers 1 district, 9 counties and 103 villages.

A total population in Pu'er city is about 2.34 millions, of which 61.2% of the total population are ethnic minorities (e.g. Hani ethnic group, Yi ethnic group, Lahu ethnic group, Wa ethnic group and Dai ethnic group etc.)

普洱市生态环境优美

Beautiful ecological environment in Pu'er City

普洱市海拔在317至3370米之间，中心城区海拔1302米，有北热带、南亚热带、中亚热带、北亚热带、温带5个气候带类型，年无霜期在315天以上，年平均气温19.5℃。

The evaluation of Pu'er City is ranged from 317 meters to 3,370 meters above the sea level, and the evaluation of downtown is about 1,302 meters above the sea level. Distinctive vertical climate zones are widespread in Pu'er City, and they are north tropic, mid-subtropic area, northern sub-tropics and temperate zone. The frost-free period lasts more than 315 days per day and an annual average temperature remains 19.5℃ in Pu'er City.

普洱市生态环境优美

Beautiful ecological environment in Pu'er City

普洱市森林覆盖率68.23%，有1个国家湿地公园，3个国家森林公园，18个自然保护区，是北回归线上最大的绿洲，分布着季雨林、山地雨林、季风常绿阔叶林、暖性针叶林等森林植被类型，保存着全国近三分之一的物种，有"云南动植物王国的王宫"之称，是祖国西南重要安全生态屏障，被联合国环境署誉为"世界的天堂、天堂的世界"。

Pu'er City is rich in forest resources with forest cover of 68.23%, and has various forest types such as monsoon forest, montane rainforest, monsoon evergreen forest as well as coniferous forests.

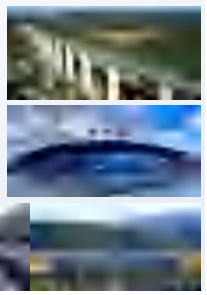
Pu'er city is the largest oasis on the Tropic of Cancer and preserves nearly one-third of the China's species, thereby it is called as "the Center of Yunnan Fauna and Flora Kingdom", served as an importance ecological shelters of Southwest China, and also appraised as "the Paradise of the World" by UNEP.

普洱市区位优势独特

Unique geographic location of Pu'er City

与越南、老挝、缅甸接壤，国境线长486公里，中老铁路、昆曼大通道穿境而过，有普洱思茅、澜沧景迈2个机场，有勐康口岸、思茅港2个国家级口岸，孟连口岸1个省政府批准的原二类口岸，7条边民通道。

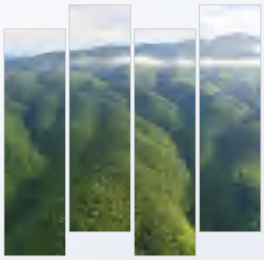
Pu'er City is boarded with Viet Nam, Laos and Myanmar, and the total national boundary is about 486 kilometers. The China-Laos railway and the Kunming-Bangkok road are passing through the border. Besides, there are 2 national ports (Mengkang port and Simaogang Port), 1 provincial-level port (Menglian port) and 7 border crossings.



普洱市自然资源富集

普洱市是云南最大的林区，也是重要的人工商品林基地，全市林地面积4866万亩，森林面积4530万亩，全市森林蓄积量3.14亿立方米，森林覆盖率68.23%。

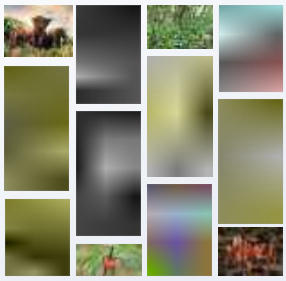
Pu'er city has the largest forest area in Yunnan Province with forest cover of 68.23% and is an important plantation base for commercial forests. Within the city, the total forestland is about 3.24 million ha and the forest area occupies 3.02 million ha. The total of forest stock in Pu'er City is 314 million cubic meters.



普洱市自然资源富集
Abundant nature sources in Pu'er City

有国家I级重点保护野生动物33种、国家II级重点保护野生动物167种；有国家级保护植物150种。

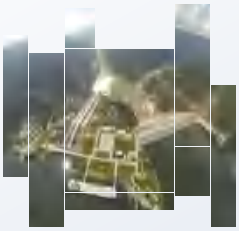
In Pu'er city, about 33 kinds of key protected wild animals at national level I and 167 kinds of key protected wild animals at national level II are recognized. Around 150 species of plants are under national protection.



普洱市自然资源富集
Abundant nature sources in Pu'er City

多年平均水资源总量305.5亿立方米，人均水资源1.27万立方米；有热带、亚热带土地面积4350万亩；矿产资源丰富，铁矿石储量、镍金属、钾盐、稀土氧化物矿等储量均居全省第1位。

The annual average water resources remain 30.55 billion cubic meters, and the per capital water resource is approximately 12,700 cubic meters; There are 2.9 million ha of tropical and subtropical lands in Pu'er city; The mineral resources is abundant, of which the amount of mineral metals such as iron ore, nickel, sylvine and rare-earth oxide all rank the top one in Yunnan Province.



普洱市文化绚丽多彩
Culture-based city

有彝族、哈尼族、傣族、拉祜族、佤族等14个世居民族，是民族文化大观园、茶马古道的源头，被誉为"世界茶源"、"中国咖啡之都"。

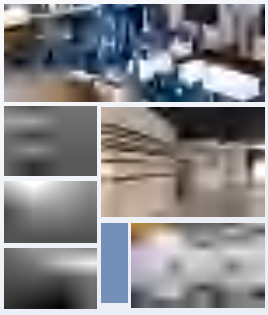
Among 26 ethnic minorities in Pu'er city, 14 of whom are indigenous inhabitants (e.g. Yi people, Hani people, Lahu people and Wa people etc.). Pu'er is culture-based city, the source of ancient tea trading road, It's also reputated as "the World Tea Source" and "Coffee City in China".

02
林产业发展情况
Forestry Industry Development in Pu'er City

林浆纸产业 wood pulp and paper

建成云南唯一的林浆纸企业，达到年产30万吨浆、6万吨纸的产能。

Pu'er city has constructed the first and only one wood pulp and paper industry in Yunnan Province with an annual production capacity of 300,00 tons of pulp and 60,000 tons of paper.

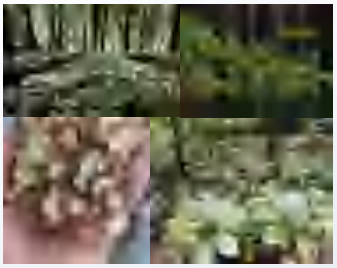


林板产业wood board

林板方面，年产木材450万立方米，人造板150万立方米以上，培育木材加工企业412户。

The annual output of wood is 4.5 million cubic meters and the wood board is 1.5 million cubic meters, which are produced by 412 manufacturing firms in Pu'er city.

林下经济产业 understory economy development



- **发展现状 Development status**

可以开发面积达2000**万**亩，已开发670**万**亩。

The total area used for understory economy development is estimated to 1.3 million ha in Pu'er city, and of which about an area f 446,667 ha are developed currently.

森林康养产业
Forest-based wellness industry

发展现状 Development Status

普洱市被中国林业产业联合会列为全国森林康养基地建设试点市，全市建立国家森林公园**3个、国家湿地公园1个、省级森林公园1个，普洱先后荣登"2020年度中国康养旅游目的地案例"和"中国康养城市50强"榜单。**

Pu'er city is listed as a pilot city for forest-based health care program at the national level by the China Forestry Industry Federation. In this area, there are 3 national forest parks, 1 national wetland park and 1 provincial forest park. This city successively is rewarded as "China Health Care Tourism Demonstration Site in China in 2020" and "the top 50 Forest-based Wellness Base in China".

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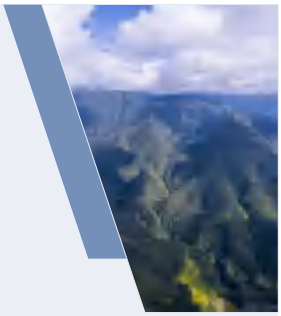
谢谢!
Thank You!



Forest Management towards to Sustainable Development

JIANG Chunqian

Chinese Academy of Forestry (jiangchq@caf.ac.cn)

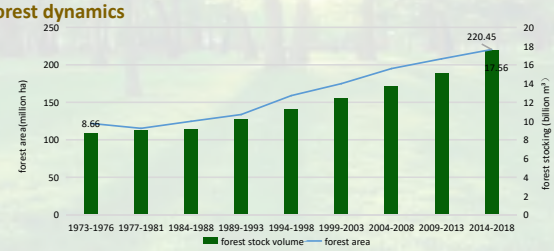
Outline

1. The status of forest resource in China

Forest across climate zone

1. The status of forest resource in China

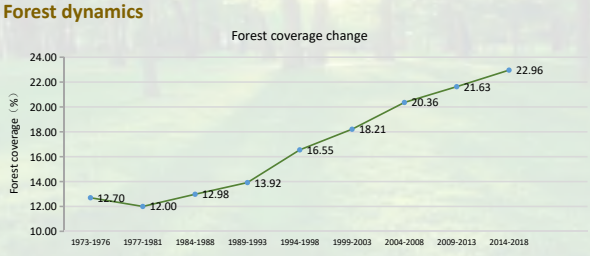
Forest dynamics



The area and forest stock volume of the 9th NFI was increased by 98.59 million ha and 8.90 billion m³ compared with the 1st NFI, respectively.

1. The status of forest resource in China

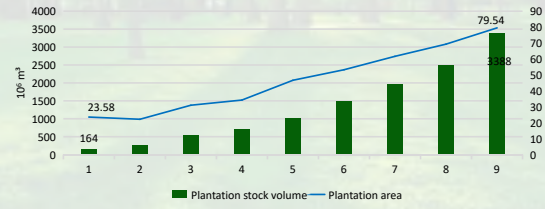
Forest dynamics



The forest coverage rate of the 9th NFI is 10.26% more than that of the 1st NFI.

1. The status of forest resource in China

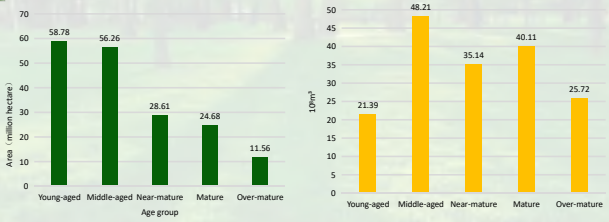
The dynamics of Plantation



The forest area and stock volume of the 9th NFI are 55.96 million ha and 3.22 billion m³ more than the results of the 1st NFI, respectively.

1. The status of forest resource in China

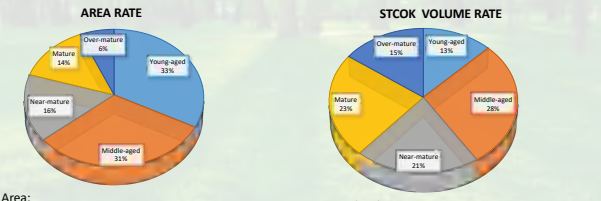
Current forest condition



Forest area and stock volume by age class according to the 9th NFI

1. The status of forest resource in China

Current forest condition



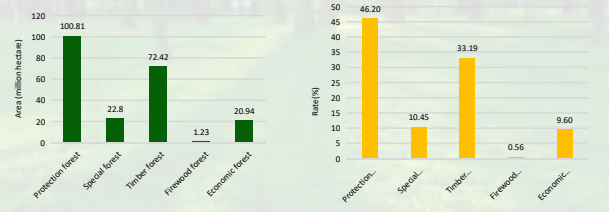
Area:
Young+ Middle-aged 64%

Stock volume :
Young+ Middle-aged 41%

Forest area and stock volume by age class according to the 9th NFI

1. The status of forest resource in China

Current forest condition



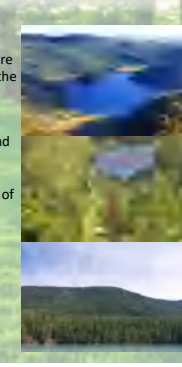
Forest area and stock volume by forest category according to the 9th NFI

1. The status of forest resource in China

At the beginning of the new China, there were only about 120 million hectares of forest in the economy.

From 1954 to the early 1970s, agriculture and over cutting for construction resulted in deforestation and forest degradation, the planting timber forest was placed in priority of forestry of China

In 1998, the central government established and implemented six key forestry projects towards eco-environment improvement.

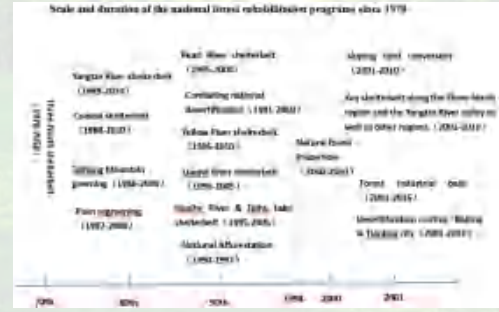


Change of forest management concept

The change of forest management concept can be divided into the following four stages:

1. Timber production stage. According to the 1st NFI , the timber forests accounted for more than 73%.
2. Timber production as the dominate objective with taking ecological benefits. (1978)
3. Sustainable forest management concept and multiple forest function. (1990s)
4. Under SFM, increasing forest quality through forest management. (2008)

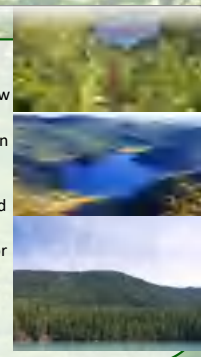
Overview-Key Ecological Programmes for forest rehabilitation



2. The Achievements of China's Forest Rehabilitation

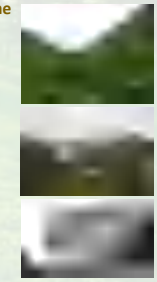
(1)The Natural Forest Resources ConservationProgramme

- Long time over cutting and natural forest degradation (low productivity)
- 2000: launched the Natural Forest Resources conservation Programme.
- 2012-2016:completed a total of 2.783 million hectares of afforestation, and 8.8 million hectares of middle-aged and young forests were tended.
- 2017: 198 million hectares of natural forest accounting for about 64% of the total forest area.



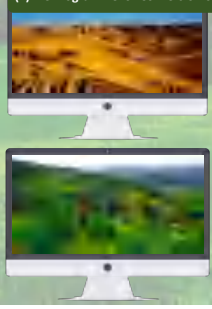
2. The Achievements of China's Forest Rehabilitation

(1)The Natural Forest Resources ConservationProgramme



2. The Achievements of China's Forest Rehabilitation

(2)The Programme for Conversion of Slope Farmland into Forests (Food for green)



The Programme for Conversion of Slope Farmland into Forests was started in 1999.

The central government has invested more than 430 billion yuan in project funds, and it is the world' s largest ecological construction project to date.

As of 2017, forest coverage rate in project area has increased by 3.6% on average.

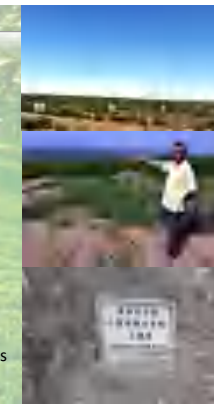
2. The Achievements of China's Forest Rehabilitation

(3)The Programme on Sandification Control for Areas in the Vicinity of Beijing and Tianjin

2000:started.

According to resource inventory and monitoring, forest area in project region has increased by 370,000 hectares per year on average, forest coverage rate has increased 0.8% annually on average.

In 2017, the Programme on Sandification Control for Areas in the Vicinity of Beijing and Tianjin completed 185,000 hectares of afforestation and 7,000 hectares of sand stabilization.



2. The Achievements of China's Forest Rehabilitation

(4) Key Shelterbelts DevelopmentProgrammes in the Three-North Region and the Yangtze River Basin and Other River Basins

North China, Northeast, and Northwest

With the implementation of the five-phases projects in the past 40 years, the afforestation area of the Three-North Project has increased considerably, with a total afforestation area of over 29 million hectares, and the forest coverage in the area has increased from 5.05% to 13.02%.

2017:the shelterbelt projects such as the greening along Yangtze River, Pearl River, coastal andTaihang Mountains have completed the afforestation of 306,000 hectares.

2. The Achievements of China's Forest Rehabilitation

(5)Fast-growing and high-yielding forest bases constructionprogramme

2002:started the project

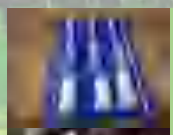
2015:According to incomplete statistics, the fast-growing forest base of 11.134 million hectares in total has been completed by the end of 2015, the afforestation by various fast-growing forest projects reached 63.33 million hectares in 2015.

Among them, 195,300 hectares are made by forestation in barren hills and lands, 233,300 hectares by regeneration, and 21,300 hectares by afforestation in other land use.

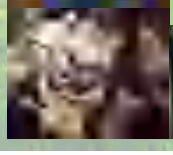
2. The Achievements of China's Forest Rehabilitation

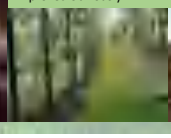
Forest restoration and rehabilitation in typical ecological vulnerable region

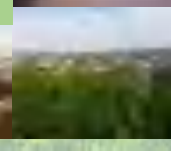
(1)Loess Plateau



Arid and semiarid area, and serious soil erosion
According to the data of the SFA, the forest coverage in the Loess Plateau has increased from 11% in 1977 to 19.55 at present.
The skeleton of the regional shelterbelt system has been built, the forest ecosystem has been restored preliminarily, and the ecological situation has been improved obviously.

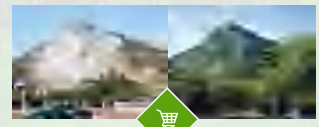




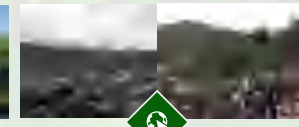


2. The Achievements of China's Forest Rehabilitation

Forest Rehabilitation of Degraded Karst



Karst region is one of the typical vulnerable ecological region in China, an area of about 91—130 km².



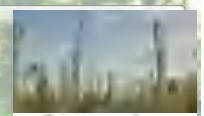
For the Rehabilitation of vegetation in this place, researcher mainly put forward the following several kinds of ecosystem restoration techniques and models.(water and soil conservation, tree species selection etc.).

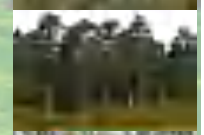
2. The Achievements of China's Forest Rehabilitation

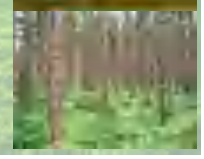
(3)Forest Rehabilitation in Northeast and Inner Mongolia (National Forest Area)

Over the past five years, Inner Mongolia has completed a total of 3,832,000 hectares of afforestation and 320 million voluntary trees.

To restore and improve the structure and function of coniferous mixed forest in Changbai Mountain, based on the analysis of composition and diameters of its tree species and spatial structure, the researchers put forward the theoretical and method system of structural adjustment of coniferous mixed forest.

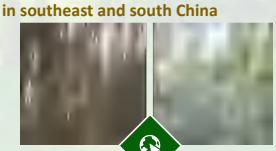






2. The Achievements of China's Forest Rehabilitation

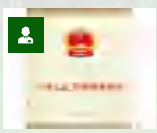
(4) Forest restoration and rehabilitation in southeast and south China

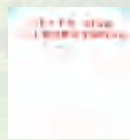


Enough water and sunlight;
In addition to planting trees, aerial seeds, assisted regeneration, and “hill closure” to promote natural succession are also effectives to rehabilitate forest.

3. Experiences

4.1 Policy and law support



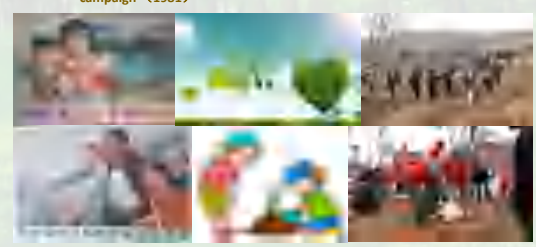


(1) New forestry policies have been implemented in succession.

Forest Law of the People's Republic of China
Measures on the Administration of Forest Cutting and Renewal
Measures on the Administration of Subsidized Forestry Funds of the Central Finance
Measures on Management of Natural Forest Resources Protection Projects,
Regulations on Administration of Three-North Shelterbelt Projects
Regulations on Returning Farmland to Forest
.....

3. Experiences

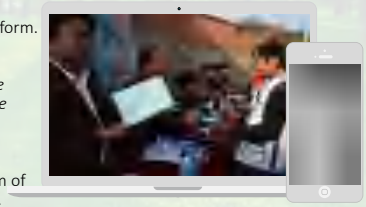
(2) A national compulsory tree-planting campaign （1981）



3. Experiences

(3)Collective forest tenure reform

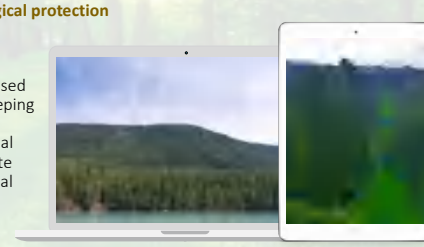
Since 2008, collective forest right reform. *Decision on Several Issues of Forest Protection and Development and Opinions of the General Office of the State Council on Perfecting Collective Forest Right System* guarantee the security of ownership and allow the circulation and lease of right to use, which greatly arouse the enthusiasm of forest farmers for forest restoration.



3. Experiences

(4)Red lines for ecological protection

In 2017, the government released guidelines on Defining and Keeping the Red Line for Ecological Protection to safeguard national ecological security and promote sustainable economic and social development.



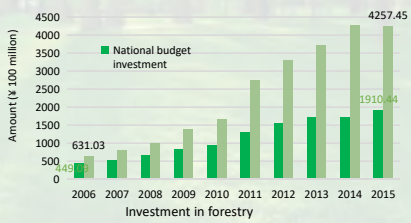
3. Experience-Financial support

1

The amount of investment in forestry has increased from 82 million yuan in the three-year rehabilitation period to 1,408.248 billion yuan in the twelfth five-year plan period.

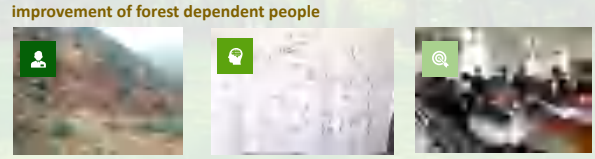
2

In 2015, the completed funds of national forestry investment reached 425.745 billion yuan. Among them, the investment of key forestry ecological projects is 70.566 billion yuan, an increase of 5.96% over 2014



3. Experiences

3.3 Forest rehabilitation together with poverty reduction and livelihood improvement of forest dependent people

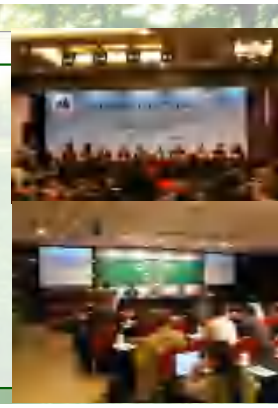


There are 592 state-level key poor counties in China, of which 496 are distributed in mountainous areas. These mountainous areas contain abundant forest resources .

3. Experiences

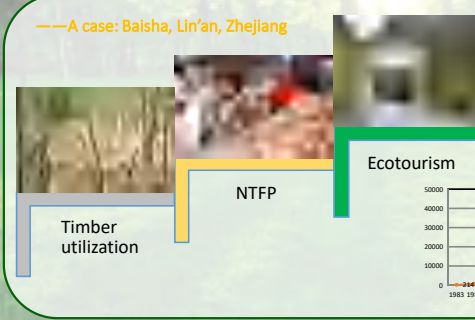
3.4 International Cooperation

International organizations
Bilateral cooperation
Seed money
New concept in the practice
Capacity building



3.5 Forest rehabilitation and rural village development

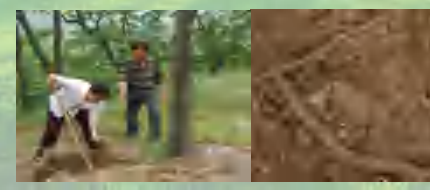
——A case: Baisha, Lin'an, Zhejiang



3.5 Forest rehabilitation and rural village development

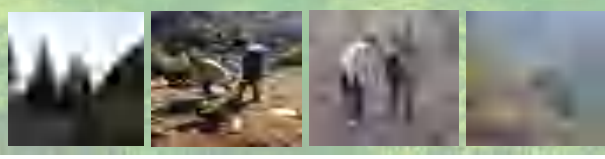
4. Case study: Forest Rehabilitation and Restoration towards to Improve Forest Ecosystem Services

- Intensive management such as fertilization in *Phllostachys praecox* may result in rich nutrition of water
- Intensive management will result in pest and disease happened in hickory trees



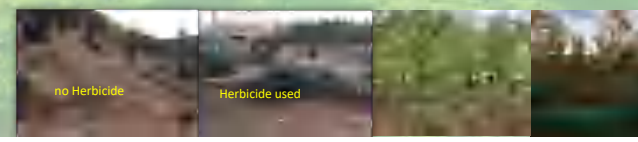
4. Case study: Forest restoration in Limestone hills based on development of NTFPs

- Deforestion resulted from growing crops which led to severe loss of water and soil in this hilly area. Many parts of it became rubbles and barren lands
- Approaches
  - Planting Chinese torreya through eco-environment friendly techniques (no herbicide)
  - Chinese torreya + broad leaf tree species
  - Forest farmers cooperatives



4. Case study: Low impact techniques to improve the management of hickory

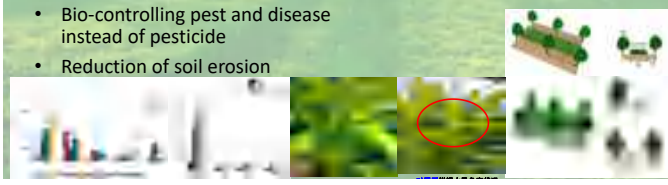
- Approaches
  - Soil improvement
  - Keeping grass and vegetation around hickory trees
  - Interplanting with broadleaf trees
  - Intercropping with medicinal plants



4. Case study: Soil conservation and pollutant reduction for citrus plantations

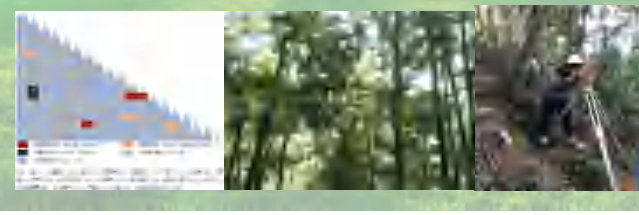
Vegetation configuration modes

- Increased the number of individuals and groups of soil animals
- Increased the content of soil organic matter and total nitrogen
- Bio-controlling pest and disease instead of pesticide
- Reduction of soil erosion



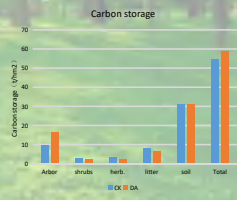
4. Case study: Forest management for Carbon Sink

- Emission Peak and Carbon Neutral
- CCER
- Secondary Forest;



4. Case study:Degraded Forest Restoration in Stony Mountainous Area

- The total carbon storage of forest ecosystem was as follows: DA (58.76 t/ha) > CK (54.48 t/ha).
- The carbon sink from demonstration activities was 1.84t CO_2/ ha/a.



DA: Demonstration area

4. Case study:Management of Chinese fir Plantation

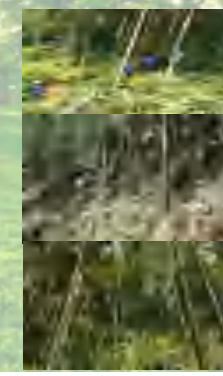
Chinese fir plantation (*Cunninghamia lanceolata* (lamb.) hook.)
Forest age 18a
Mean DBH14.1 cm and Height 12.3 m

Project activities: Transformed into conifer-broadleaved mixed forest

(1)Thinning intensity 20%

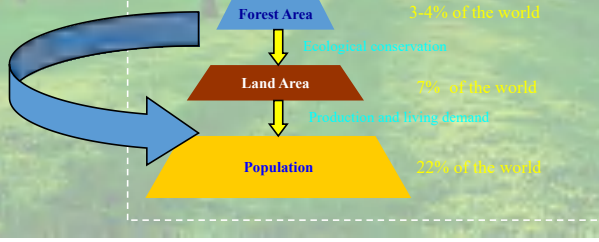
(2)Shrub cutting and weeding twice a year from 2018 to 2020;

(3)Planting *Phoebe chekiangensis C. B. Shang.*（浙江楠）and *Sassafras tzumu*（Hemsl.） Hemsl（檫木）450 seedlings / ha, respectively.



5.The rehabilitation in the future of China

★ Poverty reduction and develop economy



5.The rehabilitation in the future of China

5.1 Political will

"Two mountains"theory：Lucid waters and lush mountains are invaluable assets

President Xi: The green mountains and good environment itself means the economy. If you protect the environment, you will receive rewards from the environment.

19th CPC congress report: Ecological civilization building, ecological conservation and restoration---Highest political will

5.The rehabilitation in the future of China

5.2 Forest rehabilitation and restoration from the perspective of landscape

Forest restoration in landscapes is beyond planting trees.

It is necessary to develop cross-industry and cross-department cooperation mechanisms, and apply the participatory approach to forest landscape restoration

Landscape level

5.The rehabilitation in the future of China

5.3 Forest ecosystem integrity and forest ecosystem services provided

Forest rehabilitation will also consider multiple forest ecosystem services and comprehensively consider the trade-off among different services of forest ecosystem, so as to meet various needs of society and human beings.

5.The rehabilitation in the future of China

5.4 Forest ecosystem integrity and forest ecosystem services provided

- Realizing: Forest ecosystem services provided to meet needs of high population and development
- More understanding on forest species, forest ecosystem structure, function, process, and services and trade-off
- Bright future and a long way to go

5. Mountains, rivers, forests, farmland, lakes, grasslands and deserts are part of the community of life

- This vision of President Xi Jinping raises public awareness to natural ecosystem management
- It serves as a guide to action on building an eco-civilization in the new era.
- A Holistic Approach to the Conservation of Mountains, Rivers, Forests, Farmlands, Lakes and Grasslands

Scientific interpretation "the community of life"

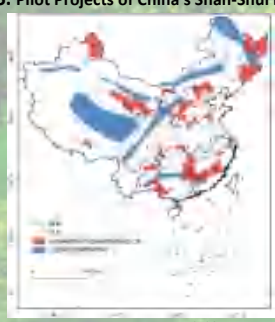
- Relationsips among ecosystem
- Trade off and Synergy
- Multiple ecosystem service
- Forest management under integrated land use

National ecological security pattern construction

Ecological protection strategy: eco-environmental defense ;
Forest rehabilitation opportunity

three zones and four sheltbelts

5. Pilot Projects of China's Shan-Shui Initiative



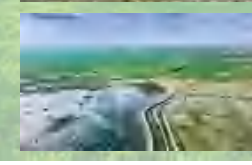
Ecological protection and restoration projects (25) for mountains, rivers, forests, land, lakes and grasses, with national ecological security strategic pattern.

Ecological protection and restoration projects (25)for mountains,rivers, forests, land, lakes and grasses, with counties with the key ecological functions. (LUO ,et al 2019)

Pilot Projects of China's Shan-Shui Initiative

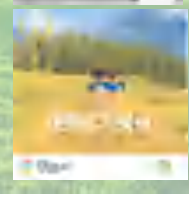
Coastal belt protection and restoration projects and mangrove protection and restoration projects have made the area of mangrove forests in China reach 438,000 mu, an increase of about 108,000 mu

For the China's Shan-Shui Initiative, the number of birds in the Wuliangsu hai, in the Inner Mongolia Autonomous Region



Ecological protection and restoration projects for mountains, rivers(akes), forests, farm land, , grassland and desert

- The Chinese government has carried out 51 ecological protection and restoration projects for mountains, rivers, forests, land, lakes, grasses and sand, with a total area of 80 million mu under control, with the goal of restoring 30 million hectares of natural ecosystems by 2030.
- In 2022, the China's Shan-Shui Initiative was recognized by the UN as one of the first 10 "World Restoration Flagships. (COP15, CBD)
- This is one of the most promising, ambitious and inspiring examples of large-scale ecological restoration in the world, according to the UN Environment Programme (UNEP)



Enhancing forest restoration through inclusive policies and effective implementation

Wasantha Dissanayake

Introduction

- Almost all economies are embarking on **ambitious efforts to rehabilitate / restore degraded lands.**
- Key questions relevant in this context are:
  - Are the **present policies** support large scale forest restoration?
  - Are there any **gaps in existing policies** and policy implementation that inhibit forest restoration on a large scale?
  - How can we **address these gaps** to avoid deforestation and degradation while achieving large-scale restoration?
- This presentation outlines some of the **issues related to national policies** in implementing **large-scale forest restoration / rehabilitation programmes**.

Structure of the presentation

General introduction.
The broader policy context.
National policy formulation and process
Evolution of forest policies.
Major gaps in policy formulation and implementation.
How to address these gaps to enhance restoration efforts.
Summary, and key take home messages.

Deforestation and forest degradation

- Ecosystem degradation impacts over **3.2 billion people** worldwide.
- Its financial impact exceeds **10% of global GDP**.
- Approximately **10 million hectares** of forest were lost annually between 2015 and 2020
- Over **2 billion hectares** globally require restoration.
- Estimated financial requirement for restoration is about **1,600 billion USD.**
- 2021–2030 is designated as the United Nations **Decade on Ecosystem Restoration.**
- Kunming-Montreal Global Biodiversity Framework (KMGBF) target 2 aims to restore **30 percent of global ecosystems** by 2030.

Asia-Pacific Region

- The Asia-Pacific region encompasses about **740 million hectares** of forests, which is roughly 18.1% of the world's total forest area.
- The region has experienced **significant deforestation** rates, although these rates have slowed in recent years. Between 2000 and 2020, Southeast Asia lost about 1.2% of its forest cover annually.
- The region is home to some of the world's **most biodiverse forests,** such as the tropical rainforests.
- Forests in the Asia-Pacific region are crucial for carbon sequestration, with an estimated **50 billion metric tons** of carbon stored in the region's forests.
- The forestry sector is a **significant part of many Asia-Pacific economies**.

Asia-Pacific Region
Forest cover

Source: Laumonier. et al (2022)

Asia-Pacific commitments

- Many economies in the region have **specified restoration goals** in their:
  - National Forest Policies and Plans,
  - Land Degradation Neutrality (**LDN**) targets,
  - Nationally Determined Contributions (**NDCs**), and
  - National Biodiversity Strategy and Action Plans (**NBSAPs**).
- Six economies have committed to the **Bonn Challenge,**
- Five to the **New York Declaration of Forests,**
- Seventeen to the **Glasgow Leaders Declaration on Forests and Land Use**.
- Fifteen have either put in place **REDD+ strategies** or are pursuing REDD+ activities.

Terminology (Lamb & Gilmour, 2003)

- **Forest Reclamation**
  the term "reclamation" is used for situations where **productivity or structure is regained but biodiversity is not**. In fact, native species may not be used at all.
- **Forest Rehabilitation**
  the term "rehabilitation" is used where the original **productivity or structure is regained as well as some,** but not all, of the **original biodiversity**.
- **Forest Restoration (FLR)**
  the term "restoration" is used only for those situations where the intent is to **recreate an ecosystem as close as possible to that which originally existed** at the site. The site then contains most of the original plant and animal species and has a structure and productivity matching that originally present.

Barriers for effective FLR

- Political will
- Legislative and policy environments
- Finance
- Technical capacity
- Scientific research
- Public awareness

What is a policy?

"A policy is a set of principles or rules that guide decisions and actions"

- A proposed or adopted course or principles of action.
- A cohesive set of responses/decisions towards a long-term purpose or to a particular problem.

National Forest Policy

"A government endorsed, negotiated agreement among stakeholders that outlines a shared vision, goals, and objectives for the country´s forests and trees".

An overview of the policy framework

- Policies articulate what society, government, communities, and private enterprises **need to achieve** to meet **long-term objectives**.
- Through various policies, society (via governments) attempts to **influence the behaviour** of different actors.
- This leads to **changes in resource use**, including forests, thereby impacting forest conservation, deforestation, and degradation.

Policies – The sectoral dimension

- Forest policies **do not operate in isolation**. There are numerous actions across various areas, and every sector or stakeholder group has its own explicit or implicit policies, strategies, and plans.
- The biggest challenge is **achieving consistency and balancing trade-offs** between **conflicting objectives** in different policies.

A mosaic of policies

- What we are seeing is a mosaic of policies on a wide array of issues, with some of them **occasionally overlapping** in varying degrees.
  - e.g., Socio-economic development, land use, agriculture, trade, industry, etc.
- Within each sector there are multiple of **sub-sectors**, each with its own policies, programmes, and projects.
- This overlapping mosaic of policies extends **beyond the national borders.**

Policies – The spatial dimension

- In addition to the sectoral dimension, we must also consider the **spatial dimension** and how policies are formulated, implemented, and impact at the:
  - Local level;
  - National level; and
  - Global level.
- The major challenge is how to **ensure consistency and synergy** between policies at different levels.
- At each level, the **costs and benefits of land management** are perceived differently, which is a major cause of inconsistency in policy formulation and implementation.

Impacts of forest policies

- **Land/ forest tenure**: In most instances tenure improvement has encouraged sustainable land management.
- **Centralization/ decentralization**: Impacts of centralization/ decentralization have varied. In some instances, it has encouraged sustainable management, whereas in others, it has contributed to unsustainable use.
- **Regulatory measures**: Imposing/easing restrictions on forest products transport, tree felling and similar measures.

National policy formulation

- Formulating a comprehensive national forest policy is a **multifaceted process** that involves numerous stages and the engagement of various **stakeholders**.
- The aim is to create a policy framework that promotes **sustainable forest management,** conservation, and the **equitable use** of forest resources.

Key considerations

- **Sustainability**: Ensure the policy promotes the sustainable use and management of forest resources.
- **Inclusivity**: Make the policy inclusive by considering the needs and rights of all stakeholders, particularly indigenous and local communities.
- **Scientific basis**: Base policy decisions on sound scientific research and data.
- **Legal framework**: Align the policy with existing national laws and international commitments.
- **Economic viability**: Consider the economic implications and ensure the policy supports the livelihoods of communities dependent on forests.

Policy formulation and process

1. **Preliminary assessment and preparations**
   - Situation analysis
   - Stakeholder identification
2. **Stakeholder engagement**
   - Consultations and workshops
   - Forming committees and working groups
3. **Policy drafting**
   - Setting objectives
   - Drafting policy provisions

Policy formulation and process

4. **Review and revision**
   - Public reviews
   - Incorporating feedbacks
5. **Approval and adoption**
   - Government approval
   - Official adoption
6. **Implementation planning**
   - Action plans and strategies
   - Capacity building

Policy formulation and process

7. **Monitoring and evaluation**
   - Setting indicators
   - Regular assessments
   - Feedback mechanisms
8. **Public awareness and education**
   - Awareness campaigns
   - Community involvement
9. **Periodic review and revision**
   - Regular updates

Generalized policy format

1. Executive summary
2. Vision and objectives
3. Introduction
4. Sustainable Forest Management
5. Conservation and biodiversity protection
6. Afforestation and reforestation
7. Climate change mitigation and adaptation
8. Forest governance and institutional framework

Generalized policy format

9. Socio-economic development
10. Research, education, and capacity building
11. Monitoring, evaluation, and reporting
12. Financing and resource mobilization
13. Conflict resolution
14. Integration with other policies
15. Conclusion
16. Annexes and appendices

Evolution of forest policies

- Land use and forest policies have evolved over time in response to changing perceptions about **economic development** and growing awareness about **environmental issues**.
- For analytical convenience, we can divide the post – Second World War period into the following:
  1. Post World War II to 1970
  2. 1970 – 1990
  3. 1990 – 2010
  4. Post 2010

Changing Forest Policies

Period	Priorities and key developments
Post world war II - 1970	• Forests were seen from the perspective of **meeting local and national needs**. • Serving as a **source of wood**, reserve land for **agricultural expansion**, and a **source of revenue** to exchequer. • International support primarily focussed on technical improvements, particularly in **wood production and processing**.
1970 – 1990	• The era of large-scale **plantation development**. • Focus on production of **industrial wood**. • International tropical timber agreement (1985). • Tropical Forestry Action Plan (TFAP – 1985). • **Master plans** for the forestry sector.

Changing Forest Policies

Period	Priorities and key developments
1990 – 2010	• National forestry **action plans** • Focussed on **social dimensions** and **Community participation** • Forest certification • Rio –forest principles and wider acceptance of **SFM** (1992) • Supporting **international forest policy** process (IPF – 1995, IFF – 1997, UNFF – 2000)
Post 2010	• Rio+20 (2012) • Sustainable Development Goals (**SDG - 2015**) • Paris Agreement (2015) • Integrating diverse objectives – Social, economic, environmental • Dealing with complexities through **landscape approach** • Large-scale reforestation, restoration for **climate change mitigation** and **biodiversity conservation**

National forest policies and forest restoration

- Most forest policies in the Asia-Pacific region stipulate **national forest area targets**.
- Some policies go further, specifying the need to **improve stocking** in terms of volume per hectare.
- Increasingly, policy targets also include **carbon stocks** in forests.
- Achieving these targets will require **substantial efforts** to reduce deforestation and degradation, as well as significant increases in restoration and rehabilitation investments.

Major gaps in forest policies

1. Policy and legal gaps
2. Governance and Implementation gaps
3. Financial and economic gaps
4. Social and stakeholder engagement gaps
5. Environmental and ecological gaps
6. Technological and knowledge gaps

Policy and legal gaps

i. **Lack of comprehensive approaches:** Policies often lack integrated approaches that consider the **multiple functions** of forests, such as biodiversity conservation, carbon sequestration, and community livelihoods.

ii. **Poor cross-sectoral integration:** There is often a **lack of coordination** between forest policies and other sectoral policies such as agriculture, mining, and infrastructure development.

iii. **Inconsistent legal frameworks:** Many economies have **fragmented or outdated forest laws** that do not align with contemporary environmental, social, and economic needs.

iv. **Limited focus on community rights:** Policies frequently overlook the rights and roles of **indigenous and local communities** in forest management, leading to conflicts and unsustainable practices.

Governance and implementation gaps

i. **Weak institutional frameworks**: Many countries **lack strong institutions** dedicated to forest management and restoration, leading to poor coordination, insufficient enforcement of laws, and weak implementation of restoration initiatives.

ii. **Poor governance and enforcement:** Corruption, lack of transparency, mismanagement of resources, and inadequate enforcement mechanisms undermine the effective implementation of forest policies.

iii. **Inadequate monitoring and evaluation:** There is often a lack of robust systems for **monitoring, reporting, and verifying** forest activities, leading to poor implementation and oversight.

iv. **Market and economic pressures:** High demand for timber, agricultural land, and other forest resources drives illegal logging and deforestation, challenging policy enforcement.

Financial and economic gaps

i. **Lack of funding:** Insufficient funding from both public and private sectors for large-scale forest restoration projects.

ii. **High initial cost:** The upfront costs for reforestation and afforestation can be high, including expenses for seedlings, labour, infrastructure, and ongoing maintenance. These costs can deter investment, especially in low-income countries.

iii. **Poverty and livelihood dependence:** Many rural communities rely on forests for their livelihoods, and restrictive policies can exacerbate poverty and lead to unsustainable forest use.

iv. **Lack of public awareness and participation:** Often there is a lack of awareness and involvement of local communities and the general public in forest policy processes, reducing the effectiveness of implementation efforts.

Social and stakeholder engagement gaps

- **Unclear land tenure and property rights**: Ambiguous or contested land tenure and property rights may discourage investment and create uncertainty on forest restoration activities.
- **Conflicting interests**: Different stakeholders, such as farmers, conservationists, and policymakers, often have conflicting interests and priorities.
- **Insufficient community involvement**: Insufficient involvement or empowerment of local communities will result in a lack of local support and ownership
- **Limited public awareness and education**: Lack of public awareness and understanding of the importance of forest restoration can result in limited support for restoration initiatives and insufficient pressure on policymakers to prioritize these efforts.
- **Social inequalities**: Marginalized groups, including indigenous communities, the poor, and women, often lack access to the resources and decision-making processes needed to participate in forest restoration efforts.

Environmental and ecological gaps

i. **Degraded lands and soil quality:** Many areas targeted for forest restoration have severely degraded soils due to erosion, nutrient depletion, or contamination. Poor soil quality can hinder tree growth and the successful establishment of forests.

ii. **Biodiversity loss:** Policies often fail to address the drivers of biodiversity loss, such as habitat destruction, invasive species, and climate change.

iii. **Degradation and fragmentation:** Insufficient measures are in place to prevent forest degradation and fragmentation, which threaten ecosystem health and resilience.

iv. **Climate change impacts**: Climate change poses significant challenges, such as altered precipitation patterns, increased frequency and intensity of extreme weather events, and shifting temperature regimes.

Technological and knowledge gaps

i. **Limited access to advanced technologies:** There is a gap in the adoption of advanced technologies like remote sensing, GIS, and data analytics for forest monitoring and management.

ii. **Insufficient research and development**: inadequate policy support and investment in R&D for forest restoration techniques and practices.

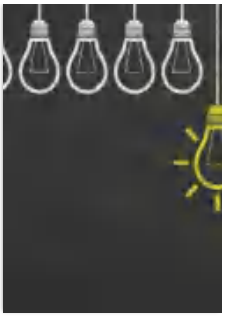
iii. **Knowledge transfer and dissemination gaps:** Lack of effective mechanisms for data collection, sharing, and dissemination hampers informed decision-making and policy implementation.

iv. **Lack of integration of traditional knowledge**: Traditional ecological knowledge, which includes indigenous and local practices, is often underutilized.

v. **Inadequate training and capacity building**: Policies should support comprehensive training programs to build the capacity of local communities, government officials, and other stakeholders.

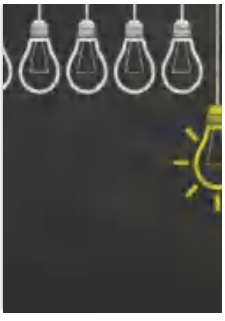
How to address these gaps

- ✓ **Policy reforms and harmonization:** Updating and harmonizing forest laws and policies to reflect current realities and integrate cross-sectoral approaches.
- ✓ **Strengthening governance and enforcement:** Enhancing transparency, accountability, and enforcement mechanisms to combat corruption and illegal activities.
- ✓ **Capacity building and training:** Investing in the training of personnel and development of technical expertise in forestry.
- ✓ **Community engagement:** Involving local and indigenous communities in forest management and policy-making processes.



How to address these gaps

- ✓ **Financial support and incentives:** Increasing funding for forest conservation programs and providing incentives for sustainable forest management practices.
- ✓ **Technological integration:** Utilizing modern technologies for monitoring, reporting, and verifying forest activities.
- ✓ **Public awareness and education:** Promoting awareness and education campaigns to foster public understanding and support for forest conservation.



Take home messages

1. **Stakeholder engagement is crucial**: Engaging stakeholders in policy making and implementation enhances policy effectiveness and ensures sustainable outcomes.
2. **Integrated approaches are essential**: Effective forest policies must adopt holistic approaches that address the diverse functions of forests, including biodiversity conservation, carbon sequestration, and support for community livelihoods.
3. **Adaptive management is key**: Policies need to be adaptable and tailored to specific contexts, considering the varying impacts of centralization and decentralization on sustainable forest management.

Take home messages

4. **Balancing restrictions with livelihoods is vital**: It is crucial to design policies that balance the need for forest conservation with the livelihoods of rural communities to avoid exacerbating poverty and promoting unsustainable forest use.
5. **Substantial investment is necessary for restoration**: Achieving large-scale forest restoration targets requires substantial efforts to reduce deforestation and degradation, alongside significant investments in restoration and rehabilitation activities.
6. **Clear and measurable targets are important**: Policies should set clear, measurable targets for forest area, stocking volume per hectare, and carbon sequestration. This provides a roadmap for implementation and allows for tracking progress.

Take home messages

7. **Monitoring and enforcement is crucial**: Effective implementation of forest policies requires robust monitoring and enforcement mechanisms to ensure compliance and to address any challenges that arise during the implementation phase.

DEGRADED FOREST REHABILITATION: EMBRACING COLLABORATIVE FOREST MANAGEMENT APPROACH IN BANGLADESH.

Dipannita Bhattacherjee
Wildlife and Biodiversity Conservation Officer
Bangladesh Forest Department

FOREST RESOURCES OF BANGLADESH

The total area of Bangladesh : 14.757 M.ha.

Population Densities : 1119 people per km2.

Dependency on Natural Resources: <80%

Agricultural Land: 65%

Forest Land : 15.58%

Major Forest Types	Area (M.ha.)
Hill forest	0.664 (29%)
Sal forest	0.12 (0.05%)
Natural mangrove forest (Sundarban)	0.602 (26%)
Coastal afforestation	0.20 (0.09%)
Freshwater swamp forest	0.023 (0.01%)

CONTEXTUALIZATION

- Deforestation and forest degradation are the biggest threats to forests worldwide.
- Deforestation occurs when forests are converted to non-forest uses, such as agriculture and road construction. Forest degradation occurs when forest ecosystems lose their capacity to provide important goods and services to people and nature.
- Over half of the tropical forests worldwide have been destroyed since the 1960s, and every second, more than one hectare of tropical forests is destroyed or drastically degraded.

STATE OF DEFORESTATION IN BANGLADESH

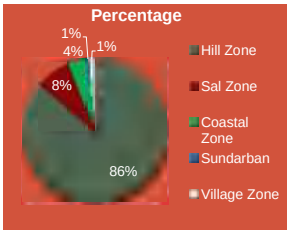
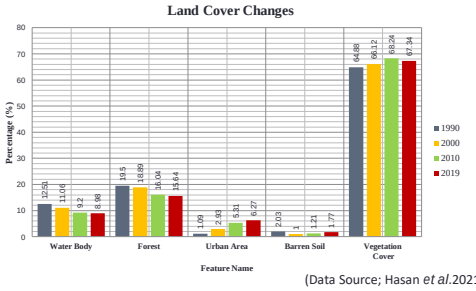


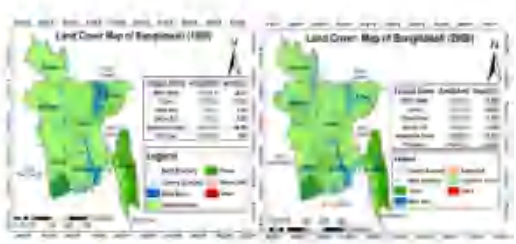
Fig: Deforestation and forest degradation in the BFI zones within 2000-2015

LAND USE AND LAND COVER CHANGE STATUS OVER 10 YEARS INTERVALS (1990-2019) IN BANGLADESH

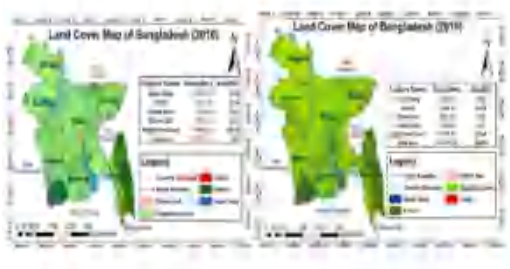


(Data Source; Hasan *et al.*2021)

LAND USE AND LAND COVER MAP OF BANGLADESH (1990-2019)



LAND USE AND LAND COVER MAP OF BANGLADESH (1990-2019)

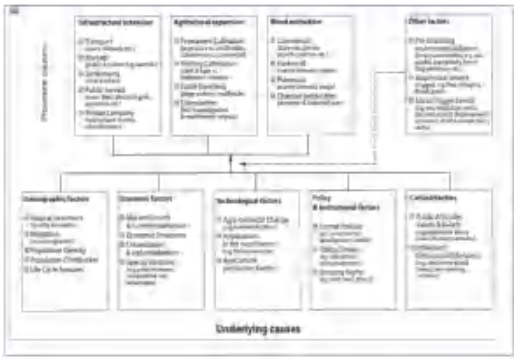


WHAT ARE DRIVERS?

Drivers (underlying causes) are processes that result in deforestation and forest degradation.

- Direct drivers, ('proximate causes'), human activities or immediate actions that directly impact forest cover and loss of carbon
- Indirect drivers, ('driving forces'), complex interactions of fundamental social, economic, political, cultural and technological processes.

UNDERLYING CAUSES TO DEFORESTATION AND FOREST DEGRADATION



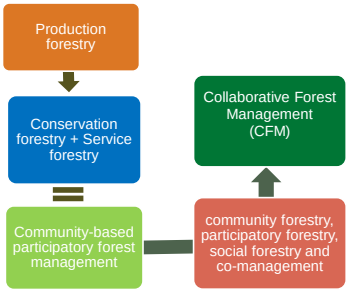
DRIVER PATHWAYS IN HILL FOREST

DRIVER PATHWAYS IN SAL FOREST

DRIVER PATHWAYS IN COASTAL FOREST

DRIVER PATHWAYS IN SUNDARBANS

OVERVIEW OF FOREST REHABILITATION EFFORTS



ONGOING FOREST REHABILITATION EFFORT

Sustainable Forests and livelihoods Project (SUFAL)	
Project area	28 districts and 211 sub-districts of Bangladesh (including Reserve forests and Protected Areas).
Project Duration	June/2018-December/2024
Supported by	World Bank
Project Cost	15.523 billion BDT

Objectives:

1. To improve organizational effectiveness by strengthening institutions, information systems and training to forest officials and staff.
2. To strengthen collaborative forests and Protected Areas management for enhancing forest restoration, Wildlife protection, Biodiversity conservation and ecosystem services.
3. To increase access to AIGAs including forest extension service in ToF areas to reduce forest exploitation and improving environment.
4. To monitor forest restoration and enhanced tree cover in the ToF.

SITE SPECIFIC PLANNING (SSP) FOR FOREST RESTORATION AND AFFORESTATION

- Entry point of consultation with local communities.
- SSP ensure stakeholder engagement for CFM and PA Co-management.
- Addressing safeguard issues, Social and environmental impact screening.
- Biodiversity conservation, Wildlife protection and sustainable use of natural resources and climate change risk.

PLANTATION INTERVENTION

32 types of plantation activities are performed all over Bangladesh through SUFAL project . BFD has planted site specific indigenous species during regular planting program. Already 90,438 hectares plantation has been completed by SUFAL project.

Fig: Strip Plantation in Coastal Area

Fig: Enrichment Plantation With indigenous species

Fig: Wildlife Corridor & Habitat improvement Plantation in PAs

Fig: Assisted Natural Regeneration (ANR)

Fig: Mangrove plantations in Coastal areas

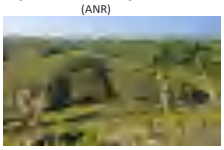


Fig: Mixed Plantation With fast growing indigenous species in hilly denuded areas

COMMUNITY ENGAGEMENT

The collaborative forest management (CFM) has been introduced in 615 forest conservation villages (FCVs) and they formed 615 nos. CFMCs.

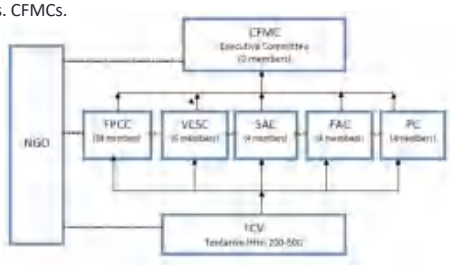
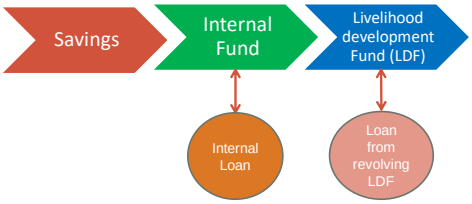


Fig: Diagram of village level institutions for CFM

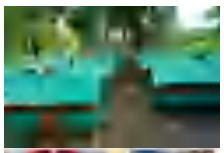
HOW DOES THE VILLAGE LEVEL INSTITUTIONS WORK

Community finance consists of following elements-



AIGA SUPPORT FOR THE COMMUNITY

- Each beneficiary got 0.042 million BDT. So far 1.3997 billion BDT has been distributed among 37,610 beneficiaries out of 41000 targeted households.



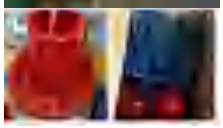


Fig: Supply of necessary equipment for poultry farming to the Beneficiaries.

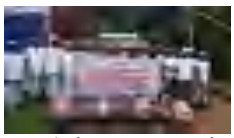


Fig: Supply of necessary equipment for Cattle farming to the Beneficiaries.

Fig: Supply of necessary equipment for vegetable farming to the Beneficiaries.

DEVELOPMENT ACTIVITIES FOR THE COMMUNITY

- 0.42 million BDT have been allocated for each project. So far 0.2374 billion BDT has been distributed through 1652 small projects among 615 FCV.

Fig. Construction of Passenger canopies

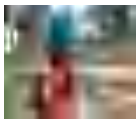


Fig. Installation of submersible pump for safe drinking water

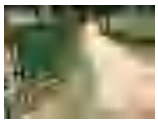


Fig: Construction of Herring Bone Bond Road

Fig: Construction of culvert

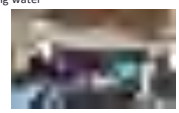


Fig: Education equipment distribution

NEW APPROACHES TO ADDRESS FOREST DEGRADATION

1. WILDLIFE OLYMPIAD: "Wise youth will save the forest"

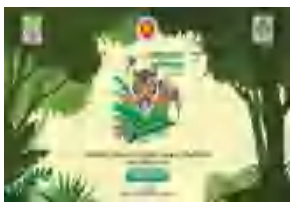


Fig: Wildlife Olympiad Campaign

2. Spatial Monitoring & Reporting Tool (SMART) patrolling in Forest management: SMART patrolling is a spatial information based monitoring platform that helps protect PAs effectively. Under the SUFAL project SMART patrolling is initiated in 8 PAs. Effective results has already been found in Sundarbans from SMART patrolling.

Fig: SMART Patrolling in Sundarbans

3. Ecosystem service valuation of natural resources: Valuation of ecosystem services is an economic process which assigns a value (either monetary, biophysical, or other) to an ecosystem or its ecosystem services. Valuation of ecosystem service survey work taken by the SUFAL project has been completed in Madhupur National Park, Teknaf wildlife sanctuary and Sitakunda Reserved forest which is new type of study in Bangladesh and the report will be published soon.

4. Initiated first ever Plant Red Listing and invasive alien species (IAS) control strategy: Under the project, a detailed Plant Red List Index will be prepared and Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) list of plants in Bangladesh will be updated based on the results of the developed Red List. A total of 44 invasive alien species (IAS) have initially recorded from 5 PAs.

Fig. IUCN Red list of Plant Status

5. Innovation Grant for forestry and Wildlife Research: SUFAL project is supporting 34 innovative research ideas. These innovative action research will build up knowledge based climate smart forest management, forestry science and technology. However, this research will improve the institutional research capacities of public and private universities and forestry research entities.

6. Innovation in Financial Transaction: The beneficiaries (community patrolling team and watcher) who are involved in the project activities are getting their labor payment at home through NAGAD mobile banking. Till date more than BDT 11.54 crore (115.4 million BDT) has been distributed to more than 16,235 project beneficiaries.

Fig: Payment through Mobile Banking

SUCCESS ACHIEVED AGAINST THE BENEFITS PROVIDED TO THE BENEFICIARIES SO FAR

Fig: Habitat improvement Plantation (2019-2020FY)

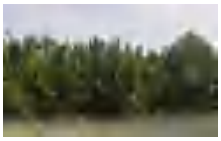


Fig: Golpata Plantation in Mangrove

Fig: Strip Plantation in Coastal areas

.....Continue

Fig: Banana cultivation

Fig: Goat rearing

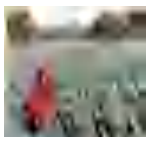


Fig: Cabbage cultivation

Fig: Making of bamboo chatai

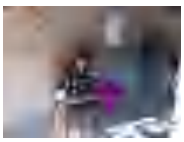


Fig: Tailoring

Fig: Poultry Farming

EPILOGUE

- Proposed concept of collaborative forest management cannot be considered at its final shape during this project implementation period.
- Rather necessary adjustments will be required in the development of community engagement and benefit sharing modalities, institutional and/or committee formation, decision making processes and financial benefit sharing and sustainability.
- BFD should be allowed to give final shape of the collaborative forest and Protected Area management practices by bring necessary changes during the implementation process.

THANK YOU ALL FOR YOUR PATIENCE HEARING

APFNet Workshop on
Degraded Forest Rehabilitation and
Management in Asia-Pacific Region

Cambodia Forest Restoration: Case study on Flooded Forest Restoration's Carbon Stock Assessment at Tonle Sap Great Lake in Pursat Province

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18-27 August, 2024 YUNNAN PROVINCE

Outline

1. Overview of Forest in Cambodia
2. Status of Deforestation in Cambodia
3. Drivers for Deforestation
4. Forest Management and Restoration
5. **A case study on Flooded Forest Restoration's Carbon Inventory**
6. Lesson learnt

1. Overview of Forest in Cambodia

- Cambodian forests are intimately linked to agriculture and in-land fisheries, and to maintaining the sustainability and productivity of both these sectors.
- Generally, all forest area in Cambodia is **owned by state**, in particular natural forest.
- However, private forest including forest or tree plantation, is privately **owned by private company**, **individuals and local households.**

1. Overview of Forest in Cambodia (Cont')

- The forest land remains approx. **7.4 million hectares** and planted forest has around 0.6 million hectares, or **41%** of land nationwide (FAO, 2020).
- The evergreen forest is recorded as **15.76%,** followed by **5.9%** semi-evergreen forest, **18.37%** deciduous forest, and **8.09%** other forest (MoE, 2020).

2. Status of Deforestation in Cambodia

- From 2002 to 2023, Cambodia lost 1.44 Mha of primary forest, making up approx. 30% of its total tree cover loss during this period.

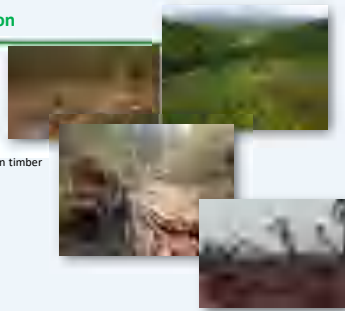
3. Drivers for Deforestation

1. Impact of population growth
- Agricultural expansion
- Residential area expansion
- Sifting cultivation/slash and burn

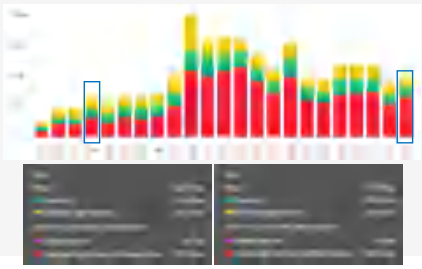
2. Illegal logging
- Domestic demand
- External requirements for Cambodian timber

3. Forest Degradation
- Climate change

4. Forestry Administration System
- Lack of trained human resources
- Accessibility and security
- Forest monitoring and control

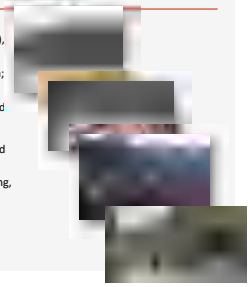


3. Drivers for Deforestation (Cont')



Challenges in Forest Management in Cambodia

- Lack of boundary demarcation (land registration), management and zoning plans;
- Illegal logging; land encroachment and migration; and the unsustainable use of NTFPs;
- Land use conflicts involving local communities and commercial interests;
- Limited collaboration between line Ministries and local authorities;
- Inadequate resources for the day-to-day patrolling, monitoring and enforcement;
- Inadequate levels of government funding and supports



4. Forest Management and Restoration

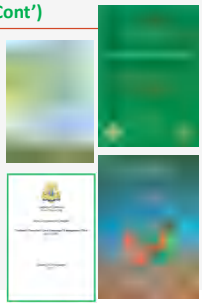
Laws and regulations that influence the management of Cambodia's forest and protected areas:

- **Forestry Law (2002),**
- Fisheries Law (2006),
- Law on Water Resources Management (2007),
- Land Law (2001)
- Law on Environmental Protection and Management of Natural Resources (1996)

4. Forest Management and Restoration (Cont')

National policies reflect development and conservation strategies of the Royal Government of Cambodia (RGC) include:

- National Strategic Development Plan (2014-2018);
- Pentagon Strategy Phase I (2023-2028);
- Long-Term Strategy for Carbon Neutrality (2021)
- National Strategic Plan on Green Growth (2013-2030);
- Cambodia Climate Change Strategic Plan (2014-2023);
- Cambodia National REDD+ Strategy (2017-2026);
- Circular Strategies on Environment (2023-2028);
- National Environment Strategy and Action Plan (2016-2023)
- **National Forest Program (2010-2029)**
- **National Protected Area Strategic Management Plan (2017-2031)**



4. Forest Management and Restoration (Cont')

National Forest Program (2010-2029)

- The National Forest Programme (2010-2029) provides strategic directions that aim to place governance at the heart of sustainable forest management and increase forest contributions to national development objectives.
- The NFP mission is to advance the sustainable management and development of forests, enhanced livelihoods, economic growth and environmental protection, including conservation of biological diversity and cultural heritage.
- The NFP consist of **6 programs** as following:

PROGRAM 1: Forest Demarcation, Classification and Registration (2010-2029)

1. Forest Demarcation and Registration
2. National Function-based Forest Classification

4. Forest Management and Restoration (Cont')

PROGRAM 2: Conservation and Development of Forest Resource and biodiversity (2010-2029)

1. Forest Management Action Plan
2. Development and Management of Production Forests
3. Monitoring, Assessment and Reporting
4. Conservation of Wildlife and Biodiversity
5. Conservation and Development of Genetic Resources and Seed Sources
6. Tree planting and Development of Forest Plantations
7. Development of Forest Product and Market Promotion
8. Wood Technology Development and Forest Product Processing
9. Forest Certification System.

4. Forest Management and Restoration (Cont')

PROGRAM 3: Forest Law Enforcement and Governance (2010-2029)

1. Legal and Administrative Reform
2. Law Enforcement and Forest Crime Monitoring and Reporting
3. Rapid Response on Forest Crime Information

PROGRAM 4: Community Forestry Program (2010-2029)

1. Community Forest cation and Formalization
2. Community, Institutional and Livelihoods Development
3. Community Forestry Development Support.

4. Forest Management and Restoration (Cont')

PROGRAM 5: Capacity and Research Development (2010-2029)

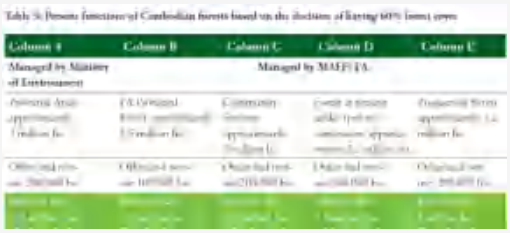
1. Institutional and Human Resource Development
2. Extension and Public Awareness Raising
3. Research Capacity Building Development.

PROGRAM 6: Sustainable Forest Financing (2023-2029)

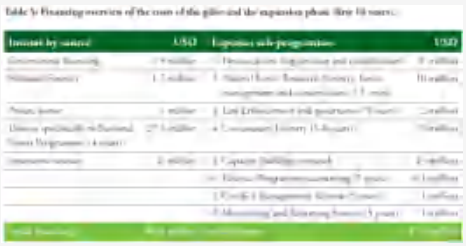
1. Government Financing
2. Income from National Forestry
3. Private Sector Income Generation including Community Forestry
4. Financing via Donors
5. Innovative financing sources

4. Forest Management and Restoration (Cont')

4. Forest Management and Restoration (Cont')



4. Forest Management and Restoration (Cont')

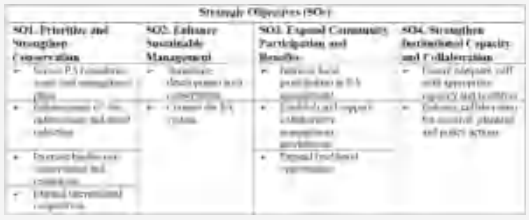


4. Forest Management and Restoration (Cont')

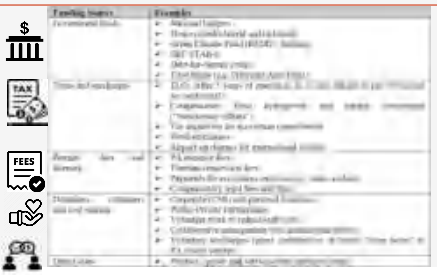
National Protected Area Strategic Management Plan 2017-2031

- It contributes to the country's economy and sustainable development, including poverty reduction, through the conservation and sustainable use of its biological, natural and cultural resources and other ecosystem services.
- The NPASMP mission is to achieve the most effective, efficient and equitable management of the national protected area system in the Royal Kingdom of Cambodia.

4. Forest Management and Restoration (Cont')



4. Forest Management and Restoration (Cont')



4. Forest Management and Restoration (Cont')

NPASMP Results Indicators and Budgets (2017-2031)

4. Forest Management and Restoration (Cont')

4. Forest Management and Restoration (Cont')

4. Forest Management and Restoration (Cont')

4. Forest Management and Restoration (Cont')

Protected Area

Cambodia now has 57 natural protected areas and three diversified conservation corridors (The Northern, Northeastern and Cardamom Mountain areas) covering a total of approximately more than **7.2 million** hectares, including:

- 12 National parks
- 18 Wildlife sanctuary
- 11 Protected landscapes
- 7 Multiple use areas
- 4 Ramsar sites
- 2 National heritages
- 1 Marine national park
- 3 Biodiversity Corridors

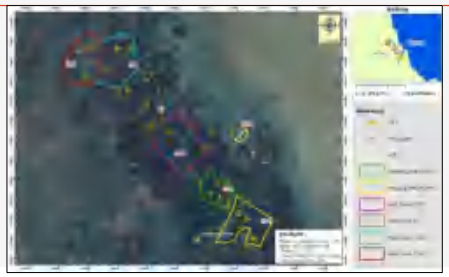
Case study: Flooded Forest Restoration's Carbon Stock Assessment at Tonle Sap Great Lake in Pursat Province

5. Case study on Flooded Forest Restoration's Carbon Stock (Cont')

- The total area of temporarily flooded forest covers **647,406 ha** in the five provinces around Tonle Sap (Kampong Chhang, Pursat, Battambang, Siem Reap, and Kampong Thom)
- The study took place at 7 restoration areas within Pursat province.

Site Name	Area (ha)	X	Y	Year	Age at sampling	Treatment	Clusters	Plots
ADB	~5	411463	1393424	2005	18	Mixed species	3	15
Kdat Taprum	20	411153	1393419	2010	13	Mixed species	4	20
Knach Leap	20	411069	1393233	2012	11	Mixed species	4	20
Khnach Leap_1	15	410381	1394027	2014	9	Single species	3	15
Khnach Leap_2	15	410381	1394027	2015	8	Single species	3	15
Kampong Prak_1	7	411072	1392814	2020	3	Single species	3	15
Kampong Prak_4	15	411546	1392585	2020	1	Single species	4	20
Total							24	120

5. Case study on Flooded Forest Restoration's Carbon Stock (Cont')

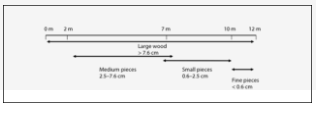


5. Case study on Flooded Forest Restoration's Carbon Stock (Cont')

- The objective of this survey is to assess above and below-ground carbon stored within seven flooded forest restoration sites at the Tonle Sap Lake in Pursat province
- The study was conducted using Sustainable Wetlands Adaptation and Mitigation Program (SWAMP) protocol
- The survey focused on aboveground and belowground biomass, deadwood, and soil carbon

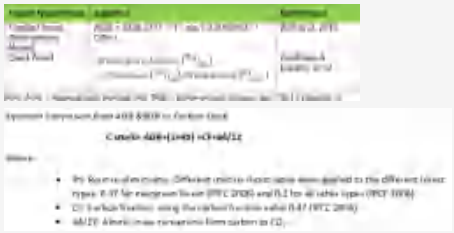
5. Case study on Flooded Forest Restoration's Carbon Stock (Cont')

Deadwood assessment



Soil organic carbon

5. Case study on Flooded Forest Restoration's Carbon Stock (Cont')

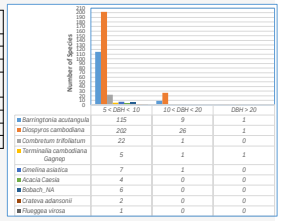


5. Case study on Flooded Forest Restoration's Carbon Stock (Cont')

Results

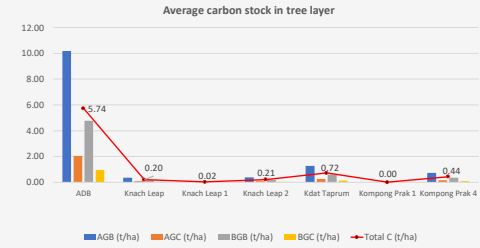
5. Case study on Flooded Forest Restoration's Carbon Stock (Cont')

No	Khmer Name	Species	Wood density (g/cm3)
1	Rang Toek	*Barringtonia acutangula*	0.493
2	Phtorl	*Diospyros cambodiana*	0.538
3	Chrokeng	*Mallotus anisopodus*	0.484
4	Taor	*Terminalia cambodiana Gagnep*	0.880
5	Nhor Toek	*Morinda persicaefolia Ham.*	0.49
6	Phnom Pneng	*Hymenocardia wallichii Tul.*	0.702
7	Thngan	*Crateva adansonii*	0.460
8	Tros	*Combretum triforatum vent*	0.582

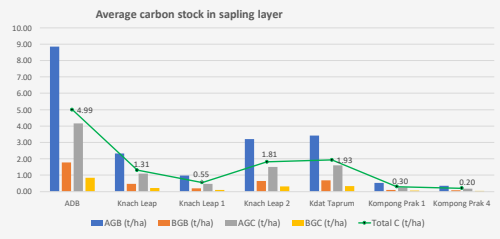


	5 < DBH < 10	10 < DBH < 20	DBH > 20
Barringtonia acutangula	115	9	1
Diospyros cambodiana	202	26	1
Combretum trifoliatum	22	1	0
Terminalia cambodiana Gagnep	5	1	1
Gmelina asiatica	7	1	0
Acacia Caesia	4	0	0
Rabach_NA	6	0	0
Crateva adansonii	2	0	0
Fluggea virosa	1	0	0

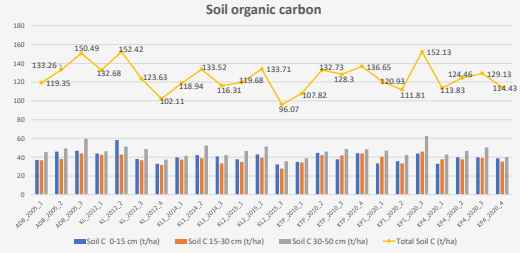
5. Case study on Flooded Forest Restoration's Carbon Stock (Cont')



5. Case study on Flooded Forest Restoration's Carbon Stock (Cont')



5. Case study on Flooded Forest Restoration's Carbon Stock (Cont')



5. Case study on Flooded Forest Restoration's Carbon Stock (Cont')

Sites	ADB (t C ha)	KP_4 (t C ha)	KP_1 (t C ha)	KTP (t C ha)	KL (t C ha)	KL_1 (t C ha)	KL_2 (t C ha)
Carbon in trees, saplings							
Trees (> 5 cm)	4.78±1.97	0.36±0.43	0±0	0.6±0.52	0.17±0.16	0.02±0.03	0.17±0.19
Saplings & (< 5 cm)	4.2±2.25	0.2±0.16	0.2±0.35	1.6±0.93	1.1±1.27	0.5±0.54	1.5±1.46
Carbon in downed woody debris							
Large sound (>7.6 cm)	0.1	0.0	0.0	0.0	0.1	0.0	1.0
Large rotten (7.6 cm)	0.0	0.0	0.0	0.0	0.0	0.0	0.3
Medium (2.54-7.7 cm)	0.5	0.2	1.2	0.3	0.7	0.8	2.1
Small (0.64-2.54 cm)	1.8	1.4	2.5	2.3	2.5	3.7	2.3
Fine (<0.64 cm)	0.3	0.4	0.4	0.5	0.3	0.6	0.4
Downed wood carbon	2.7	1.9	4.0	3.1	3.6	5.1	6.1
Total above-ground carbon	**11.68±2.99**	**2.48±0.46**	**4.23±0.35**	**5.29±1.07**	**4.85±1.28**	**5.62±0.54**	**7.72±1.47**
Below-ground carbon in roots							
Trees (>5cm)	**0.96±0.39**	0.07±0.09	0±0	0.12±0.1	0.03±0.03	0.004±0.01	0.03±0.04
Saplings (<5cm)	0.8±0.45	0.03±0.03	0.05±0.07	0.32±0.19	0.22±0.25	0.09±0.11	0.3±0.29
Soil carbon by depth below-ground							
0-15 cm	43.3±3.1	43.3±3.49	41±4.37	37.7±3.54	40.4±5.11	37.6±2.69	37.9±5.45
15-30 cm	39.5±2.99	38.4±2.01	36.5±5.03	34.1±2.58	40.5±3.39	39.9±2.92	37.6±4.75
30-50 cm	51.5±4.72	46±3.25	45.5±5.56	44.7±3.03	45.5±4.11	50.8±5.56	45±5.6
Soil carbon	134.4±6.39	127.7±5.17	122.9±8.67	116.5±5.32	126.4±7.38	128.3±6.83	120.5±9.15
Total BG carbon	**136.16±8.49**	**127.8±6.43**	**122.95±11.46**	**116.94±6.64**	**126.65±9.1**	**128.394±9.28**	**120.83±11.73**
Total ecosystem carbon	**147.84±7.08**	**130.28±5.19**	**127.18±8.68**	**122.23±5.43**	**131.5±7.49**	**134.0±6.85**	**128.55±9.27**
CO_2 e of the ecosystem	**542.08**	**477.69**	**466.33**	**448.18**	**482.17**	**491.38**	**471.35**

5. Case study on Flooded Forest Restoration's Carbon Stock (Cont')

Conclusion

- The result indicated that the ADB restoration site (542.08 CO2 t/ha) is the highest carbon stock in compared to other clusters across all sites.
- Mixed forest planting technique makes the plants growth faster and competitions
- Restoring flooded forests is not only about increasing carbon stocks but also about enhancing ecosystem resilience, increase fish habitat and biodiversity, and community well-being.
- By learning from past experiences and integrating these results into future restoration efforts, we can create healthier, more sustainable forest ecosystems that contribute to climate change mitigation and adaptation.

6. Lesson Learnt

1. Comprehensive knowledge of the Tonle Sap ecosystem, including its hydrology, biodiversity, and seasonal dynamics, is essential for effective restoration. This understanding informs the selection of appropriate species and restoration techniques
2. Continuous monitoring of carbon stocks helps assess the effectiveness of restoration practices and informs adaptive management strategies
3. The natural flooding cycle is crucial for maintaining the health of the flooded forest. Restoration efforts should follow natural hydrological patterns to ensure the survival of native species and the overall functionality of the ecosystem.
4. Engaging local communities in restoration efforts can enhance project success. Local knowledge and participation can lead to better management practices and increased stewardship of the restored areas.
5. Strong governance and supportive policies are necessary for successful restoration initiatives. Collaboration with governmental and non-governmental organizations can facilitate resource mobilization and technical support.
6. Providing economic incentives for conservation, such as payment for ecosystem services, can motivate local communities to engage in and support restoration efforts, ultimately contributing to carbon stock enhancement.

សូមអរគុណ!

Thanks you for your attention !

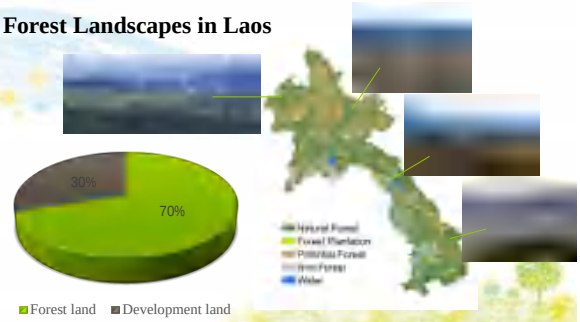
Status Report on the State of Degraded Forest Rehabilitation and Sustainable Forest Management in Lao PDR

by: Boutthavong Saykham
Faculty of Forest Science, National University of Laos

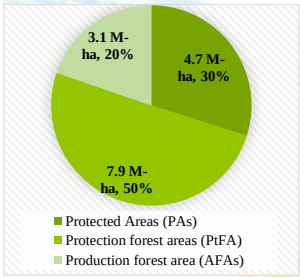
APFNet Workshop on Degraded Forest Rehabilitation and Management in Asia-Pacific Region
18-27 August, 2024 Yunnan Province, P R China

Contents of the presentation

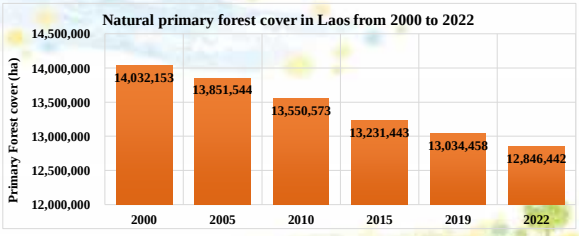
Forest Landscapes in Laos



Forest categories and forest area

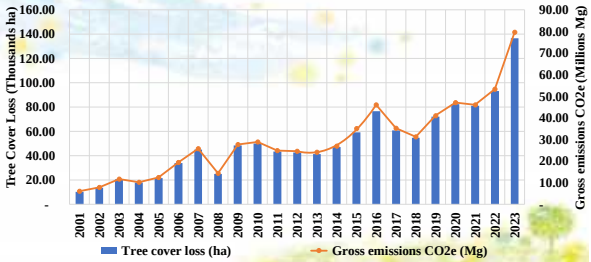


Natural Forest Cover Change



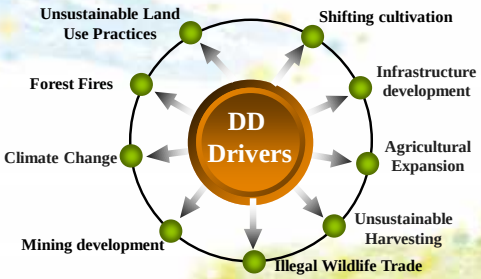
Data sources: https://nfms.maf.gov.la/

Lost of Primary Forest in Laos

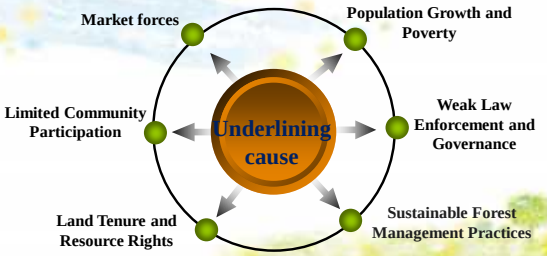


Data sources: GFW (globalforestwatch.org)

Drivers of deforestation and forest degradation



Underlining cause of DD

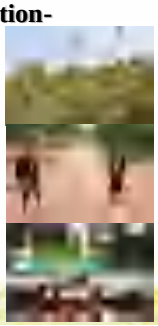


Addressing deforestation and forest degradation

- Strengthening Legal Frameworks
- Addressing the Governance Issues
- Stakeholder Coordination
- Promoting Sustainable Agriculture
- Enhancing Monitoring and Enforcement
- Supporting Community-Based Conservation
- Promoting Sustainable Development Practices

Forest management and rehabilitation-related projects

- Village-based Forest Rehabilitation in Lao PDR (AFoCO)
- Community-based Forest Restoration and Management for Livelihood (WWF-Laos)
- A model for restoring forests and improving livelihoods in Lao PDR: The FLOURISH project



Others related programs and projects

- Climate Protection through Avoided Deforestation and Implementation of the Governance, Forest Landscapes and Livelihoods (CliPAD/I-GFLL) (I-GFLL)
- Lao Landscapes and Livelihoods Project (LLL)
- Integrated Conservation of Biodiversity and Forests (ICBF)
- Forest Law Enforcement, Governance and Trade. Financial Cooperation (FLEGT-FC)
- Etc

Forest Management and Rehabilitation Challenges

- Community Forestry
- Reforestation and Afforestation
- Policy and Legal Framework
- Economic Development
- Climate Change
- Insufficient staffing
- Limitation in participatory planning
- Utilization of forest lands for the development
- Limitations in land use and forest allocation plans

Barrier needs to be overcome

- Weak cross-sectoral coordination, limited land use planning capacities
- Low agricultural productivity and limited opportunities for green value chains contribute to forest degradation
- Inadequate financing; carbon stocks in primary forest landscapes not recognized among; lack of ecosystem valuation approaches
- Lack of regional vision and cooperation
- Lack of capacity for integrated planning

Conclusion and recommendations

- Country facing significant challenges due to deforestation and forest degradation
- The nation's progress in restoring degraded forests, implementing sustainable management practices
- Addressing deforestation and forest degradation requires a holistic approach considering economic development, social dynamics, and environmental conservation.
- Implementing sustainable land use practices, strengthening legal frameworks, engaging local communities, and promoting international cooperation

谢谢

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Thank You!

MINISTRY OF NATURAL RESOURCES AND ENVIRONMENTAL SUSTAINABILITY
FORESTRY DEPARTMENT OF PENINSULAR MALAYSIA

RESTORATION, RECLAMATION AND REHABILITATION OF DEGRADED FOREST AREAS IN PENINSULAR MALAYSIA

NABILAH HAMIDAH BINTI SABAR
FORESTRY DEPARTMENT OF PENINSULAR MALAYSIA

APFNet Workshop on Degraded Forest Rehabilitation and Management in Asia-Pacific Region
18 -27 August 2024

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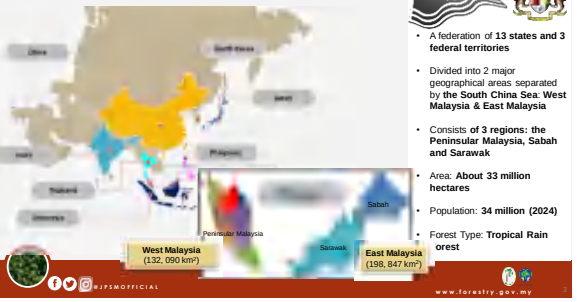
OVERVIEW

BACKGROUND ON MALAYSIA



- A federation of **13 states and 3 federal territories**
- Divided into 2 major geographical areas separated by **the South China Sea**: **West Malaysia & East Malaysia**
- Consists **of 3 regions: the Peninsular Malaysia, Sabah and Sarawak**
- Area: **About 33 million hectares**
- Population: **34 million (2024)**
- Forest Type: **Tropical Rain Forest**

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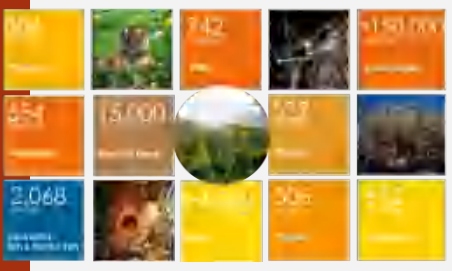
Malaysia is recognised as one of the 17 megadiverse countries worldwide

Ranked 12th on the National Biodiversity Index



At the Earth Summit in 1992, Malaysia pledged to keep at least 50% of its land areas as forest cover and trees

FOREST RESOURCES IN MALAYSIA

FORESTED AREAS IN MALAYSIA 2020

Forest cover (2020)
54.6%
18.05 million hectares of the total land area

Region	Area (ha)
Peninsular Malaysia	5.695 million
Sabah	4.68 million
Sarawak	7.671 million

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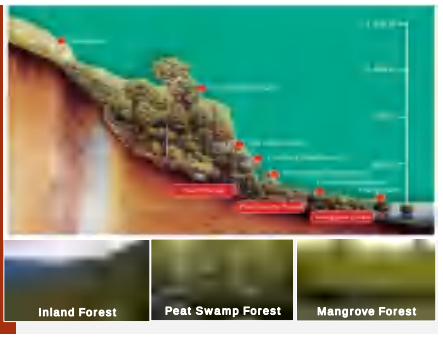
FOREST TYPE IN MALAYSIA



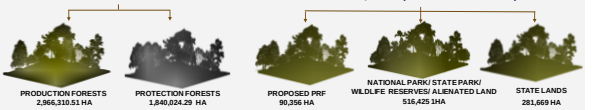
FOREST RESOURCES IN PENINSULAR MALAYSIA

FORESTED AREAS 2020
PENINSULAR MALAYSIA

FORESTED AREAS
5,694,784 (43% of total land area)

PERMANENT RESERVE FORESTS (PRFs)
4,806,334 HA (36.80% of total land area)

NON-PERMANENT RESERVE FORESTS (NON-PRFs)
888,450 HA (6.63% of total land area)



PRODUCTION FORESTS
2,866,310.51 HA

PROTECTION FORESTS
1,840,024.29 HA

PROPOSED PRF
90,356 HA

NATIONAL PARK/ STATE PARK/ WILDLIFE RESERVES/ ALIENATED LAND
516,425 1HA

STATE LANDS
281,669 HA

FOREST RESOURCES IN PENINSULAR MALAYSIA

MAP OF FORESTED AREA IN PENINSULAR MALAYSIA

FOREST GOVERNANCE

FEDERAL CONSTITUTION
Article 7(3)

- The **forest is under the respective State Government's jurisdiction**. Each state is empowered to enact laws & manage forestry policies in their respective states independently.
- The executive authority of the **Federal Government** is limited to provide **advice and technical assistance to states, maintenance of trail stations and demonstration stations, training and research**.
- **National Land Council** - enable the Federal & the State Governments to discuss and resolve common problems & issues related to **forestry** policy, administration, & management, as well as to enhance cooperation among the federal and state governments.

- Ministry responsible for forestry sector: **Ministry of Natural Resources & Environmental Sustainability (NRES)**
- Administration & management Federal level: **Forestry Department of Peninsular Malaysia (FDPM)**
- Administration & management State level: **State Forestry Departments (SFDs)**

SUSTAINABLE FOREST MANAGEMENT (SFM)

THE CONCEPT OF SFM

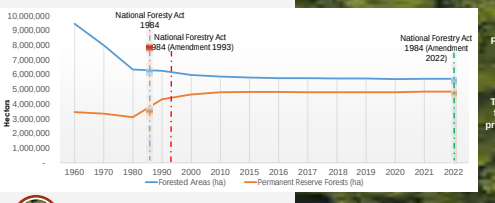
"The process of managing permanent forest land to achieved one or more clearly specified objectives of management with regard to the production of continuous flow of desired forest products & services without undue reduction in its inherent values & future productivity & without undue undesirable effects on the physical & social environment"

(ITTO, 1992)

Government designated the Permanent Reserved Forests (PRF) and legally secured & gazette in accordance with the National Forestry Act 1984 - to be managed under Sustainable Forest Management (SFM) for the benefit of present & future generations.

CHANGES OF FOREST COVER

CHANGES IN FOREST COVER IN PENINSULAR MALAYSIA FROM 1990 TO 2022

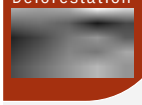


WRI's Global Forest Watch & University of Maryland:

4th

Top 10 countries for reduction in primary forest loss as of 2022

Main Drivers of Deforestation



Expansion of settlements and infrastructure development

- To meet the demand of the country's population
- Construction of roads/highways can indirectly lead to higher deforestation - enabling colonisation & opening up remote forest areas

Population growth

- 2004 : 25.5 million
- 2024 : 34 million
- 2040 : estimated to reach ≈40 million

Agricultural expansion

- Dominated by oil palm & rubber production
- 2nd largest producer & exporter of palm oil in the world
- 4th largest producer of natural rubber in the Asia Pacific region

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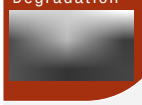
Main Factors of Degradation



Forest fragmentation

- Breaks up continuous forest areas into isolated patches separated by non-forested lands, restricting the mobility of fauna and flora - habitat destruction. a decline in biodiversity

Encroachment from past activities like agriculture & settlements

- Large areas of natural forests have historically been cleared for agricultural & settlement development - increased access to exploitation & encroachment

Legacy issues from past management & shifting cultivation

- Some areas have suffered degradation due to past management practices (e.g. drained peatlands in 1960s & 70s)
- Shifting cultivation or slash-and-burn agriculture was used to clear forest land for agriculture – land degradation over time.

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POLICY & LEGISLATION GOVERNING FOREST RESTORATION &REHABILITATION

The Malaysia Policy on Forestry

- Substituted the National Forestry Policy 1978 (Revised 1992).
- This policy was revised to incorporate the new emerging issues in the forestry sector.
- Strengthen the relationship & cooperation between the Federal & State Governments in the development of the forestry sector.
- Emphasises forest rehabilitation, as outlined in **2nd objective**:

  " Manage, conserve and rehabilitate the permanent reserved forests or forest reserves or permanent forests based on the principles of Sustainable Forest Management."

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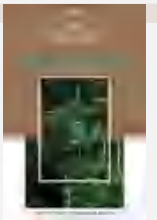

Forestry Policy of Peninsular Malaysia

- A new policy document.
- The main thrust in managing & developing sustainable forest resources in line with the national socioeconomic and environmental needs.
- **Thrust 3: Sustainability, Strategy 2: Enhancing the Forest Capacity in Reducing Climate Change Impacts - Increase in tree planting programmes and restore the degraded forest area in order to increase carbon absorption**

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National Forestry Act 1984

- The National Forestry Act (1984) provides for the administration, management, conservation & strengthen the enforcement of forests & forestry development within the States of Peninsular Malaysia.
- The Act was amended in 2022 to tighten the process of de-gazetting PRF, increase fine & penalty on forest offences, & strengthen enforcement against forest crime.

National Policy on Biological Diversity 2022-2030

- The updated version of National Policy on Biological Diversity
- Provides the direction and framework to conserve its biodiversity, promote its sustainable use, & ensure fair & equitable sharing of its benefits in the face of increasingly complex challenges now and in the future.

Twelfth Malaysia Plan (2021-2025)

- The Government has committed to continuous ecosystem conservation, ensuring natural habitats are protected and ecologically connected, as stipulated under **Priority Area B: Managing Natural Resources Efficiently to Safeguard Natural Capital, Strategy B1: Conserving Natural Ecosystems - Forest restoration, rehabilitation and enrichment will be intensified through multi-stakeholder collaboration.**

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RESTORATION & REHABILITATION OF DEGRADED FOREST INITIATIVES IN PENINSULAR MALAYSIA

Early Efforts on Forest Rehabilitation

- Malaysia is committed to the sustainable management of its natural resources.
- For decades, forest replanting has been a common practice to address the demand for timber, non-timber products & to rehabilitate degraded areas.
- The **primary objective was focused on the sustainable production of high-value timber**, while **non-timber products & forest services were accorded secondary importance.**

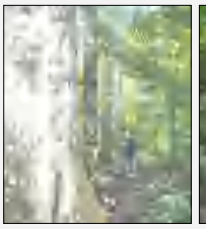
Shift in Focus

- Over the past two decades, the **focus has shifted towards providing ecosystem services.**
- Increased **global awareness** of the crucial role of ecosystem services in **mitigating climate change.**
- Recognising the importance of forests in delivering essential ecosystem services, the Malaysian Government has strengthened reforestation and rehabilitation efforts.
- Current efforts **aim to integrate ecological, economic, & social goals to achieve comprehensive & sustainable outcomes** - national & global commitments.

ENRICHMENT PLANTING IN IN THE PERMANENT RESERVED FOREST (PRF) IN PENINSULAR MALAYSIA FROM 1970 -2020

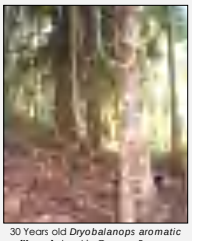
- Enrichment planting has been taking place since the 1900s & actively implemented since the mid-1960s in the PRFs.
- Involves introducing valuable selected timber species (commercial species, usually indigenous) into degraded forest areas without removing the existing timber trees - to supplement natural regeneration.
- In 1978, it became the routine silviculture intervention for logged forests with poor natural regeneration under the Selective Management System (SMS) - prescribed after the Post-Felling inventory.

1970-2000 (ha)	2001-2005 (ha)	2006-2010 (ha)	2011-2015 (ha)	2016-2020 (ha)	Total Planted (ha)
23,820	4,325	4,860	4,477	2,356	39,838



40 Years old *Rubroshorea parvifolia*, former name *Shorea parvifolia* **(Meranti Sarang Punai)** stand in Tapah Forest Reserve, Perak

25 Years old *Rubroshorea leprosula*, former name *Shorea leprosula* **(Meranti Tembaga)** stand in Bukit Tinggi Forest Reserve, Bentong, Pahang



30 Years old *Dryobalanops aromatic* **(Kapur)** stand in Gunung Bongsu Forest Reserve, Kulim, Kedah

3RSM

RESTORATION, RECLAMATION & REHABILITATION OF DEGRADED FOREST AREAS IN PENINSULAR MALAYSIA PROGRAMME

Floods and Landslide – December 2014

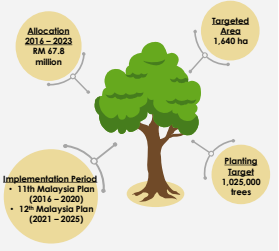
"About RM2.8 billion loss & over 300,000 victims suffered damage or loss of homes"

The 2014 Flood Disaster Special Forensic Committee

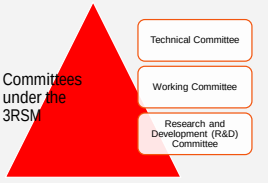
RESTORATION, RECLAMATION AND REHABILITATION OF DEGRADED FOREST AREAS IN PENINSULAR MALAYSIA PROGRAMME (3RSM)

OBJECTIVES

1. To restore an area of 1,640 hectares of degraded forests that were affected by natural disasters or anthropogenic disturbances through the planting of a total of 1,025,000 trees
2. To carry out silvicultural treatment on a total of 1,025,000 trees planted according to the silvicultural treatment regime
3. To upgrade the infrastructure of the Lentang Seed & Plant Material Procurement Centre in Pahang State and nine nurseries of SFDs
4. To produce high-quality plant material to support the implementation of forest conservation & preservation activities.



- The 3RSM employs an **Integrated Participatory Approach** involving of multi stakeholders.
- To ensure effective implementation of the program, three committees have been established.



- From 2016 to June 2014, **1,235 hectares** of degraded forest areas in Peninsular Malaysia have been restored with the planting **of 731,176 trees** of various indigenous species.

Period	Areas (ha)	Number of Tress
1. 11th Malaysia Plan (2016 – 2020)	809.8	463,481
2. 12th Malaysia Plan (2021 – 2025) - until Jun 2024	425.2	267,695
Total	**1,235.0**	**731,176**

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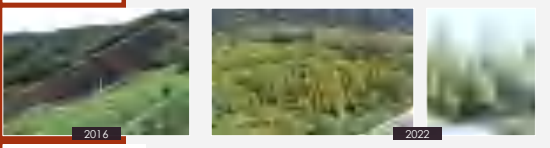
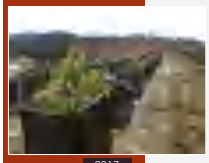
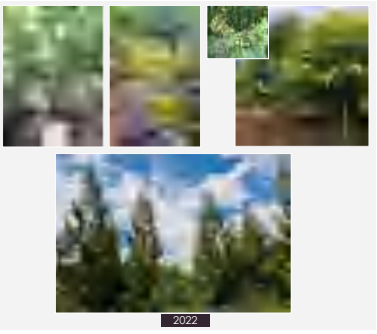
BERTAM FOREST RESERVE



BUKIT JERUT FOREST RESERVE

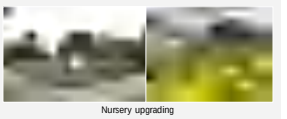
TERLA B FOREST RESERVE



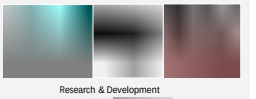


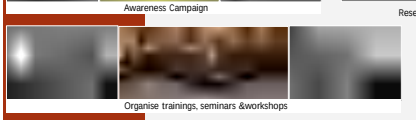
OTHER ACTIVITIES


Greening Programme with NGO


Nursery upgrading


Awareness Campaign


Research & Development


Organise trainings, seminars &workshops


Publications

THE GAPS IN POLICY & IMPLEMENTATION IN 3RSM

Funding & willingness constraints

- 3RSM is fully funded by the Federal Government.
- Restoration sites lack continued maintenance - State Governments often struggle with funding & willingness constraints.

Land Conversion

- While the National Forestry Act 1984 (Amendment 2022) tightened procedures for the degazettement of PRFs, it does not restrict the conversion of forested areas in State Lands.

Encroachment

- Encroachment & vandalism at restoration sites.
- Potential weaknesses in enforcement mechanisms, a lack of resources, existing conflicts, or insufficient awareness.

ADDRESSING THE GAPS

Innovative Financing Mechanisms (e.g. Ecological Fiscal Transfer, EFT)

Engaging stakeholders & raising awareness

Strengthening enforcement through better coordination & using technology

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LESSON LEARNED

1. **Policy Support**
   - Provides the necessary framework, resources & motivation to achieve desired outcomes.
   - Without strong policy backing - lack direction, resources & coherence
2. **Substantial Funding**
   - Ensure adequate resources (workforce, equipment & materials) are provided throughout the project.
   - Guarantees that resources are available for the maintenance necessary to sustain the restored areas.
3. **Continuous Monitoring & Adaptive Management**
   - Important to assess progress, adapt management strategies & address site-specific challenges.
   - Allows for adjustments based on what works & what doesn't.
4. **Integrated Participatory Approach**
   - Emphasises collaboration among government agencies, NGOs & research institutions
   - Leverage resources, knowledge & expertise effectively.
5. **Species Selection & Consideration**
   - Species site matching is important
   - Using native species supports local biodiversity
   - Pose significant challenges due to their complexity.

RECOMMENDATION FOR THE WAY FORWARD

1. Establishment of wildlife corridors

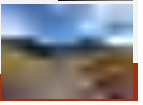
- The provision of vegetation structure, support the recolonisation of mammals.
- Studies in Cameron Highlands, Pahang indicate that rehabilitation have the potential to reverse defaunation - promote the recovery of mammal habitats
- Wildlife corridors be established at potential sites

2. Explore alternative planting methods

- Conventional techniques - time-consuming
- Explore other planting techniques to improve efficiency & accelerate the restoration
- e.g. drones

3. Encourage the use of Internet of Things (IoT)

- The Smart Forest Monitoring System (SFOMOS) - a monitoring system using IoT (e.g. used at 3RSM site in Raja Musa FR)
- Employs sensors & remote monitoring tools to collect real-time data on environmental parameters
- Expand it use at other sites to test its effectiveness.



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CONCLUSION

The restoration & rehabilitation of degraded forest initiatives is a long-term commitment to address deforestation & forest degradation. These initiatives have been ongoing in Malaysia to address deforestation and forest degradation, supported by numerous national policies for sustainable development.

The 3RSM program is a significant initiative in this effort, supporting Malaysia's international commitment to maintain that at least 50% of its land area is under forest & tree cover and in line with SDGs.

Key lessons from the 3RSM implementation highlight the need of robust policy support, substantial funding, continuous monitoring & adaptive management, integrated participatory approach, & careful species selection.

It is recommended to establish wildlife corridors at potential sites, explore alternative planting methods & expand the use of IoT application to enhance restoration & rehabilitation efforts.

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The Republic of the Union of Myanmar
Ministry of Natural Resources and Environmental Conservation
Forest Department

Degraded Forest Rehabilitation and Sustainable Forest Management: Opportunities and Challenges in Scaling up Forest Rehabilitation Efforts in Myanmar

Maung Phyo
Range Officer
Forest Department, Myanmar

21-8-2024

Contents

1.Introduction

- Location - South East Asia
- Latitude - 09°32'N & 28°31'N
- Longitudes - 92°10' E & 101°11'E
- Territorial Area - 676,552 km^2
- Coastal strip - 1,761 miles (2,833 km)
- Population - 51 million
- Topography can roughly divided into 4 parts; Western Hills, Central Valley, Eastern Hills and Taninthatyi Coastal Strip
- Seasons - Three distinct season; hot, rainy and cold season
- Annual Rainfall - Central Myanmar < 1,000 mm , Rakhine coast > 5,000 mm
- Average Highest Temperature 43.3°C(Central), 36.1°C(Northern), 29.4°C to 35°C (Eastern)

Biodiversity Richness

Major Forest Types in Myanmar

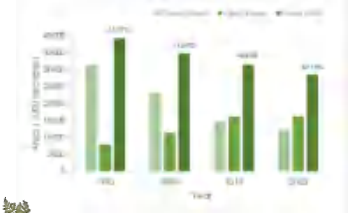
- Mangrove (Tidal, beach, dune and swamp forest)
- Dry forest
- Deciduous Dipterocarps (Indaing)forest
- Mixed Deciduous forest
- Tropical Evergreen forest
- Hill and Temperate Evergreen forest
- Scrub and Grass land

Source: Forest Department

Over 70% of Country's population resides in rural areas
Mainly depend on forest resources for food, fodder, shelter & fuel

2. Current status of Deforestation and Forest Degradation

Myanmar - the seventh-most deforested country in the world (FRA 2020)



The net annual forest area loss was

- 1.17 % (1990-2000)
- 1.03 % (2000-2010)
- 0.96 % (2010-2020)

Source: Forest Resource Assessment

The extent of forest cover changes in 10-years intervals from 1990 to 2020

3. Major Drivers of Deforestation and Forest Degradation

Within the Forestry Sector

- Overexploitation of timber (legal & illegal)
- Over-extraction of fuel-wood and charcoal
- Unstable shifting cultivation
- Forest fire
- Overgrazing
- Pest and Diseases
- Storms and landslides

Beyond the Forestry Sector

- Expansion of Agriculture
- Mining
- Infrastructure Development
- Hydropower Development
- Urbanization and resettlement
- Aquaculture Development

✓ The Goal of the Master Plan for the Agriculture Sector(2000 to 2030) is to convert about 4 million hectares of wasteland for private industrial crop production.
✓ Forest conversion for agricultural production is expected to increase.
✓ Direct driver, like Mining and Hydropower development will play a minor role.
✓ Shifting cultivation area has decreased since 2000 and is expected to decrease
✓ Only 1.6 % of mangrove deforestation between 2000 and 2012 could be attributed to Aquaculture.
✓ Overgrazing by domestic livestock is likely to be an issue in the future, especially in the Dry Zone.

Myanmar Policies, Laws, Regulation and Plans

Related to degraded forest rehabilitation and sustainable forest management, Myanmar has the following policies, laws and regulation;

- Forest Policy (1995)
- Environmental Policy (1994)
- National Environmental Policy (2019)
- National Land-Use Policy (2016)
- Myanmar Climate Change Policy (2018)
- National Wetland Policy and Action Plan (2014)
- Environmental Conservation Law (2012) and Rules (2014)
- Conservation of Biodiversity and Protected Areas Law(2018) and Rules(2019)
- Forest Law (2018) and Rules (to be enacted)

4. Overview of Myanmar Forest Policies, Laws and Regulation

- Achieving the national goals and aims of ensuring socio-economic development and stabilizing the environment and ecosystem, Myanmar Forest Policy (1995) was developed in an integrated and balanced manner, and its main six policy imperatives were set up as (1)Protection, (2)Sustainability of forest resources, (3)Basic needs, (4)Efficiency, (5)Participation, and (6)Public awareness.
- Overlapping and conflicting priorities and agendas by the forestry and agriculture sectors are a major concern. The lack of a typical land-use policy and related land-use law was a major driver of deforestation and forest degradation in the past. It led to many land-use conflicts and lack of systematic governance on land tenure, aquatic resources and forests.
- Myanmar's Forest Law, revised in 2018 based on the former Forest Law of 1992, is the main legal framework to achieve the effective implementation of the government's forest policy and environmental conservation policy.

4. Overview of Myanmar Forest Policies, Laws and Regulation(Cont;)

- The Conservation of Biodiversity and Protected Areas Law was enacted in 2018, replacing the former law entitled Protection of Wildlife and Protected Areas Law (1994). The new law brings more opportunities for recognizing the rights and potential roles of local communities while creating the new category of "Community Protected Areas."
- Community Forestry Instructions (2019) Recognizing the important role of people's participation in forest management, in line with the policy imperative "Participation of the people in the conservation and utilization of forests," Myanmar launched Community Forestry Instructions (CFIs) in 1995 and amended them in 2016 and 2019. The new CF instructions (2019) pave the way not only for the provisions of local people's basic needs but also for the commercialization of forest products while encouraging nature-based tourism for improving incomes and social welfare. These instructions are part of Myanmar's Forest Law because the establishment of community forest is described in section 7, sub-section (d), section 9, sub-section (h) and section 12, sub-section (d) of Myanmar's Forest Law. Their degree of legal powers is described in section 40 of CFIs 2019.

Myanmar Policies, Laws, Regulation and Plans

Related to degraded forest rehabilitation and sustainable forest management, Myanmar has the following plans;

- National Biodiversity Strategy and Action Plan (NBSAP) (revised in 2016)
- National REDD+ Strategy Plan (2020)
- National Master Plan (2001-2002 to 2030-2031)
- Forest Management Plan (2016-2017 to 2025-2026) (69 Districts)
- Myanmar Reforestation and Rehabilitation Plan(MRRP) (2017-18 to 2026-27)

The National Forestry Master Plan (2001-02 to 2030-31) is the guiding element for forest management in Myanmar on a sustainable basis, as well as for meeting the sectoral target of the Forest Department, Myanmar. It provides strategic direction covering a wide range of forestry issues, including protection and conservation, reforestation and rehabilitation, production, and law enforcement. It also provides guideline for the fundamental framework for the ten-year forest management plan at the district level.

5. Myanmar Reforestation and Rehabilitation Programme (MRRP)

According to FRA 2015, Myanmar was a country of third highest deforestation rate among countries in the world. Deforestation was due to a number of political, social and economic factors of the nations. Large scale reforestation and rehabilitation is, thus, urgently needed in order to increase forest cover, and to be compliance with the international agreements related to climate change mitigation and adaptation.

5.1 Goals

- To regain the ecosystem rich in biodiversity through reforestation and rehabilitation of forests.
- To mitigate the impacts of climate change
- To support the socio-economic development of the nation
- To support the sustainable forest management

5. Myanmar Reforestation and Rehabilitation Programme (Cont;)

5.2 Objectives

- To restore and rehabilitate the forest with the appropriate methods
- To strengthen the investment of large- and small scale private plantation
- To support the community forestry and agro-forestry practices
- To formulate the plantation policy through consultation with relevant stakeholders
- To encourage the participation of all relevant stakeholders in restoration and rehabilitation programme

5.3 Project Period

- 10 years, based on two project phases taken by five years of each.
- Phase I ----- 2017-2018 Fiscal Year to 2021-2022 Fiscal Year,
- Phase II ----- 2022-2023 Fiscal Year to 2026-2027 Fiscal Year.

5. Myanmar Reforestation and Rehabilitation Programme (Cont;)

5.4 Project Area

- implemented in 69 Forest Districts of 15 States and Regions.

5.5 Implementing Agencies

- Forest Department (FD) and
- Dry Zone Greening Department (DZGD)

5.6 Budget

- Within the fiscal years from 2017-2018 to 2026-2027, the budget which is consumed for forest operations, infrastructure, vehicles, fuel, other necessitates & staff salary are 589 Billion MMK (~ 280.8822 million USD by 27-7-2024 CBM Exchange Rate).
- The whole budget is funding by Myanmar Government Capital.

5. Myanmar Reforestation and Rehabilitation Programme (Cont;)

5.7 Plantation Zone

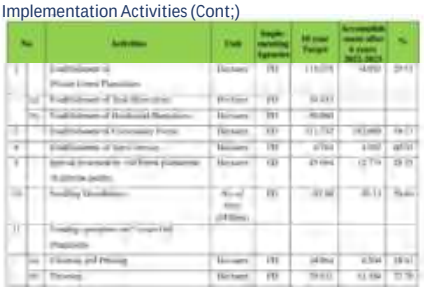
- Plantation zones are classified in order to successfully accomplish objectives of the rehabilitation and reforestation program based on the management and accessibility.

5. Myanmar Reforestation and Rehabilitation Programme (Cont;)

5.8 Implementation Activities

5. Myanmar Reforestation and Rehabilitation Programme (Cont;)

5.8 Implementation Activities (Cont;)

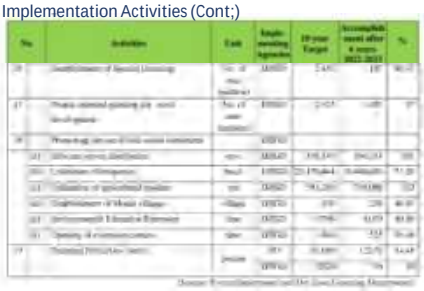


5. Myanmar Reforestation and Rehabilitation Programme (Cont;)

5.8 Implementation Activities (Cont;)

5. Myanmar Reforestation and Rehabilitation Programme (Cont;)

5.8 Implementation Activities (Cont;)



5. Myanmar Reforestation and Rehabilitation Programme (Cont;)

5.9 Recorded Photos


Assisted Natural Regeneration
Kalawpa Reserved Forest, Pinlebu Township, Sagaing Region

5. Myanmar Reforestation and Rehabilitation Programme (Cont;)

5.9 Recorded Photos


Gap Planting

Line Planting

Enrichment Planting
Pinlebu(2) Protected Public Forest, Pinlebu Township, Sagaing Region

5. Myanmar Reforestation and Rehabilitation Programme (Cont;)

5.9 Recorded Photos

Establishment of Community Forestry
Bago Region

Establishment of Agroforestry
Shan State

5. Myanmar Reforestation and Rehabilitation Programme (Cont;)

5.9 Recorded Photos


Nationwide Tree Planting Campaign

Myanmar Reforestation and Rehabilitation Programme (MRRP)

Establishment of Teak Plantation Process
Mankaw(3) Protected Public Forest, Pinlebu Township, Sagaing Region

Surveying

Felling & Cutting

Fire Protection before burning

Burning

Re-burning

Staking

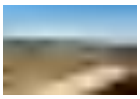
5. Myanmar Reforestation and Rehabilitation Programme (Cont;)

Establishment of Teak Plantation Process (Cont;)

Planting

Weeding

Survival Counting



Fire Protection after planting

First Year Teak Plantation

Second Year Teak Plantation

6. Finding and Discussion of MRRP ; Lesson Learned from this Programme

For adoption of Forest Plantation Strategy,

- it is weak to involve stakeholders through cross-sectoral cooperation.

For Assisted Natural Regeneration,

- it is different from economic point of view to ecological point of view.
- So, the operation processes are different and it is weak to check because these operations are carried out in large scale.

For Enrichment Planting,

- it is recommended to select suitable native species.
- It is also weak to maintain after one year operation because there is no budget plan for the second year.

6. Finding and Discussion of MRRP ; Lesson Learned from this Programme (Cont;)

For Establishment of Plantation,

- classification of plantations based on different types brings better achievement with different purposes.
- Although watershed plantations aid catchment forest and village supply firewood plantations aid local people for fuel-wood needs without depending remaining natural forest, it is need to consider establishment of commercial plantations in large scale with monoculture.
- However, establishment of large amount of plantations create job opportunities for local people and it is affective to conserve the plantation with local people interest.
- But, for the degraded forest, rehabilitation can achieve by plantation establishment because it covers land-use conflicts.

6. Finding and Discussion of MRRP ; Lesson Learned from this Programme (Cont;)

For Special treatment to old forest plantations of inferior quality,

- the budget investment is lower than establishment of new plantation although the operations are the same to the new plantation establishment.

Seedling Distribution, Community Forestry and Agroforestry activities

- are the best way for the local people to participate in the rehabilitation of degraded forest.
- With Seedling Distribution, Myanmar government is strongly and actively participate and encouraging by holding Nationwide Tree Planting Campaign throughout the whole country.
- The objective is to encourage and persuade people to plant trees and to understand the important and usefulness of forests for human being in non-forested areas.

6. Finding and Discussion of MRRP ; Lesson Learned from this Programme (Cont;)

According to the 6 year experience of MRRP,

- When a programme which cover wide areas or throughout the whole country is taken out, adoption of forest operations should not be equal in different localities.
- The budget norms for the operation should not be the same from the beginning till to the end if the program is long term duration.
- Although the Plan or Programme is a national level, we should choose site specific budget
- It should be separated in 3 to 5 year each because commodity prices are not stable and the labor charges are different in different localities.

7. Recommendation and The Way Forward

Should To-

- To pay more attention in the participation of local community in the establishment of plantations, restoration of forests, reservation and protection of biodiversity
- To effectively promote community-based forest management and sustainable agricultural practices such as agroforestry, community forestry, Nationwide Tree planting Campaign, etc.;
- To involve stakeholders in all levels and in all forms through cross-sectoral cooperation for a successful plantation strategy adoption;
- To select suitable native species for the achievement of Enrichment Planting;
- To bring better achievement of plantation in different plantation types with different purpose instead of establishment of large scale of commercial plantation in a monoculture way;
- To begin seedling one year ahead in order to make strong seedling at the time of distribution;
- To make an amendment and repair the laws, rules and regulations which are overlapping and conflicting with other department and institutions.

7. Recommendation and The Way Forward (Cont;)

Should Not To-

- Not to focus Assisted Natural Regeneration only in economic point of view for a better restoration;
- Not to be equal adoption of forest operations in different localities if a programme which cover wide areas or throughout the whole country is taken out;
- Not to be the same the budget norms for the operations of a program if the program is long term duration because commodity prices are not stable and the labor charges are different in different localities

This programme covers the reforestation and rehabilitation of Myanmar forests into national level by setting up targets for each region and state of the country, in cooperation with people participation power. The experiences from this programme can be applied and the following positive change can be replicated and scaled up to other forest related agencies for the Sustainable Forest Management and Degraded Forest Rehabilitation.

Thank you very much

For more details, Please feel free to contact:

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Degraded Forest Rehabilitation and Management in Myanmar

By
Yan Myo Naing
University of Forestry and Environmental Science, Yezin
(21.8.2024)

Introduction

- located in Southeast Asia
- latitudes 9°32' and 28°31‟N
- longitudes 92°10‟E and 101°11‟E
- Myanmar (China, Laos, Thailand, Bangladesh and India)
- The total area - 676,577 sq. km
- 936 km from east to west and 2,051 km from north to south
- The topography - four parts (the Western Hills Region, the Central Valley Region,the Eastern Hills Region and Tanintharyi Coastal Strip)

Introduction (Cont)

- hot season, rainy season and cold season
- The Central Myanmar - an annual rainfall of less than 1,000 mm
- Rakhine coast receives more than 5,000 mm.
- the average highest temperature in the Central Myanmar is about 43.3° C
- in Northern Myanmar, it is about 36.1° C
- on the Shan Plateau, between 29.4° C and 35° C.

Current Status of Deforestation and Forest Degradation

- The Seventh most deforested country in the world (FRA,2020)
- The net annual forest area loss was
  - 1.17% (1990-2000)
  - 1.03%(2000-2010)
  - 0.96%(2010-2020)

Major Drivers of Deforestation and Forest Degradation

- Overexploitation of timber
- Overexploitation of fuel-wood and charcoal
- Shifting cultivation
- Forest Fire
- Over grazing
- Past and desease
- Weekness in law enforcement
- Insufficient staff

Forest Types in Myanmar

No.	Major Forest Type	Ha	% of Forest Area
1	Mangrove Forest	325,259.20	1.12
2	Tropical Evergreen Forest	5024,093.00	17.30
3	Mixed Deciduous Forest	11,093,662.00	38.20
4	Dry Forest	2,904,100.00	10.00
5	Deciduous Dipterocarp	1,237,146.60	4.26
6	Hill and Temperate Evergreen	7817,837.20	26.92
7	Scrub and Grass Land	638,902.00	2.20
	Total Forest Area	29,041,000.00	100.00

Source : Forest Department

Myanmar Forest Policy

Myanmar Forest Policy (1995) has been formulated in a holistic and balanced manner with the overall context of the environment and sustainable development taking full cognizance of the forestry principles.

Six imperatives identified in the policy are:

(1) Protection of soil, water, wildlife, biodiversity and the entire environment;

(2) Sustainability of forest resources to ensure perpetual supply of both tangible and intangible benefits accrued from the forests for the present and future generations;

(3) Basic needs of the people for fuel, shelter, food and recreation;

(4) Efficiency to harness, in the socio-environmentally friendly manner, the full economic potential of the forest resources;

(5) Participation of the people in the conservation and utilization of forests; and

(6) Public awareness about the vital role of forests in the well-being and socioeconomic development of the nation.

Forest Law

- The old Forest Law (1992) was repealed by the new Forest Law enacted in 2018.
- The basic principle, management of forest land, conservation and protection, administrative actions, and offences and penalties were revised and updated in the new Forest Law (2018).
- The new Forest Law comprises nine basic principles and 58 sections under 13 Chapters, highlighting the constitution of reserved forest and declaration of protected public forest, management of forest land, establishment of forest plantation, extraction and removal of forest produce, disposal of drift, stranded and waif timber, establishment of wood-based industry, administrative action (search, arrest and administrative action) in respect of offences and penalties.
- The new Law recognizes local and indigenous peoples' rights, encourages people's participation in forest management, private sector involvement in forestry sector development, human resource development and extension to local people.

Rehabilitation of Dry Zone

- The dry zone of Myanmar lies in the central portion of the country and covers about 12% of the total land area.
- It has very harsh climatic conditions with extreme temperature, prolonged drought period and erratic rainfall.
- Thus, the "Agricultural and Rural Development Corporation" (ARDC) implemented afforestation projects in Dry Zone since 1953-54 and ended on 30th September 1963.
- In 1994, the Government launched a project entitled "Nine District Special Greening Project" in the Dry Zone of Central Myanmar for rehabilitation as well as greening of the Dry Zone.
- Based on the experiences and success of the Project, Dry Zone Greening Department (DZGD) was constituted under Ministry of Forestry in July 1997.
- The working area of Dry Zone Greening Department consists of 53 Townships from 13 Districts of 3 Regions, covering 19.54 million acres of the central dry zone of Myanmar.

Rehabilitation of Dry Zone (Cont)

Dry Zone Greening Department has formulated a comprehensive master plan for a 30-year period from 2001-2002 to 2030-2031 with a view to implement the following four main tasks;

(i) Establishment of Forest Plantations
(ii) Protection and Conservation of Remaining Natural Forests
(iii) Promotion on Utilization of Fuelwood Substitutes
(iv) Water Resources Development

Myanmar Reforestation and Rehabilitation Programme (2017-18 to 2026-27)

In order to restore the degraded forests, Forest Department launched Myanmar Reforestation and Rehabilitation Programme (MRRP) (2017-18 to 2026-27) in 2017.

MRRP is being implemented in all 15 States and Regions (i.e., 68 Districts) of the country. Dry Zone Greening Department is also cooperating with Forest Department in implementing MRRP.

It is a milestone and significant initiative of the Government with various objectives

- To restore and rehabilitate the degraded forests for climate change mitigation and adaptation as well as to enhance ecosystem services
- To fulfill the demands on teak and other commercial timber species
- To strengthen the investment of private sector in forest plantations
- To improve the livelihood and socioeconomic conditions of the rural people through increasing job opportunities and the community forestry

Myanmar Reforestation and Rehabilitation Programme (2017-18 to 2026-27) (Cont)

- Formulation of Forest Plantation Policy In order to achieve the objectives, the following targets are set, and being implemented:

  establishment of 148,627 ha of state-owned forest plantations

  establishment of 115,427 ha of private plantations

  encouraging and improving Assisted Natural Regeneration covering 331,392 ha in the Production Forests

  conservation of 202,429 ha of remaining natural forests in Central Dry Zone

  establishment of 311,875 ha of Community Forests

  reservation of (6.195% of country area) to fulfill the national target of 30% of PFE in accordance with Myanmar Forest Policy 1995.

  formulation of forest plantation policies and strategies

Challenges in Forestry Sector

- High rate of deforestation and forest degradation
- Expanding area of reserved forest and protected public forest up to 30 percent of the total country"s area as well as protected area coverage up to 10 percent of the total country"s area.
- Conflict of interests; powerful (political and economic) interests may favor deforestation and forest degradation
- Conflict of sectoral policies and plans as well as legislation which may accelerate deforestation and forest degradation
- Some of the main drivers of deforestation and forest degradation often lying outside of forest sector (eg. related with agriculture, mining, infrastructure development etc.)
- Weak law enforcement and poor coordination mechanism among line ministries in fighting against illegal logging
- Integration of criteria and indicators into national forest programmes

Opportunities

- Political will and supports to the sustainable forest management and environmental conservation
- Moratorium of timber harvesting in Bago Yoma Region, Home of Teak Tectona grandis (area of 1.5 million ha) for 10 years starting from 2016-17 fiscal year
- Export ban for any log or timber extracted incompliant with sustainable manner,
- Export ban of round log since 1st April 2014 not only to promote exporting the value-added products but also to fulfill the demand of raw materials for domestic wood-based industrial sector.
- Logging below Annual Allowable Cut (AAC) (for teak, under 55% of the AAC and for other hardwoods, under 33%) to reduce deforestation and forest degradation
- Implementation of the Myanmar Restoration and Rehabilitation Programme (MRRP) for 10- year period (2017-2018 to 2025-2026) with government's budget .

Lessons-learnt

For MRRP

- Adoption of plantation strategy
- Assitted natural regeneration
- Enrichment planting

To control deforestation and forest degradation,

- Revise forest Policy
- Law enforcement
- Institutional Strengthing
- Inter ministrial cooperation
- Enough funding

Recommendations

- To revise forest policy to reflect current saturations in forest management
- Urgent plantation policy for effective management in sustainable way
- To manage natural forest, pay more attention to reduce deforestation and forest degradation
- To contact International organizations for funding
- To pay more attention on capacity building
- To carry out scientific research
- To utilize advanced techniques

Thank You So Much!

APFNet Workshop on
Degraded Forest Rehabilitation and Management in Asia-Pacific Region
(Yunnan Province, China 18-27 August, 2024)

A participant paper by

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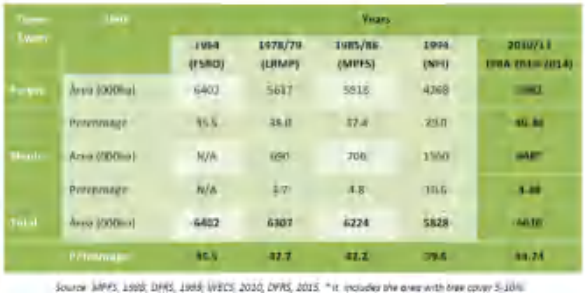
August 2024

CHAPTER 1 – COUNTRY BACKGROUND

CHAPTER 2 – STATUS OF DEFORESTATION AND FOREST DEGRADATION IN NEPAL

- In Nepal, significant land cover changes have occurred over the past few decades because of natural and anthropogenic causes.
- The latest National Forest Resource Assessment in Nepal found that the country has 44.74% (6.61 million hectare (ha) of the land area under forest cover (DFRS, 2015).
- Between 1994 and 2010, the forest area increased from 29% to 40.36% and shrub area decreased from 10.6% to 4.38%, showing a significant reduction in the rate of deforestation.
- Research has found a noticeable improvement in forest cover throughout the country except in Tarai (deforestation rate 0.44% in between 2001 and 2010), which has a higher population density (Chaudhary, Uprety, and Rimal, 2016).
- Drivers of deforestation and forest degradation (D&D) across the country have been documented in Nepal's first stages of REDD+ preparation (MoFE, 2018).
- The REDD+ Strategy has presented the drivers of D&D, its potential level of effect on forests, affected physiographic regions, and the underlying causes.

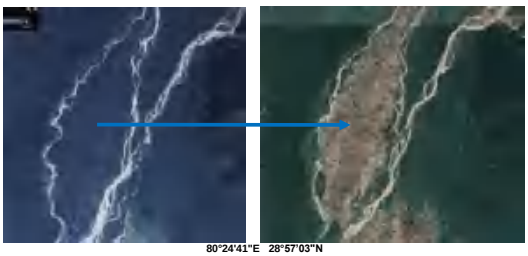


Source: MPFS, 1988; DFRS, 1999; WECS, 2010; DFRS, 2015. *It includes the areas with tree cover 5-10%

FOREST FIRE

Forest Encroachment

1990 2020



80°24'41"E 28°57'03"N

Jhalaripipaladi, Shuklaphanta Nagarpalika, Kanchanpur (Around 200 ha)

CHAPTER 3: OVERVIEW OF THE APPROACHES TO FOREST REHABILITATION

- Government of Nepal has been adopting the approach of restoring forest ecosystem functions through rehabilitation, reconstruction, and reclamation of forest systems since 1960s and has made budgetary provisions to restore the forests through carrying out several restoration activities like nursery establishment, seedlings development, and plantation programs annually in public and private lands.
- Furthermore, large-scale planation such as *Dalbergia sissoo*, *Eucalyptus spp*. were promoted.
- The establishment of PAs like, national parks, wildlife reserves also contributed directly to restoration outcomes.
- The government investments are also made through deployment of security forces (Nepal army and armed forest guards) in forests and protected areas.
- It is estimated that over 370,000 hectare of plantation forests have been established in the degraded mid-hills of Nepal.
- As the forest management paradigm shifted to community management approach in the 1970s, local communities protected these plantations and thus the plantation forests have successfully been established.
- Community forestry is believed to be instrumental in restoring forests and natural ecosystems.
- So far, over 2.4 million hectares (about 38 percent) of forests have been managed as community forests in the country (CFSC, 2024).

Nepal has gone through different evolutionary phases of policy development that have at times resulted in both negative and positive consequences.

Decades	Major intervention	Remarks
1950s	The Private Forest Nationalization Act 1957	rapid deterioration of forest resulted through conversion of forested areas into farmlands through the random felling of trees across the country
1960s		Continued D&D
1970s	Paradigm shift from center to local through National Forestry Plan 1976 (Panchayat Forest/Panchayat Protected Forest)	Peoples participation emphasized
1980s	Master Plan of Forestry Sector 1988/89 introduced Community Forest Management Modality	More focus was on mid-hills of Nepal however deforestation continued in terai region.
1990s	Forest Act 1993 and bylaws legislated community forest, leasehold forest and religious forest	D&D continued due to exponential population growth and Maoist insurgency in Nepal
2000s	Collaborative Forest Management modality introduced in Terai region	Forest restoration gained momentum beyond forest area into landscape level.

2010 till date

- New constitution
- Federal structure
- Schedule 5: Federal Powers -National and international environment management, national parks, wildlife reserves and wetlands, national forest policies, carbon service.
- Schedule 6: Provincial Powers-Use of forests and waters and management of environment within the province
- Schedule 7: Concurrent Powers of Federal and Province-Utilization of forests, mountains, forest conservation areas and waters stretching in inter-provincial form
- Schedule 8: Local Powers-Protection of watersheds, wildlife, mines and minerals
- Schedule 9: Concurrent Powers of Federation, Province, and Local Level-Forests, wildlife, birds, water uses, environment, ecology and biodiversity

Major legislations (Federal Level)	Major legislations (Provincial Level)
• National Agroforestry Policy 2019 • Climate Change Policy 2019 • National Forest Policy 2019 • Forest Act 2019 • National Parks and Wildlife Conservation Act 1973 • Soil and Watershed Conservation Act 1982 • Environment Protection Act 2019	• Koshi Province – Environment Protection Act 2019, Forest Act 2020 • Madhesh Province- Forest Act 2021 • Bagamati, Gandaki and Lumbini Province- Forest Act 2019 • Karnali Province- Pradesh Forest Act 2021 • Sudurpaschim Province-Forest Act 2020

Federal level	Provincial level	Local level
Ministry of Forests and Environment Department of Forests and Soil Conservation Department of National Parks and Wildlife Conservation Department of Plant Resources Department of Environment Forest Research and Training Center REDD Implementation Center	Forest related Ministry Province Forest Directorate Division Forest Offices Soil and Watershed Management Offices Forest Research and Training Center	Forest and Environment Unit in some local levels

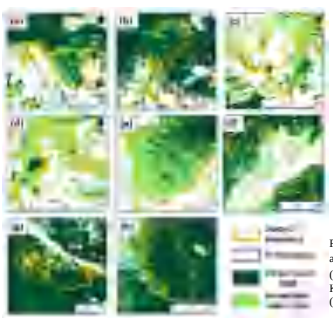
CHAPTER 4 – CASE STUDY

- Historical observation shows that unless people are given user rights and ownership to control and make decisions, people lose interest in effective practices of forest management (Gilmour and Fisher, 1998).
- Community-based forest management (CBFM) practice originated in Nepal due to the progressive degradation and deforestation of hill forests caused by institutional failure (K.C., 2016).
- After abolition of Rana regime from the country in 1950, government of Nepal promulgated Private Forest Nationalization Act 1957 to protect, manage and utilize the forest of Nepal as state property.
- All the private and communal properties had come under the control of State.
- People's traditional rights of access and use to forest resources were diminished.
- Ironically, the Private Forest Nationalization Act 1957 and Forest Act 1961 were not able to prevent people from unregulated extraction of forest resources by creating conflicts between local people and administration.
- In the mid-1970s, government of Nepal and a number of donor agencies began showing concern about the accelerating degradation of Nepal's forests and the negative effects it was having on the environment (Acharya, 2003).

- This led to the local communities being given the rights to manage and use their local forests as the main strategy to reverse the trend.
- Government of Nepal formulated the National Forest Plan in1976 which for the first time recognized the role of local communities and explicitly emphasized people's participation in forest management.
- The major thrust to the community forestry program came through the Master Plan for Forestry Sector of 1989 which fully recognized community and private forestry as the largest among the six identified primary forestry programs and encouraged transfer of forests to local communities for active management and utilization.
- Subsequently, Forest Act 1993 and Forest Regulation 1995 provided detailed guidelines and policy framework for community forestry program.
- This legislation opened the door to implement community forestry programme nationwide and became the milestone in the history of forest management governance in Nepal.
- Community forest (CF) in Nepal is defined as national forests handed over to the local user group pursuant to section 18 of Forest Act, 2019 to develop, conserve use, and the forest and sell and distribute the forest products independently by fixing their prices as according to approved Operational Plan.

- The forests are managed according to the Operational Plan (OP) prepared by Community Forest Users Groups (CFUGs), approved by the Divisional Forest Office (DFO).
- According to the Act, CFUGs have to be established and registered at the Divisional Forest Office before handing over of the forests and they are self-sustained institutions.
- The CFUGs can act as self-governing entities to generate, utilize and sell the forest products as mentioned in the Operational Plan.
- Community forestry promotes the management of forests as Common Pool Resources (CPRs) (Ostrom, 1992; Acharya, 2003).
- The CFUGs mange the community forests based on local situation and their interests.
- Furthermore, almost all the benefits that come from the community forest belongs to the users, the benefit sharing mechanism inside group can be determined by the users themselves.
- Nepal's community forest (CF) management program is one of the most prominent and long-standing examples of forest management decentralization (Gilmour, 2016; Paudel et al., 2021).

- Today, CFs occupy around 2.4 million ha and are managed by over 23,000 CF user groups comprising 3.2 million households and nearly 47% of Nepal's population (CFSC, 2024).
- Community forests have created natural capital in the form of new forests, and improved existing forest conditions and biodiversity.
- According to Smith et al. (2023) report, forest conditions have improved in between 1988 and 2016, with an average of 47% showing improvements in forest cover within the study area.
- K.C. (2016) concluded that community forestry management in Nepal significantly improved biodiversity.
- It led to increased forest biomass and carbon stocks, a shift towards more productive tree species, and a rise in wildlife populations.
- Additionally, forests became denser, providing better habitats for animals, though this also resulted in some wildlife causing damage to nearby crops.



Forest cover (FC) in 1988 and FC gain between 1988 and 2016 for the eight study community forests (CF): (a) Khorthali, (b) Charnawati, (c) Devithan, (d) Kupri Salleri, (e) Kankali, (f) Pragati, (g) Nibuwater, (h) and Devidhunga

CHAPTER 5: LESSON LEARNED

1. Decentralization of Forest Management empowered local communities to halt deforestation and forest degradation

The decentralization of forest management in Nepal through Community Forestry, initiated under the Forest Act of 1993 and updated in 2019, has significantly bolstered forest cover and sustainability efforts nationwide. By empowering local Community Forest User Groups (CFUGs) with the authority to manage nearby forest resources, this approach fosters a sense of ownership and responsibility among community members.

2. Strong legal support is utmost

The Forest Act of 1993 and Forest Regulation of 1995 laid the foundation by empowering Community Forest User Groups (CFUGs) with clear rights and responsibilities. For example, Section 16 of the 1993 Act enabled CFUGs to draft constitutions, elect leaders democratically, and formulate operational plans, thus legitimizing their role and fostering a sense of ownership. The Forest Act of 2019 further strengthened these provisions with specific measures detailed in Chapter 5, Section 18. Additionally, the Forest Act of 2019 includes mechanisms for accountability and enforcement. These comprehensive legal provisions have not only empowered local communities but also ensured effective protection and sustainable use of forest resources, leading to increased forest cover and reduced degradation in Nepal.

3. Inclusiveness is crucial

Inclusiveness is crucial for successful forest management interventions in Nepal as it ensures that diverse perspectives and knowledge systems are incorporated into decision-making processes. The active involvement of women, Dalits, indigenous people, and other marginalized groups fosters a sense of ownership and responsibility towards forest conservation. When these groups are included, they bring unique insights and practices that contribute to more effective and sustainable management of forest resources.

CHAPTER 6: TAKE HOME MESSAGE

- Policy Support: Ensure continuous policy support and legal frameworks that uphold community rights and responsibilities in forest management. Regular updates and revisions of forest laws should reflect evolving community needs and environmental priorities.
- Partnerships and Collaboration: Foster partnerships with government agencies, NGOs, academia, and private sectors to leverage resources and expertise for sustainable forest management. Collaborate on research, funding opportunities, and technical support to enhance program effectiveness.
- Community Empowerment: Continue to prioritize inclusive governance and community empowerment in all aspects of forest management. Support capacity building efforts that strengthen local leadership, decision-making, and sustainability practices within community forest user groups.

THANK YOU!!!

APFNet Workshop on
Degraded Forest Rehabilitation and Management in Asia-Pacific Region
18-27 August 2024 Yunnan Province, China

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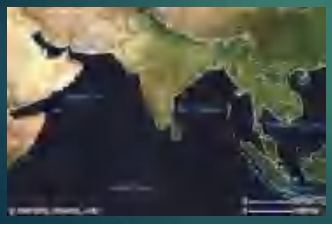
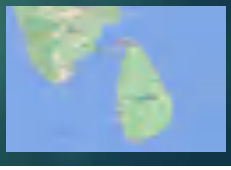
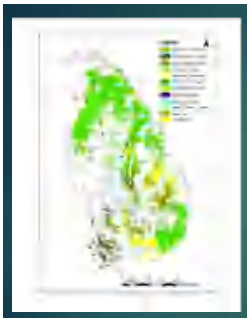
Introduction

- Sri Lanka is an island with an area of 65,610 km2
- Being an island, Sri Lanka's forests are rich in endemic species of flora and fauna.
- Sri Lanka has the highest species density (number of species present per unit area) for flowering plants, amphibians, reptiles, and mammals in the Asian region (NARESA, 1991)

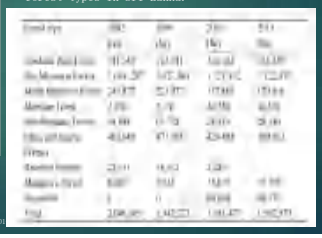


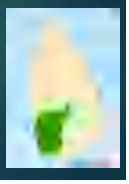




- Sri Lanka has a total natural forest area of approximately 1.92 million ha covering 29.7% of the total land area of the country.

- Sri Lanka is divided into three main climatic zones (wet, dry and intermediate) based on the average annual rainfall. Diversified topographic features, varying climatic conditions and edaphic factors have led to the development of different forest types in Sri Lanka.





Source : The Sri Lanka Forester, Vol.40 , 2021, 01

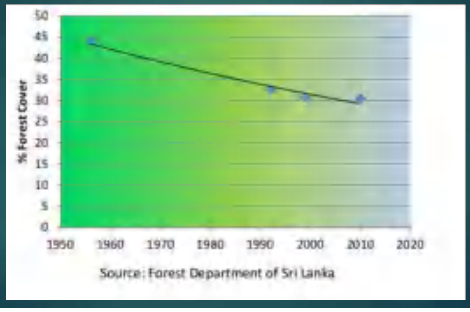
- In order to conserve biodiversity, the Government of Sri Lanka (GoSL), through the two major agencies concerned,

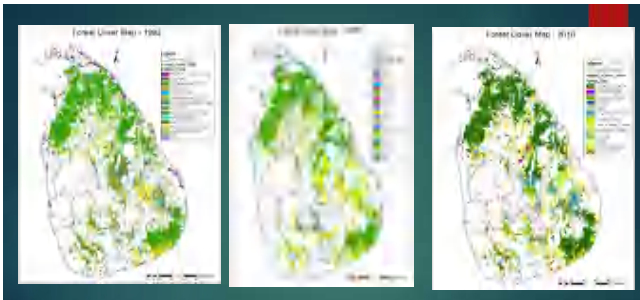
  Forest Department (FD)

  Department of Wildlife Conservation (DWC).

Forest Department	Wildlife Conservation Department
• 125 Conservation Forests (176,691 ha)	• 3 Strict Nature Reserves (31,571 ha)
• 4 International Biosphere Reserves (143,106 ha)	• 16 National Parks (738,547 ha)
• 722 Reserved Forests (1,157,023ha)	• 7 Nature Reserves (101,645 ha)
• World Heritage Site- 1 (Sinharaja - 11,127 ha)	• 1 Jungle Corridor (8,777 ha)
• World Heritage Site- 2 Central Highlands of Sri Lanka(Knuckles Conservation Forest (31,305 ha)	• World Heritage Site- 2 Central Highlands of Sri Lanka(Horton Plains National Park (3,109 ha) and the Peak Wilderness Protected Area (20,596 ha)
	• 61 Sanctuaries (277,122 ha)

- According to four forest cover assessments since 1956 to 2010, the rate of deforestation shows a slightly decreasing trend over time.





Loss of forest cover in Sri Lanka between 1992 and 2010
(Source: Sri Lanka UN REDD Programme, 2017)

Recent and current drivers of deforestation and forest degradation

- Encroachments – for agriculture, for residential settlements, for gem mining, for shrimp farms
- Infrastructure development projects –
  - Irrigation development projects;
  - Major hydro-power generation projects;
  - Mini hydro power projects;
  - Road development projects including highways;
  - Agricultural and livelihood projects;
  - Resettlement projects;
  - Tourism projects;
  - Airports and harbours.
- Private agriculture ventures
- Illicit felling
- Illegal extraction of NTFPs
- Firewood collection
- Grazing lands
- Regular forest fires
- Spread of invasive species
- Occurrence of natural disasters
- Pest and disease attacks on forest trees
- Extraction of gravel, soil, metals and others products

Permissive and weak land use policies, regularization of encroachments. unclear ownership of forest lands, long delays in legal proceedings, weak implementation and planning, political patronage and interference, poor coordination among agencies, population growth, commercialization of rural economies and improved agricultural technology are consider as major catalysts

Forest policy and protected area management, environmental laws and regulations, home gardens, community dependence and customary rights, public pressure and awareness about environment and forests and off-farm employment opportunities are considered as major factors that helped to reduce the rate of deforestation and degradation to some degree by acting as inhibitors

Approaches of forest rehabilitation

- The National Forestry Policy

i. To conserve forests for posterity, with particular regard to biodiversity, soils, water, and historical cultural, religious and aesthetic values;

ii. To increase tree-cover and productivity of the forests to meet the needs of present and future generations for forest products and services; and

iii. To enhance the contribution of forestry to the welfare of the rural population, and strengthen the national economy, with special attention paid to equity in economic development.

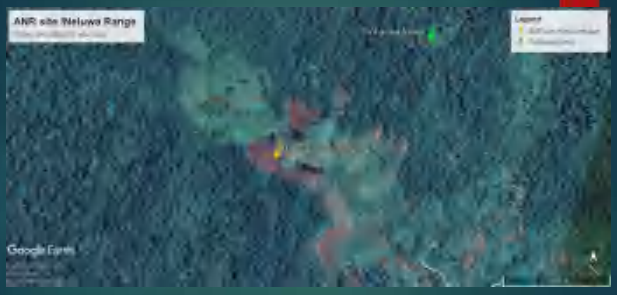
- The Forest Ordinance
- The Flora and Fauna Protection Ordinance
- National Heritage and Wilderness Area Act

- In order to increase percentage of forest cover of Sri Lanka up to 32% of the land area from 29.7 %Forest Department started forest enhancement programme in 2014.
  - Protection and conservation of existing forests
  - Expansion of forests in to new areas
  - Improvement of tree cover on private land

- **Block Reforestation**
- **Block planting by local level organizations**
- **Social forestry approaches**
  a) Co-operative Reforestation/Village Reforestation/Taungya
  b) Farmers' Woodlots
- **Private Sector Leasehold Reforestation**
- **Forest plantations as an investment scheme**
- **Non- Governmental Organizations**

Selected Restoration project

- The project was funded by private agencies called MAS Capital (Privet limited and Linea Aqua (private) limited, restoration work has been done under the supervision of forest department.
- Introduction
- The Pidurukanda degraded land is located in the edge of the Thibbotuwathota Forest which categorized as a Lowland rain forest, Neluwa, Galle, Southern province of Srilanka.
- Elevation varies from 1200m to 1400m, annual temperature is approximately 23.5 ^{0} C, rainfall lies within 3600-4500mm. There is no dry spell throughout the year.
- People who lived in adjoining villages had cleared forest for cultivation after some time they have abandoned the land and ***Dicranpteris linearis*** is densely occupied at present, natural regeneration has been suppressed and no other species can occupy the land.



Location of the restoration site

- **Objectives**

  To improve the species composition and forest biomass five hectare of degraded forest within the Pidurukanda forest by 2021.

- **Time Duration**

  From June 2017 and continued till end of December 2021

- **Interventions have been carried out in Pidurukanda Degraded Forest**

  a) Surveying and mapping

  b) Fire Protection

  c) strip planting

Three meter wide strips were cleared (root removal treatment) at three meter interval along the contour planting was done along the strip at two meter interval. In between two planted strips 3m wide strips were low slashed. Around 830 seeding were planted in each hectare.

Late succession species have been introduced in the beginning.

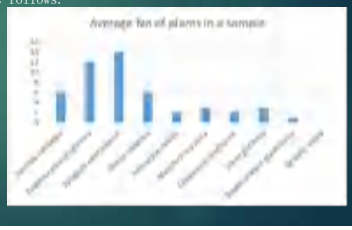
- **Promotion of the growth of young seeding**

Dicranpteris linearis have been completely removed in planting strips and other strips were low slashed. Low slashed was done at least twice a year.

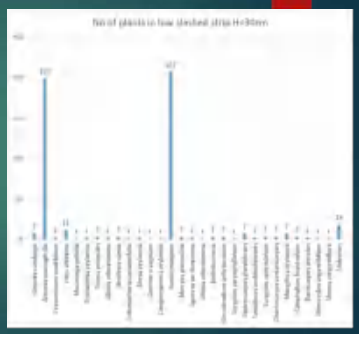
- **Data collection**

Data series were taken after 3 years of the establishment of the plantation. 3m x 50m sample plots were established on the planting strips and low slashed strips separately. Data were summarized as follows.

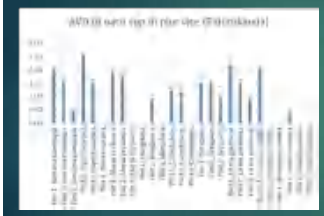
Average no of plants in planting strips .



Sampels in Low slashed stips, plant count was taken according to two height class

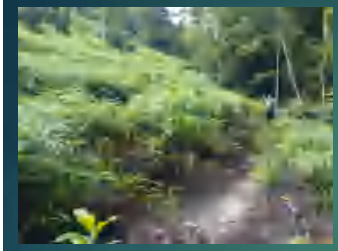


Sample plots in the planting strip were established as first one was plotted near the thick forest boundary, second one was located 50m away from the forest boundary and third one was located in 100m away from the forest boundary, mid of the fernland.



Average diameter of each species in plot vice

Average height of each species in plot vice



The lessons that can be learned from this project

- Here we have identified on the effects of five biotic factors (seed dispersal, development of a soil seed bank, seedling emergence, herbivory, competition) and five abiotic factors (fire, microclimatic conditions, soil nutrients, water availability, disturbance) as constraints to forest succession on degraded anthropogenic fernland in a Pidurukanda restoration site.
- Experiments have proven that in such cases the sequential amelioration of the site by way of relay floristic patterns of vegetation establishment can be an approach that can work. But in this small restoration work such kind of approach was not followed. As a example in the biging of the establishment of plant nitrogen fixing species like *Puerazia phascoloides*, *Gliricidia sepium* were not introduced.
- In this context late- successional species were introduced in the beginning, it was badly effected to the plant growth and their survival of the planting site.
- In this restoration site 3m wide planting strips were completely removed from ferns with their rhizomes (root-removal treatment). Finally results showed growth diference in planting strip and low slashed strip and also average DBH and height of the plants much higher in forest edge than the mid of fernland

Positive changes and recommendation

- The most severe soil disturbance, like root-removal treatment was more productive than low slashed strips. By comparison, Emergence of planted seedlings, no of plants survive and their height and DBH values are more significant.
- We emphasize the importance of the edge habitat and early successional species more productive of forest ecosystem expansion into fernland. *Trema orientalis*, *macaranga peltata*, *Clerodendrum infortunatum* species which were fast-growing light-demanding species were identified as more suitable early successional plants.
- Once the micro environment is favorable, late succession species were planed to be established in fourth and fifth years. *Depterocarpus zeylanicus*, *Syzigium operculatum*, *Bhesa ceylanica* and *Garcinia cambogia* were identified as more suitable late successional species for the selected above restoration site among the planted specises
- Fire occurances were adversely effected for regenerating plant seedling. Adequate fire belts should be opened around the restoration site.
- Further researches are required to determine the relative importance of low nutrient on tree seedling establishment and strategy for forest restoration in south west part of low country wet zone in Sri Lanka, including trials of additional species from the native tree flora.

Thank you

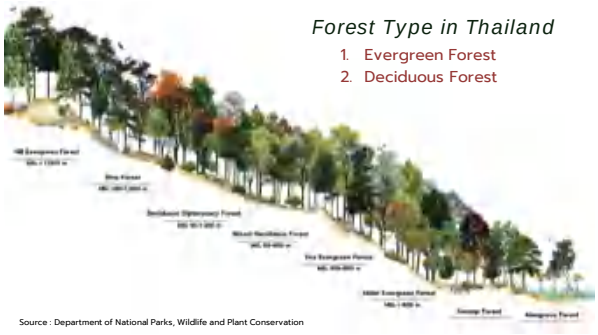
APFNet Workshop on
Degraded Forest Rehabilitation and Management in Asia-Pacific Region
18-27 August 2024 Yunnan Province, China

Degraded Forest Rehabilitation and Sustainable Forest Management: A Case study of Highland Reforestation Program in Northern Thailand

La-ongdao Thaopimai
Researcher
Faculty of Forestry, Kasetsart University, Thailand

Introduction

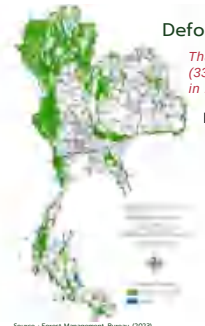
- Thailand is located in Southeast Asia
- Home to diverse flora and fauna
- Total area : 513,115 km²
- Population : 66.98 Million
- Forest land : 31.85%
- Agricultural land : 46.06%
- Non-agricultural land : 22.09%



Forest Type in Thailand

1. Evergreen Forest
2. Deciduous Forest

Source : Department of National Parks, Wildlife and Plant Conservation



Deforestation and Forest Degradation Status

Thailand's forest area has decreased from 170,110.70 km² (33.15% of total area) in 2000 to 162,909.05 km² (31.47%) in 2023

Drivers of deforestation and forest degradation

Direct factors
- Agricultural Expansion
- Illegal Logging
- Infrastructure Development
- Mining and Quarrying

Indirect factors
- Population Growth
- Economic Policies and Land Use Planning
- Land Tenure and Ownership Issues
- Global Market Demand

Source : Forest Management Bureau (2023)

Land Management Policy and Planning

Forestry Institutions

The Ministry of Natural Resources and Environment, which was established in 2002, is responsible for the conservation, protection, and restoration of natural resources and the environment, as well as sustainable management of these resources. The ministry oversees several key agencies tasked with managing Thailand's forest areas:

- Royal Forest Department :
- Department of National Parks, Wildlife and Plant Conservation :
- Department of Marine and Coastal Resources :

Supporting organizations
- Academic institutions : Kasetsart University, Mahidol University, Maejo University, Chiang Mai University, Thammasat University, etc.
- Non-governmental organization: Regional Community Forestry Training Center for Asia and the Pacific (RECOFTC), Thailand Environment Institute Foundation, Mae Fah Luang Foundation under Royal Patronage, etc.
- Private institutions: PTT, PTTEP, EGAT, SCG etc.
- Other : Forest Industry Organization, Royal Project Foundation, Highland Research and Development Institute (Public Organization), Thailand Greenhouse Gas Management Organization (Public Organization), etc.

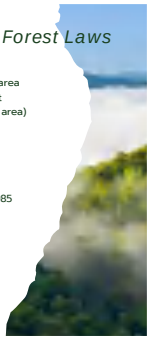
Strategies and Forest Laws

Strategies

- The 20-Year National Strategy (2018-2038) : forest and green area 55% of total area
- The 20-Year Strategic Plan of the Ministry of Natural Resources and Environment (2017-2036) : forest protection and preservation of 142,208 sq.km. (25% of total area)
- National Forest Policy : targets 40% forest cover

Key laws

- Forest Act (1941) and subsequent amendment in 1989
- National Park Act (1961)
- National Reserved Forest Act (1964) and subsequent amendments in 1979 and 1985
- Wildlife Preservation and Protection Act (1992)
- Forest Plantation Act (1992) and subsequent amendments in 2015
- Chainsaw Act (2002)
- Community Forest Act (2019)

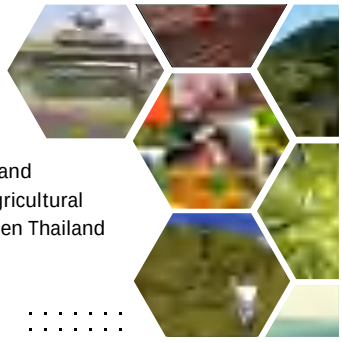


Reforestation and Forest Restoration in Thailand

Key Elements of Forest Restoration in Thailand

Government Initiatives and Policies	Community Involvement and Rights	Biodiversity Conservation and Climate Change Mitigation	Sustainable Practices and Monitoring	Environmental Education and Awareness

KU KASETSART UNIVERSITY



A Good Practice of Highland Reforestation at Royal Agricultural Station Angkhang, Northen Thailand

Background issues of the northern Thailand's highlands

Highlands in Thailand

- Elevation > 1,000 m
- Mostly in the northern part of Thailand
- Serving as head watershed areas and other ecological services to the country
- Hill tribes and local Thai people
- Forest type: Hill/Pine evergreen forest, Deciduous forest
- Forests have been converted to cropland
  ...shifting cultivation
  ...cash crop cultivation e.g. maize, corn, rice, cassava
- The problems have led to GHG emissions, biodiversity losses, soil erosion, hydrological imbalance and losses of other ecological functions

Background issues of the northern Thailand's highlands

Angkhang

- Chiang Mai province
- Elevation: 1,400 m
- Forest type: Hill/Pine evergreen forest
- Total area: 1,260 ha
- Population: 833 households/3,960 people
- 5 hill tribes + local Thai
- Driver of deforestation : opium planting and poverty

Royal Project Foundation

- The Royal Project Foundation is one of initiated projects of HM the King Bhumibol, established in 1969 after the King Bhumibol visit the highland in Chiang Mai province
- The Royal Agricultural Station (RAS) Angkhang, Chiang Mai Province, was then established as the first Royal Agricultural Research station

Objectives of the Royal Project

- To improve the quality of life of hill-tribe people
- To diminish their opium growing
- To restore the forests and water resources

Photo: www.angkhangstation.com

Highland Reforestation at the Royal Agricultural Station, Angkhang

- Started in 1981 in collaboration between the Royal Project Foundation, the Faculty of Forestry at Kasetsart University, and is supported academically and financially by Taiwan, including the National Taiwan University (NTU), the Taiwan Forestry Research Institute (TFRI), and the Forest Development Administration (FDA) of the Vocational Assistance Commission for Retired Servicemen (VACRS).

Photo:
Royal Agricultural Station, Angkhang

Reforestation area

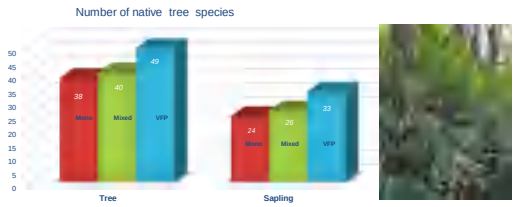
- Total station area *1,260 ha*
- Reforestation area *131.20 ha*
  - Exotic monoculture 28.43 ha
  - Exotic mixed stand 6140 ha
  - Exotic and native mixed stand 27.73 ha
  - Bamboo planting 13.64 ha
- The target extension area *1,240 ha*

superior performance

Acacia confusa
Fraxinus griffithii
Liquidambar formosana
Cunninghamia lanceolata
Cinnamomum camphora

Source: Diloksumpun, S.

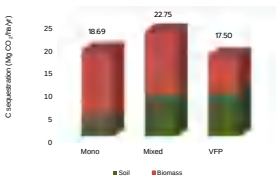
Natural regeneration of different planting schemes



Source: Diloksumpun, S.

Carbon sequestration in Biomass and Soil

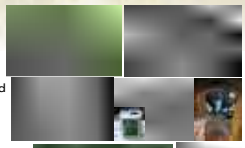
Area 117.56 ha
Total Carbon sequestration 67,830 Mg CO_2



Annual C sequestration varied with planting schemes

Source: Diloksumpun, S.

Co-benefits of highland reforestation

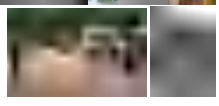


Economic Co-Benefits

- Utilization of thinned woods: furniture, souvenirs, high quality charcoals, wood vinegar...increasing household income
- Utilization of branches and dead wood: fuelwood for cooking and heating...*reducing household expenses*

Social Co-Benefits

- Knowledge transfer and sharing: Demonstration center for wood technology and utilization established in 2004
- Activities to develop people participation and conservation awareness eg. tree planting and management, forest fire control

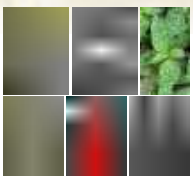


Source: Diloksumpun, S.

Co-benefits of highland reforestation

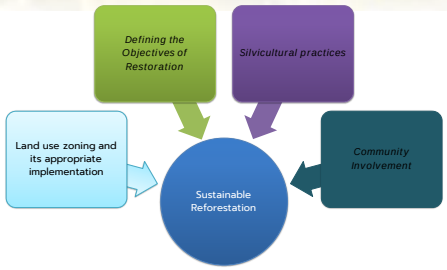
Environmental Co-Benefits

- Biodiversity and natural regeneration of native tree species (64 tree species in 31 families)
- Biodiversity of non-woody plants, animals and insects
- Conservation of watershed area for ecological services
- Conservation of water and soil through terraced planting
- Weed control without herbicides
- Soil erosion protection through reforestation
- Beautiful scenery of the reforestation area for tourist attractions e.g. hiking, photo taking



Source: Diloksumpun, S.

key points to the success of sustainable reforestation



CONCLUSSION

The success of forest restoration at the Angkhang Royal Agricultural Station can be attributed to four key factors: effective land use zoning, clear restoration objectives, silviculture principles, and strong community involvement. The careful zoning of land into distinct agricultural and forest areas ensured that each region was utilized optimally, allowing for a focused and efficient restoration. Clear restoration objectives further guided the selection of appropriate tree species, which were chosen based on specific needs of the area and local community. This strategic approach ensured that the reforestation efforts were both ecologically sustainable and beneficial to the local economy. Additionally, an active participation of the local community was integral to the restoration efforts. Community members were involved in various activities and provided with employment opportunities related to the restoration projects, fostering a sense of ownership and commitment to the initiative's success. In extending these efforts to other areas, Thailand emphasizes the importance of these factors by developing strategies and policies at both the national and agency level, accompanied by detailed action plans. The private sector also played a crucial role in supporting forest restoration, particularly through financial contributions linked to voluntary greenhouse gas reduction projects that comply with Thailand's standards for forestry and green areas.

Acknowledgement

- The Royal Project Foundation, Royal Agricultural Station Angkhang
- Kasetsart University, Faculty of Forestry
- Biodiversity-Base Economy Development Office (BEDO)
- APFNet-KTC

THANK YOU

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Organization : Forestry Research Center,
Faculty of Forestry,
Kasetsart University

Rehabilitation and Management of a Thailand Community Forest

Siriluck Thammanu
Royal Forest Department
Thailand

APFNet Workshop on Degraded Forest Rehabilitation and Management in Asia-Pacific Region
13 - 17 August 2024, Kunming/Puer City, China

Contents

Royal Forest Department (RFD) Background

- Establishment: 1896 by King Rama V
- Responsiliblity: forest reserves outside protected areas
- Area: 1,221 national forest reserve areas (23,438,870 ha)
- Ministry: Natural Resources and Environmen
- Director-General: Surachai Achalaboon

Vision

"It is an organization that focuses on preserving existing forests, increasing new forests, caring for people based on innovation and good governance"

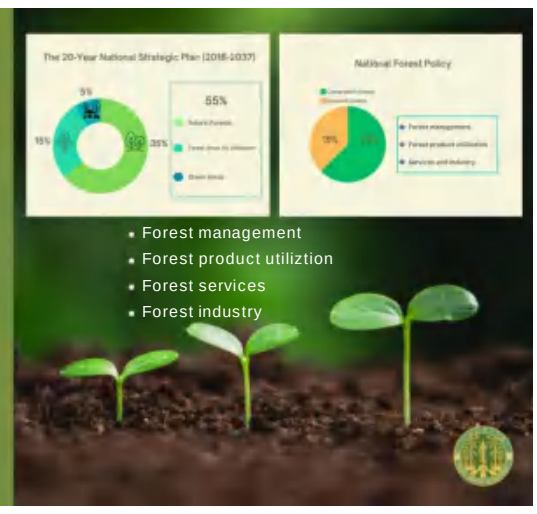
Mission

1. The 20-Year National Strategic Plan (2018-2037)

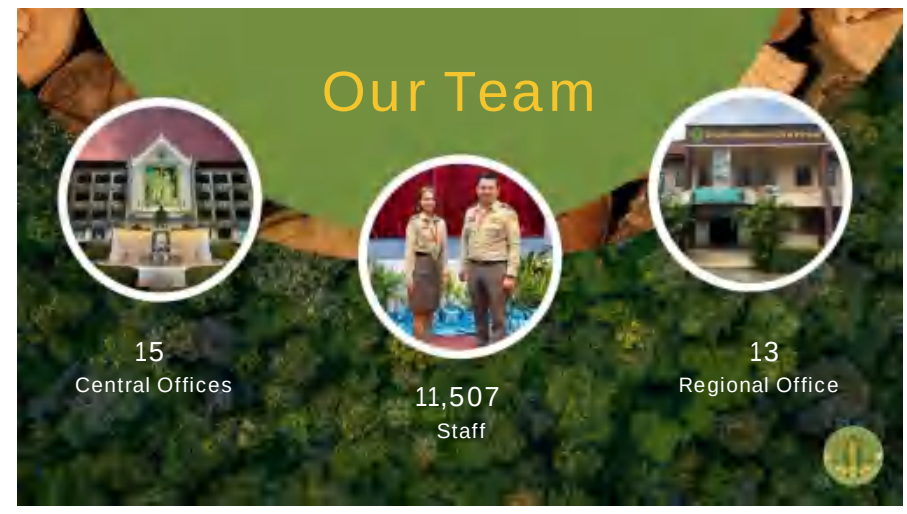
Green areas 55%

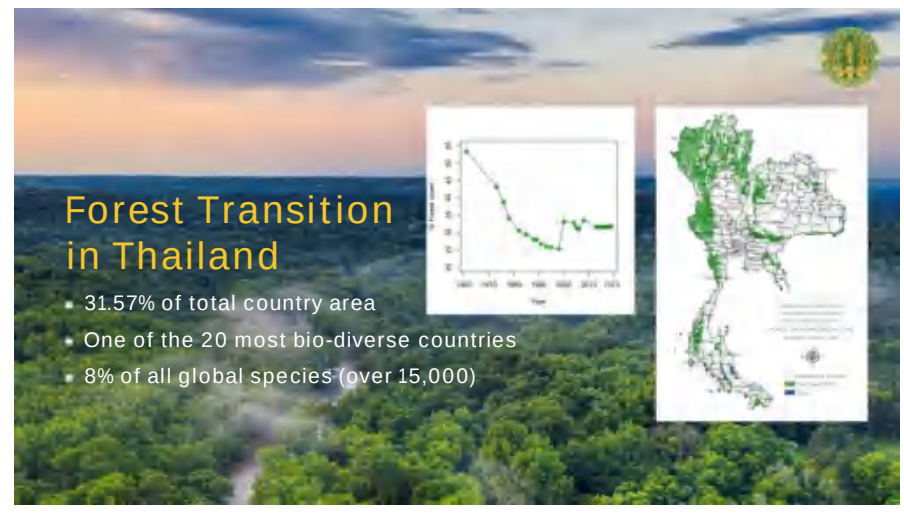
2. National Forest Policy (2019)

Forest areas 40%



Our Team



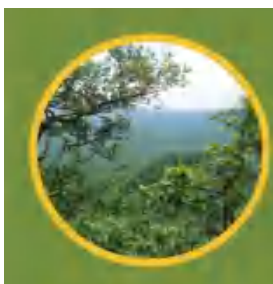


Thailand national forest reserve area encroachment and illegal logging, 2015-present

year	Encroachment			Illegal logging		
	# of cases	# of offenders	Area impacted (ha)	# of cases	# of offenders	Volume (m3)
2015	3,637	893	23,661.55	4,055	1,656	6,808.78
2016	3,298	721	17,336.52	3,527	1,344	6,581.76
2017	2,303	516	8,417.78	2,880	1,217	5,000.17
2018	1,855	391	7,869.27	2,844	1,158	5,737.69
2019	1,762	357	7,898.24	1,589	662	3,485.37
2020	2,236	493	7,279.22	1,205	590	2,998.78
2021	1,906	408	3,030.99	1,320	803	4,269.21
2022	1,523	358	3,266.30	1,089	596	3,136.86
2023	1,659	457	2,339.02	1,062	606	4,089.95
2024	1,305	308	2,621.26	777	383	2,784.51
Total	21,484	4,902	83,720.14	20,348	9,015	44,893.08

m3 = cubic meter
Source: Forest Protection and Forest Fire Control Office, Royal Forest Department (2024)

Concept of CFM



- 1/3 of all forests under CFM
- CFM: - restoring degraded forests
  - local needs/income/poor
- Thailand: Community Forest Act B.E. 2562 (2019)

Sustainable CFM

- Social benefits
- Economic benefits
- Environmental benefits

Section 50: A community forest can be divided into areas for conservation and/or utilization (not to exceed 40%).

Our Goals

The Royal Forest Department aims to establish 1.6 million ha of community forests in 15,000 villages in accordance with the 20-Year National Strategic Plan (2018-2037).

CFM in Thailand

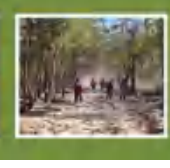
Number community forests established under the Community Forest Act 2019

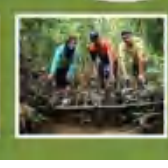
Region	Number of villages	Number of projects	Area (ha)	(%)
North	4,688	4,242	682,223.73	68.46
Northeast	6,115	4,990	195,373.75	19.61
Central	1,184	1,157	85,794.39	8.61
South	814	804	33,114.88	3.32
Total	12,801	11,193	996,506.75	100.00

Source: Community Forest Management Office, Royal Forest Department (2024)

CFM Implementation

- Survey and alignment
- CFM planning
- Plantation and weed control
- Forest patrols
- Forest fire prevention and control
- Building check dams
- Forest culture and tradition



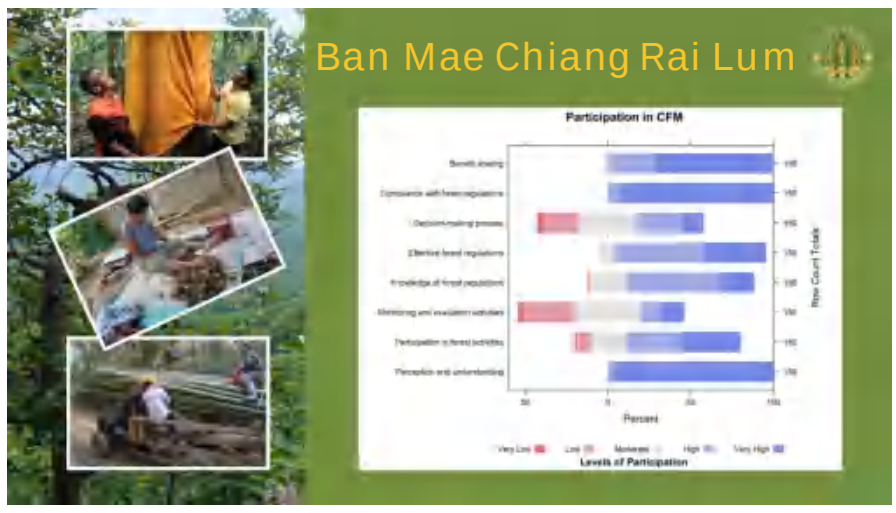


A Project of Forest Rehabilitation

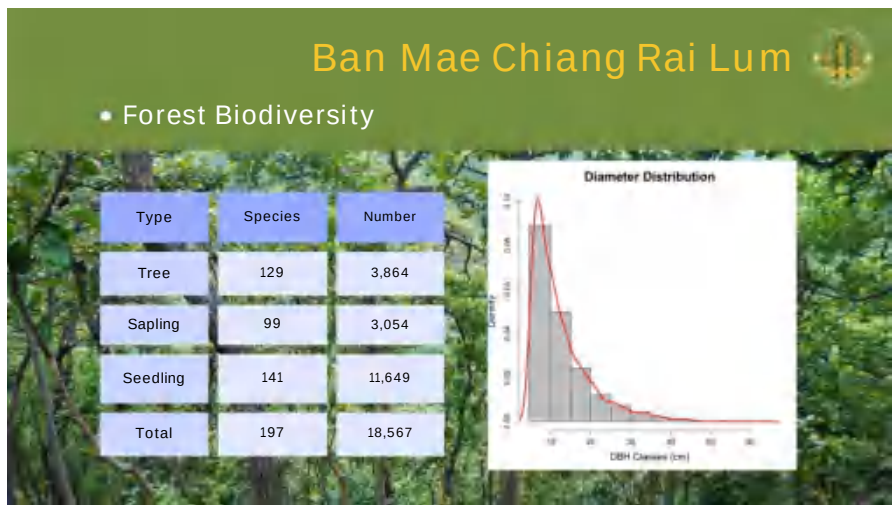
Ban Mae Chiang Rai Lum

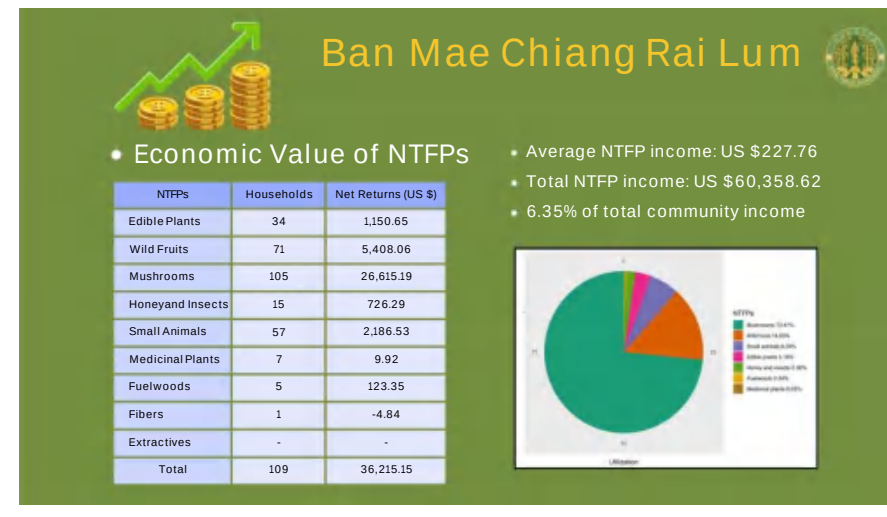
Community Forest: 3,925 ha

Community: 265 households

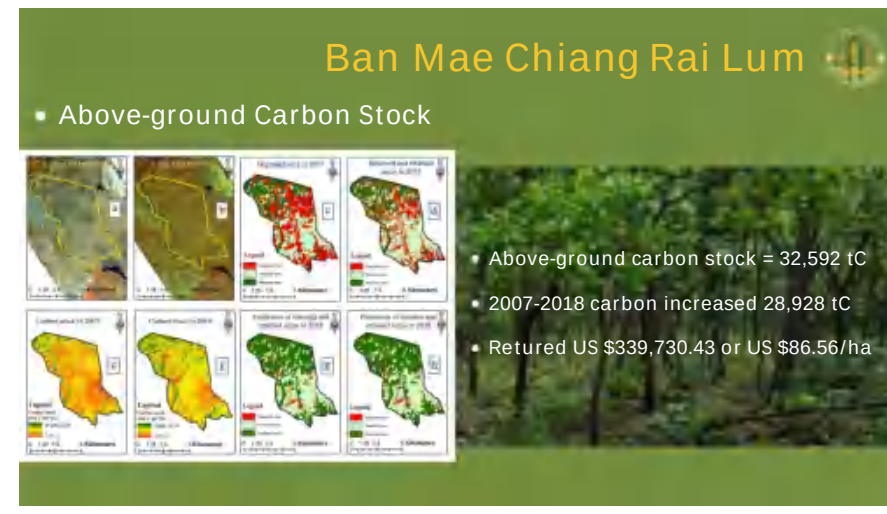

Ban Mae Chiang Rai Lum
Participation in CFM
Row Count Totals
Percent
Levels of Participation


Ban Mae Chiang Rai Lum
Ecosystem Services
Provisioning
Regulating
Cultural
Row Count Totals
Percent
Levels of Satisfaction


Ban Mae Chiang Rai Lum
Forest Biodiversity
Type
Species
Number
Tree
129
3,864
Sapling
99
3,054
Seedling
141
11,649
Total
197
18,567
Diameter Distribution
DBH Classes (cm)


Ban Mae Chiang Rai Lum
Economic Value of NTFPs
NTFPs
Households
Net Returns (US $)
Edible Plants
34
1,150.65
Wild Fruits
71
5,408.06
Mushrooms
105
26,615.19
Honeyand Insects
15
726.29
Small Animals
57
2,186.53
Medicinal Plants
7
9.92
Fuelwoods
5
123.35
Fibers
1
-4.84
Extractives
-
-
Total
109
36,215.15
Average NTFP income: US $227.76
Total NTFP income: US $60,358.62
6.35% of total community income


Ban Mae Chiang Rai Lum
Above-ground Carbon Stock


Ban Mae Chiang Rai Lum
Above-ground Carbon Stock
Above-ground carbon stock = 32,592 tC
2007-2018 carbon increased 28,928 tC
Retured US $339,730.43 or US $86.56/ha

Lessons Learnt

- Management practices can provide social, economic and environmental benefits and assist in meeting basic needs.
- Uncertain land boundaries are problematic and cause conflicts.
- The funding, knowledge, skill and technologies required for rehabilitative success are lacking.
- All management efforts and policies need to be monitored for effectiveness and modified as needed.
- Sustainable forest management requires collaboration from all sectors.

Positive Change and the Way Forward

- One Map to enhance land management efficiency
- Financial support/equipment/training
- Collaboration is pivotal to successful forest management

Contact Us!

https://scholar.google.com/citations?user=H6zh8jwAAAAJ&hi=en

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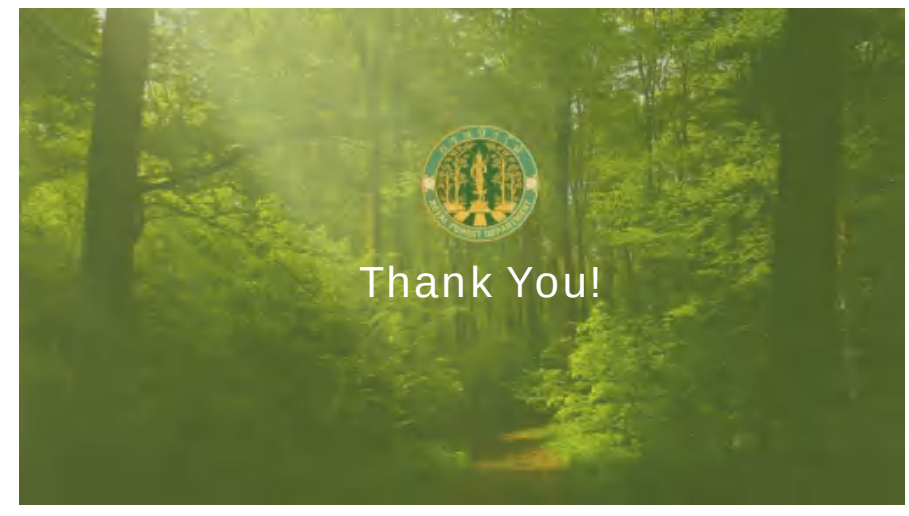


Thank You!

MANAGEMENT AND CONSERVATION OF FORESTRY IN VIET NAM

Dr. NGUYEN PHUC THO
DEPARTMENT OF FORESTRY
MINISTRY OF AGRICULTURE AND RURAL DEVERLOPMENT

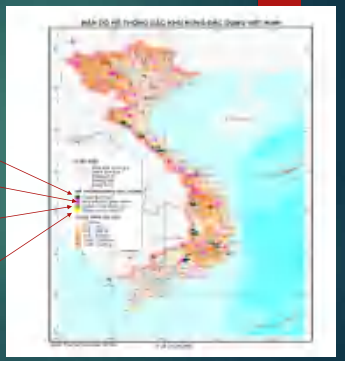
INTRODUCTION

- The Socialist Republic of Vietnam is located in the tropical belt of the northern hemisphere in the Southeast Asian Region. 75% of the land is mountains or hills and extensive coastline with over 3,260 km in length.
- Vietnam experiences a tropical monsoon climate with marked wet season in the south and more temperate weather patterns in the north. Bio-geographycally it is located at the intersection of the Indian, south Chinese and Malayan regions. This has resulted as critical for global conservation with high levels of endenism.

- Result of inventoies of forest in 2022 showed that there are 14,745,201 ha of forest areas in Vietnam, coverage equivalent to 42,02 % of the country. There are more than 10,171 million ha are natural forests and nearly 4,573 million ha of plantation forests.

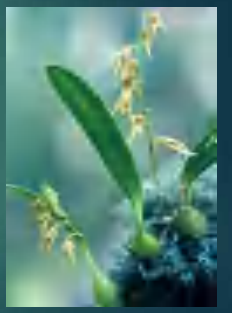
SPECIAL-USE FOREST SYSTEM OF VIET NAM

1. National Parks
2. Nature Conservation
3. Scientific research and experiment forests
4. Landscape Protection Areas



The classification protected areas

- Before 1977 protected forest is the only category of nature conservation
- After the Forest Reclassification project, forest was classified into 03 types:
  - Special-use forest
  - Protection forest
  - Productive forest
- The Special-use forest cover approximately 2,5 millions ha, making up over 7% of total land.



Forest classification:

1. Special Use Forest (Protected Area): use mainly for conservation of nature, speciesments of the national forest ecosystems and forest biodiversity resources; for scientific research; protection of historical and cultural relics as well as landscapes; in service of recreation and tourism, contributing to environmental protection.

a. National Parks

b. Nature Conservation areas including:

(i) Nature Reserves and

(ii) Species/habitat Conservation areas

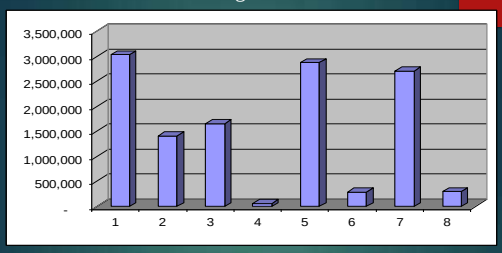
c. Landscape Protection Areas (including forests of historical or cultural relics as well as scenic landscapes)

d. Scientific research and experiment forests

2. Protection Forests: use mainly to protect water sources and land, prevent erosion and desertification, restric natural calamities and regulate climate, thus contributing to environmental protection.
a. Watershed protection forest
b. Win and sand shielding protection forest
c. Protection forests for tide shielding and seacoast protection
d. Protection forests for environmental protection

3. Production Forests: use mainly for production and trading of timber and non-timber forest products combination with protection, contributing to environmental protection.
a. Natural production forests
b. Planted production forests
c. Seeding forests, including the selected and recognized planted forests and natural forests

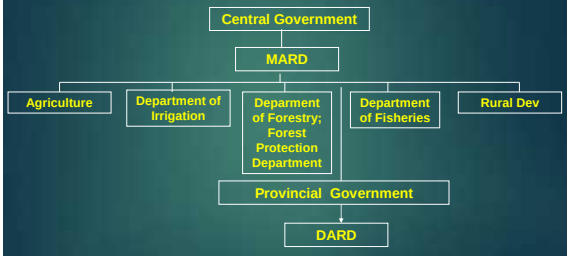
Forest Management



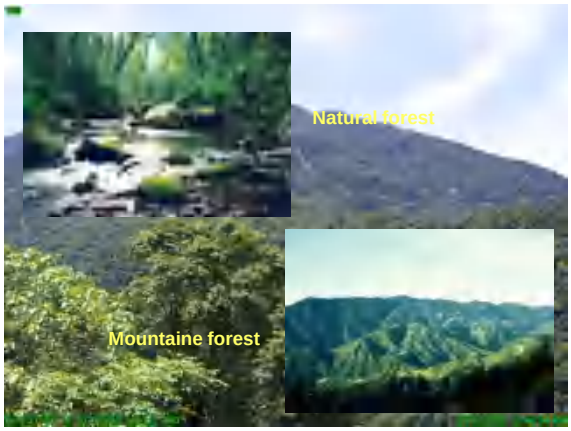
1. State Enterprise
2. Forest Protection Management Board
3. Special use Forest Management Board
4. Private Company
5. Houlshold
6. Community
7. Local Authority
8. Other sectoral

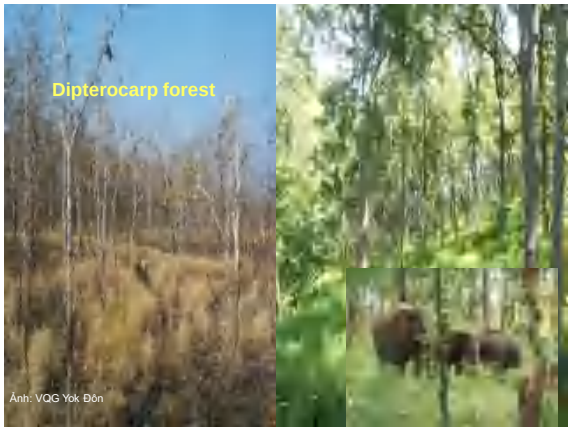
Ministry of Agriculture and Rural Development (MARD)

ORGANIZATION AND STRUCTURE



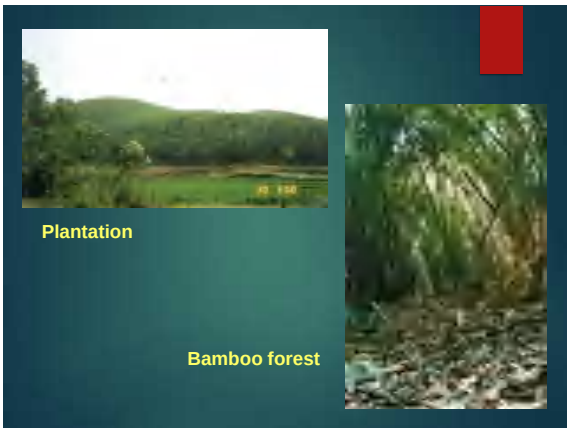
Diversity of terrains and ecosystems



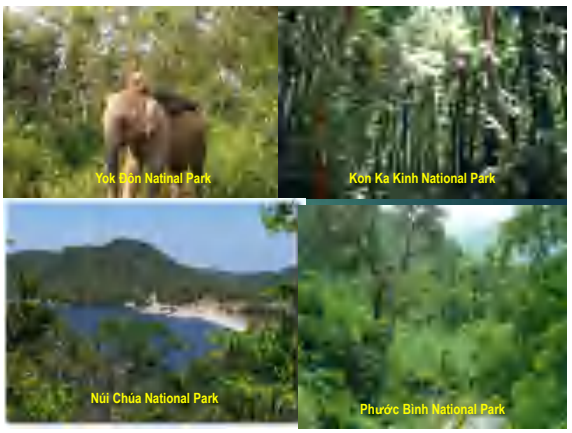

Dipterocarp forest
Ảnh: VQG Yok Đôn


Wetland


TYPICAL ECOSYSTEMS
Marine


Plantation
Bamboo forest


Tam Đao National Park
Ba Be National Park
Cat Ba National Park
Bái Tử Long National Park


Yok Đôn Natinal Park
Kon Ka Kinh National Park
Núi Chúa National Park
Phước Bình National Park


Bù Gia Mập National Park
Cát Tiên National Park
Côn Đảo National Park
Lò Gò – Xa Mát National Park


U Minh Thượng National Park
Phú Quốc National Park
Tràm Chim National Park


U Minh Hạ National Park
Mũi Cà Mau National Park


Cúc Phương National Park
Ba Vì National Park
Xuân Thủy National Park


PHONG NHA- KE BANG
NATIONAL PARK

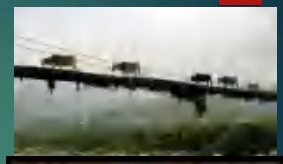

Forestry Genetic Resources

Forestry Genetic Resources

- According to an inventory by the Forest Inventory and Planning Institute (FIPI), Vietnam has about 12,000 plant species, of which about 1000 are known to be endemic. Some 354 tree species are regarded as commercially important with over 50 species providing high-quality timber.

Genetic Diversity

- More than 90 plant species used for food, more than 100 species of fruit trees



Management and Conservation of Forestry Genetic Resources

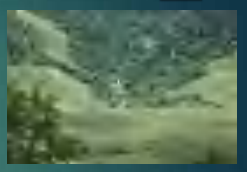
- In situ genetic conservation
- By establishing special - use forest system in protected areas systems

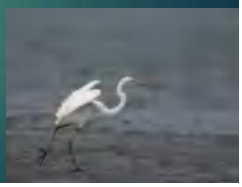
Protected areas system

Protected areas management

Responsibility for nature conservation

- Forest and terrestrial species - Ministry of Agriculture and Rural Development
- Wetland – Ministry of Natural Resources
- Marine and aquatic – Ministry of Agriculture and Rural Development





Current protected areas

Categories	Number	Area (ha)			
		Natural area	Forest	Non-forest	Water surface
I. National Park	34	1,277,519	1,108,844	59,782	108.893
II. Nature Conservation Area	70	1,198,148	938,602.69	259,546	0,0
IIa. Nature Reserve	56	1,129,726			0,0
IIb. Species/Habitat Area	14	68,422			0,0
III. Land/Scape Area	54	88,890			0,0
IV. Experimental Forest Areas	9	10,838			0,0
Total number	**167**	**2,575,395**			**108,893**

LEGISLATION

- Forest Law;
- Biodiversity Law;
- Decree No.156/2018/ND-CP of the Vietnamese Government on the guidance of the implementation of Forest Law; (Below the Decree, there are also guiding circulars signed and issued by the Minister of Agriculture and Rural Development).
- Decision No. 1976/QD-TTg, October 30, 2014 of the Prime Minister on approving the planning of the special-use forest system until 2020, with a vision to 2030
- Decision No. 523/QD-TTg, April 1, 2021 of the Prime Minister approving the Vietnam forestry development strategy for the period of 2021-2030, with a vision to 2050.
- Decree No. 65/2010/ND-CP Vietnamese Government on the guidance of the implementation of some articles of Biodiversity Law.

Vietnam Forestry Development Strategy 2021 -2030

- Strictly manage and protect existing natural forest areas; restore and improve the quality of natural forests to conserve biodiversity, use and provide forest environmental services, of which:
- a. For special-use forests: ensure harmony between biodiversity conservation, protect endangered, precious and rare forest animals and plants and develop eco-tourism and resorts;
- b. For protection forests and production forests, which are natural forests, focus on forest protection, development of forest environmental services and development models of non-timber forest products and agroforestry; Carry out activities to reduce greenhouse gas emissions through limiting forest loss and degradation; conserve and enhance carbon stocks and sustainably manage forest resources (REDD+).

Vietnam Forestry Development Strategy 2021 -2030

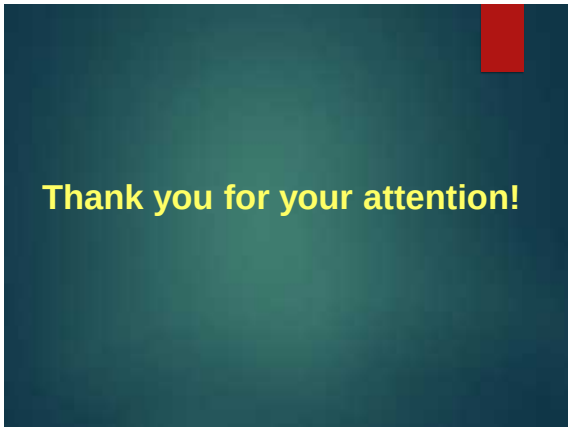
- Minimize conversion of natural forest use to non-forestry purposes; Complete the land allocation, forest allocation, and forest lease associated with the issuance of forestry land use rights certificates, ensuring that all forest and land areas planned for forestry development must be allocated and leased to the following areas: true forest owner; ensure sufficient conditions to organize forest management, protection and sustainable development of forest resources.

Vietnam Forestry Development Strategy 2021 -2030

- Promote the connection between conservation and development with the active participation of stakeholders in forest management such as: building models that engage local communities to participate and share equitable benefits in the work. manage special-use forests and protection forests through an adaptive collaborative management approach to increase the level of participation of local communities, reduce conflicts and improve management efficiency; Promote certification of sustainable forest management;

Vietnam Forestry Development Strategy 2021 -2030

- Strengthen forest governance capacity for forest owners through establishing a forest resource monitoring and evaluation system; Promote the application of remote sensing technology, geographic information system (GIS), and information technology in forestry industry management; investigation and assessment of national forest resources; develop community forestry, associated with traditional cultural identity, taking people as the center.
- Improve the capacity of forest owners to effectively manage, protect and develop forests. By 2030, 100% of forest owners will be organizations with sufficient capacity to monitor, supervise and manage forest resources and prevent fires. , fighting forest fires.


Thank you for your attention!

APFNet Workshop

DEGRADED FOREST REHABILITATION AND MANAGEMENT IN ASIA-PACIFIC REGION

Assessing Forest Rehabilitation and Solutions: A Case Study of Dong Nai Biosphere Reserve and Kon Chu Rang Natural Reserve in Vietnam

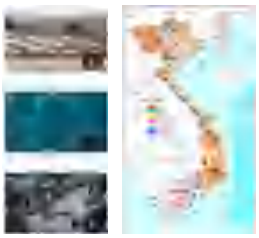
Presentator: Dr Nguyen Trọng Minh
Vietnam National University of Forestry
Email: minhnt@vnuf.edu.vn

-China, 2024-

CONTENTS

1. GENERAL INFORMATION

- Vietnam is located in Southeast Asia: diverse landscapes, including mountains, forests, and coastal areas.
- GDP Growth: GDP per capita increased to nearly $3,700 in 2023[1].
- Viet Nam is one of the world's 16 most biologically diverse countries: ~ 20,000 plants, 10,500 terrestrial animals, 2,000 invertebrates and freshwater fish, and over 11,000 marine species[2].



[1] Overview: Development news, research, data | World Bank
[2] https://vietnam.panda.org/7370898/Report-on-Viet-Nam-biodiversity-outlook-analysing-impacts-from-economic-sectors-to-address-biodiversity-degradation

FOREST AND FORESTRY

- The Government of Vietnam considers forests an important ecological resource, valuable for the socio-economic development and well-being of communities throughout the country.

FOREST AND FORESTRY

- **Economic Contributions**

GDP Contribution: accounted for approximately 11.96% of Vietnam's GDP[3].

Job Creation: Around 25 million Vietnamese people derive a significant portion of their income from forest-related activities[4].

- **Environmental Benefits**

Biodiversity: contributing to the country's rich biodiversity.

Climate Regulation: mitigating the effects of climate change.

Water Cycle Maintenance: preventing soil erosion, and reducing the risk of floods.

[3] Vietnam: GDP contribution of agriculture, forestry and fishing sector 2023 | Statista
[4] https://vietnam.opendevelopmentmekong.net/topics/forest-and-forestry/

FOREST AND FORESTRY

- CHALLENGES

Deforestation: Despite efforts to increase forest cover, deforestation remains a challenge due to agricultural expansion, infrastructure development, and illegal logging.

Forest Degradation: Forest degradation due to unsustainable practices and natural disasters also poses a significant threat.

2. DEFORESTATION AND DEGRADATION FOREST , AND REHABILITATION IN VIETNAM

- 2.1. DEFORESTATION AND DEGRADATION FOREST

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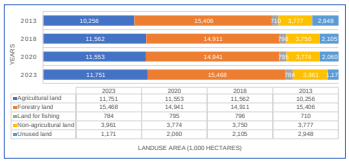


Fig. 01. Land use changes between 2013 – 2023 in Vietnam.

- Agricultural and non-agricultural land areas expanded, while unused land significantly decreased.
- Converting forestry land to agricultural production, transforming agrarian areas into urban zones and industrial sites, replacing mangroves with aquaculture, and afforesting barren land and hills

2. DEFORESTATION AND DEGRADATION FOREST , AND REHABILITATION IN VIETNAM

- 2.1. DEFORESTATION AND DEGRADATION FOREST

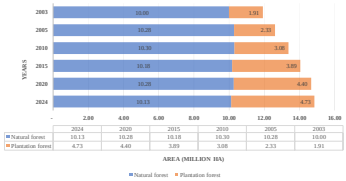


Fig. 02. Forest types in Vietnam between 2003 and 2024

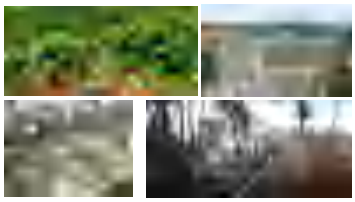
- Forest cover: 14.83 million ha (2024).
- Between 2015 and 2020, Vietnam experienced deforestation at a rate of 1.59 thousand ha/yr, and the total area of humid primary forest decreased by 11%.

2. DEFORESTATION AND DEGRADATION FOREST , AND REHABILITATION IN VIETNAM

- 2.1. DEFORESTATION AND DEGRADATION FOREST

KEY DRIVE

- ❖ Forest land conversion.
- ❖ Unsustainable logging practices
- ❖ Forest fires
- ❖ Climate change: Natural disasters and weak forest protection policies.



2. DEFORESTATION AND DEGRADATION FOREST , AND REHABILITATION IN VIETNAM

- 2.2. FOREST REHABILITATION

- ❖ Approximately 2 million ha of natural forests have undergone rehabilitation through national forest rehabilitation programs.
- ❖ Rehabilitation approaches: enrichment planting, assisted natural regeneration, introduction of native species into production and protection forests, and additional soil and water conservation measures.

2. DEFORESTATION AND DEGRADATION FOREST , AND REHABILITATION IN VIETNAM

- 2.2. FOREST REHABILITATION

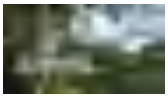
POLICIES AND LAWS

The Vietnamese government has implemented various policies and strategies to promote sustainable forest management.

- ❖ Decision 2242/2014/QD-TTG
- ❖ The 2017 Forestry Law
- ❖ The Payment for Forest Environmental Services (PFES).
- ❖ The National REDD+ program

- ✓ To modernize the forest sector, ensure sustainability, and enhance the well-being of local communities.
- ✓ To provide crucial sources of financing for forest owners and local communities, enhancing biodiversity conservation.
- ✓ Benefit sharing.

2. DEFORESTATION AND DEGRADATION FOREST , AND REHABILITATION IN VIETNAM



Forest rehabilitation measures are relatively systematic and well-defined, guided by technical regulations and scientific foundations.

- Overlooking the significant influence of site factors (topography, soil conditions, microclimate) on the selection of silvicultural techniques for forest rehabilitation.
- There is a lack of extensive research that systematically validates the accurate and effective application of silvicultural methods to specific forest types through experimental models.
- The lengthy growth cycles of forestry species limit the project duration.

3. CASE STUDY IN DONG NAI BIOSPHERE RESERVE AND KON KA KINH RESERVE

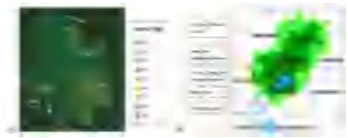
3.1. RESEARCH INFORMATION

Research in Dong Nai Biosphere Reserve	Rehabilitation Solutions in Kon Ha Nung Biosphere Reserve
The project has developed criteria for assessing the degree of forest rehabilitation, and alignment with the standpoint of living in harmony with nature.	This research project adopts a landscape-based approach to natural forest rehabilitation. The overarching objective is to achieve effective and sustainable landscape restoration while enhancing livelihoods.

3. CASE STUDY IN DONG NAI BIOSPHERE RESERVE AND KON KA KINH RESERVE

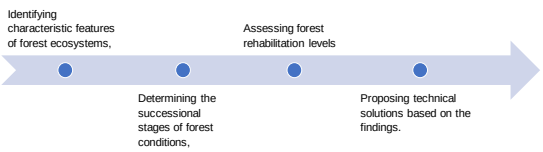
3.1. RESEARCH INFORMATION

- The Dong Nai Biosphere Reserve (DNBR) was established in 2011, covering a total area of 173,073 hectares.
- The Kon Chu Rang Nature Reserve (KCR), located in Kon Ha Nung Biosphere Reserve recognized by UNESCO at the 33rd session, encompasses an area of 719 km^2,



3. CASE STUDY IN DONG NAI BIOSPHERE RESERVE AND KON KA KINH RESERVE

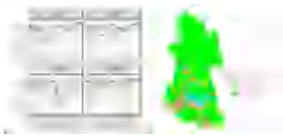
3.2. RESEARCH METHODS AND WORKFLOW



3. CASE STUDY IN DONG NAI BIOSPHERE RESERVE AND KON KA KINH RESERVE

3.3. RESEARCH RESULTS

Forest status, successional stages of forest and main reasons for deforestation and forest degradation



NDVI changes by time for DNBR (a) and map of forest deforestation and degradation for KCR (b).

The NDVI-based classification.

The classification map for successional stages, forest status, and the planning forest map provides valuable data to assist managers of both forest boards at the macro level.

3. CASE STUDY IN DONG NAI BIOSPHERE RESERVE AND KON KA KINH RESERVE

3.3. RESEARCH RESULTS

Forest status, successional stages of forest and main reasons for deforestation and forest degradation

MAIN REASONS FOR DEFORESTATION AND FOREST DEGRADATION

Policies and Institutional Frameworks:

- Community forest management models are underutilized, and management mechanisms lack robustness.
- Communities often don't actively engage in forest protection, and residents face challenges related to land use rights.
- Benefits sharing was unclear.

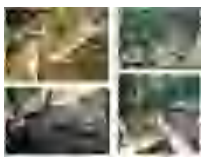
3. CASE STUDY IN DONG NAI BIOSPHERE RESERVE AND KON KA KINH RESERVE

3.3. RESEARCH RESULTS

Forest status, successional stages of forest and main reasons for deforestation and forest degradation

MAIN REASONS FOR DEFORESTATION AND FOREST DEGRADATION

Timber Exploitation: The illegal logging is still occurring.



- Commonly in protected and production forests.
- Reasons:
  Lacking fund.
  Poverty.
  Local people, communities did not assigned to protect the forest.

3. CASE STUDY IN DONG NAI BIOSPHERE RESERVE AND KON KA KINH RESERVE

3.3. RESEARCH RESULTS

Forest status, successional stages of forest and main reasons for deforestation and forest degradation

MAIN REASONS FOR DEFORESTATION AND FOREST DEGRADATION

Non-Timber Forest Product Exploitation and Other Impacts: firewood collection, hunting, and honey harvesting.

- The ethnic minorities do not typically engage in agricultural practices or livestock rearing within their households



3. CASE STUDY IN DONG NAI BIOSPHERE RESERVE AND KON KA KINH RESERVE

3.3. RESEARCH RESULTS

Forest status, successional stages of forest and main reasons for deforestation and forest degradation

MAIN REASONS FOR DEFORESTATION AND FOREST DEGRADATION

- Encroachment on Forest Land for Shifting Cultivation.
- Negative Impacts on Indigenous Tree Plantations: reliance on intercropped trees without alternative income sources, a lack of technical knowledge.
- Indirect Causes Contributing to Forest Resource Decline: Population growth, Environmental pollution, Lax enforcement of forest protection laws and insufficient financial support...

3. CASE STUDY IN DONG NAI BIOSPHERE RESERVE AND KON KA KINH RESERVE

3.3. RESEARCH RESULTS

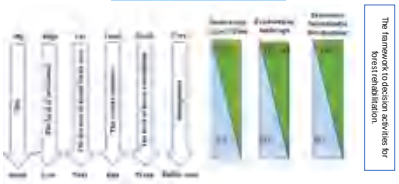
Criteria for assessing the degree of forest rehabilitation

3. CASE STUDY IN DONG NAI BIOSPHERE RESERVE AND KON KA KINH RESERVE

3.3. RESEARCH RESULTS

Management, Restoration, and Conservation Solutions

SOLUTIONS FOR NATURAL FORESTS



The framework for restoration activities for forest rehabilitation.

3. CASE STUDY IN DONG NAI BIOSPHERE RESERVE AND KON KA KINH RESERVE

3.3. RESEARCH RESULTS

Management, Restoration, and Conservation Solutions

SUSTAINABLE MANAGEMENT OF INDIGENOUS TREE PLANTATIONS

Strengthening support from agricultural and forestry extension officers is crucial for knowledge transfer related to sustainable cultivation techniques.

SUSTAINABLE MANAGEMENT OF INDIGENOUS TREE PLANTATIONS

Prioritize protection through patrols and monitoring for small, high-value conservation forests. For larger areas, immediate measures involve strengthening supervision by forest officers.
Long-term solutions include improving the socio-economic livelihoods of communities living near forests and enhancing community-based forest management.

3. CASE STUDY IN DONG NAI BIOSPHERE RESERVE AND KON KA KINH RESERVE

3.3. RESEARCH RESULTS

Management, Restoration, and Conservation Solutions

SOLUTIONS IN ECONOMIC, CULTURAL, SOCIAL, AND INSTITUTIONAL CONTEXTS

- Implementing community-based forest management models.
- Creating income opportunities for locals.
- Supporting livestock and crop models to provide food security for ethnic minority communities and reduce pressure on forest resources.
- Organizing training workshops on technical skills, business knowledge, market access, and etc.
- Facilitating business development to generate employment opportunities, especially for young laborers from ethnic minority households.

3. CASE STUDY IN DONG NAI BIOSPHERE RESERVE AND KON KA KINH RESERVE

3.3. RESEARCH RESULTS

Suggestions

LONG-TERM MONITORING

- Establishing a system of fixed sample plots allows continuous, long-term monitoring. This approach ensures robust results by tracking and assessing research outcomes over time.
- Investment from diverse sources (including non-governmental organizations, biosphere reserve management boards, and national parks) is crucial for sustained monitoring efforts.

3. CASE STUDY IN DONG NAI BIOSPHERE RESERVE AND KON KA KINH RESERVE

3.3. RESEARCH RESULTS

Suggestions

ADDRESSING POLICY CHALLENGES

- Research should identify existing policy gaps hindering economic development and sustainable forest management.
- Propose strategic policy directions for economic development in different regions, considering socio-economic livelihoods and community-based forest management.

COLLABORATION WITH STAKEHOLDERS

- Engage relevant stakeholders to leverage and replicate successful socio-economic characteristics that promote harmony between forests and human activities.

4. CONCLUSION

- The complex interplay of socio-economic factors, policy decisions, and environmental dynamics influences the trajectory of forest cover change. While poverty reduction, forest conservation, governance improvement, and population control are of paramount importance, a comprehensive approach is essential.
- No single solution can effectively address deforestation and degradation thus policymakers must address multiple issues simultaneously. Despite efforts, these processes persist in diverse ways, varying across regions and changing over time.
- Understanding the approximate drivers is crucial for sustainable forest management.
- Long-term monitoring, policy evaluation, community engagement, and knowledge transfer are key imperatives.

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Thank you for your attention

A SWOT Analysis

Institutional arrangements in forest rehabilitation and management

What is SWOT Analysis?

SWOT Analysis is a powerful tool introduced by an American business and management consultant Albert S. Humphrey in the 1960s and 1970s.

It helps organizations and individuals assess their current situation by analysing four key elements:

- Strengths: Internal attributes and resources that support a successful outcome.
- Weaknesses: Internal factors that could hinder success.
- Opportunities: External factors the organization could exploit to its advantage.
- Threats: External factors that could cause trouble for the organization.

What is SWOT Analysis?

A SWOT analysis provides a structured way to identify the key factors that can impact on success.

Its role is to help organizations to develop strategies that use their strengths and opportunities to their advantage while reducing their weaknesses and threats.

However, it's important to note that SWOT analysis is just one tool in a broader strategic planning toolkit. To ensure a comprehensive approach, it should be used in combination with other strategic analysis tools and frameworks.

Uses of SWOT analysis

- Strategic Planning - To identify an organization's internal strengths and weaknesses, and external opportunities and threats.
- Competitive Analysis - To understand an organization/company's position in the market relative to competitors.
- Product Development - To evaluate the strengths and weaknesses of a new product idea, as well as the opportunities and threats in the market.
- Problem-Solving - To analyse a specific problem by understanding internal and external factors that contribute to it.
- Personal Development - To identify personal strengths and weaknesses, as well as opportunities for growth and potential challenges.

SWOT analysis for an organization

- Strengths – the areas where the organization excels or has a competitive advantage over others.
- Weaknesses – the areas that put the organization at a disadvantage. These are the areas where the organization needs to improve or faces challenges that may affect its performance.
- Opportunities – external factors that the organization can take advantage of to grow.
- Threats – external factors that may constitute a risk or challenge.

SWOT Matrix

Dos and Don´ts in SWOT analysis

- Dos
  1. Involve a diverse team
  2. Be honest and objective
  3. Focus on specifics
  4. Prioritize key points
  5. Align with objectives
  6. Analyse the interconnections
  7. Consider both short-term and long-term perspectives
  8. Keep it actionable
  9. Regularly update the SWOT analysis
  10. Use data and evidence

Dos and Don´ts in SWOT analysis

- Don´ts
  1. Don't confuse internal and external factors
  2. Don't be overly optimistic or pessimistic
  3. Don't ignore minor details
  4. Don't overcomplicate the analysis
  5. Don't focus solely on the present
  6. Don't neglect to validate assumptions
  7. Don't work in isolation
  8. Don't forget to monitor competitors
  9. Don't skip the action plan
  10. Don't use SWOT as the sole tool

APFNet Workshop on
Degraded Forest Rehabilitation and Management in Asia-Pacific Region
18-27 August, 2024 Yunnan Province, China

GROUP DISCUSSION

A SWOT analysis in institutional arrangement in forest rehabilitation and management

23 August 2024
APFNet Kunming Training Center

Outlines

- Evolution and change of institutional arrangements for sustainable management of land and forests.
- Practice on strengths, weaknesses, opportunities and threats of the different institutional arrangements.

Background

- Institutions form the very basis of collective actions of a society.
- As the larger socio-political and economics changes take place, institutions have to continuously adapt and change.
- There are a wide array of institutional arrangements that address different aspects of management of natural resources, including arresting degradation and taking up restoration.
- To effectively address deforestation and forest degradation, it is essential to examine how a society to accomplish these through its various institutions.

Institutions involved in land management

Broadly institutions involved in land management, including forest rehabilitation, can be roughly grouped into two groups:

1. **Directly involve in implementing restoration/rehabilitation on the ground.**
2. **Provide a wide range of support service.**

Various forms of Institutions

Public Sector Forestry Organizations	Farmers/Land owners	International Organizations
Industries and Corporate Investors	Community organizations	Civil Society Organizations

Evolution of institution arrangements

- Institutions have emerged, grew and declined over time. However many traditional institutions were unable to handle complex internal and external changes, as a result they are replaced by new forms of institutions.
- In most developing settings of the Asia-Pacific region, public sector forestry organizations broadly play functions in terms of regulatory function, directly undertaking restoration works as well as facilitation role.
- Traditional public sector forestry organizations faced a number of challenges and required to be evolved over a period of time.
- In recent years, public sector forestry departments have been performing is increasingly shifting to other organizations:

Functions of public sector forestry organizations	
1. Wood production	• Small holders • Corporate investors
2. Production of wood and other products for local community needs	• Community organizations
3. Provision of environmental services	• Public sector agencies • Local communities • Civil society organizations

Practice on a SWOT analysis of institutional arrangements in forest rehabilitation

- Grouping into 3 groups;
- Each group to undertake a SWOT analysis of one of the following:
  a) Government forest departments;
  b) Local community organizations;
  c) Large corporate players.

STRENGTHS	WEAKNESSES
OPPORTUNITIES	THREATS

APFNet Workshop on
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Management in Asia-Pacific Region

SWOT of the Government Forest Department

Group 1

- Teamhy SIEN, cambodia
- Nabilah Hamidah Sabar, Malaysia
- Siriluck Thammanu, Thailand
- B A K C Bamunusinghe, Sri Lanka

18-27 August, 2024 YUNNAN PROVINCE

Strengths	Weaknesses
1. Regulatory authority-provide direction, legitimation power 2. Budget, funding- provide support for rehabilitations 3. Expertise-experience skills officers, human resources capacity 4. Resources allocation-equipment, infrastructures, vehicles, resource mobilization 5. Implementing power 6. Collaboration and partnership with inter-agencies/development partners 7. Synchronization of operation inter-agency 8. Capability to monitor and evaluate – have the authority to access the data/information 9. Offices/officers throughout the country	1. Follow the government policies/political interference 2. Insufficient staff to monitor large area of forest 3. Conflict of policies of other department agency (e.g. Agriculture) 4. Possibility of corruption 5. Budget constrains 6. Time consuming to amend or update any policies 7. Lack of public engagement 8. Inadequate training
Opportunities	**Threats**
1. Policy innovation 2. Fund support from national and international 3. Cooperation at all levels (e.g. capacity building, etc.) 4. Global awareness on CC issue/SDG commitment 5. Strengthening livelihood of the communities 6. Emerging of new technologies and innovations 7. Public engagement-private sectors interest 8. Technology integration	1. National policies influence 2. Geopolitical influences 3. Economic pressure 4. Funding limitation from the other relevant institutions/NGOs 5. Negative public perception/lack of public support 6. Possibility Corruption system 7. Climate Change lead to more restrictive forest measures

Thanks you

for

your attention !

SWOT Analysis of institutional arrangement and forest rehabilitation on Local Community Organizations

By: Group 2
Dippanita Bhattacherjee
Nguyen Phuc Tho
Saykham Boutthavong
Yan Myo Naing

SWOT-LCO

Strengths

- Knowledgeable on geography & environmental conditions
- Good relationship inside the community
- Traditional knowledge
- Available human and labor working on rehabilitation
- Trust/ Believes/ Cooperation/ Actively engagement
- Unity/ overcome political pressure
- Resources mobilization
- Negotiation & Priority selections

Weakness

- Limitation knowledge on technical, scientific, policy, legislations
- Limitation skills in management, accounting, proposal preparation, procurement etc
- Limitation knowledge, experience sharing capacity
- Financial insecurity
- Priority selection (LCO interest, individual)
- Resource mobilization (M&E)

SWOT-LCO

Opportunity

- Building community network
- Improving livelihood
- Ecotourism development
- Get knowledge on policy & legislations
- Adopt the new technology
- Influencing in policy and strategies formulations
- Building up market chains
- More funding support
- Gene resources/pools
- Regional and global recognition

Threat

- Funding raising
- Control by the government agencies
- Competition to global market (Carbon,)
- Conflict with other stakeholders on land and resources
- Financial crisis, (inflation rocket jump)
- Natural disasters & climate change
- Pest outbreak
- Forest fires
- Unfavored policy & legislations

Thank you

Institutional arrangements in forest rehabilitation & management: Local corporate player private sector

Asia-Pacific Furniture Corporation Company

Main products:

- Particle board
- Chairs
- Table / Desk
- Bed

Company Location: Jagun, Myanmar

Restoration Site: Nepal

Staff: 10,000

SWOT ANALYSIS

Strengths	Weaknesses
• Big company • Funding/CSR (10%) • Eco-friendly • Decision efficiency • Advance equipment • Human Resources	• Knowledge on forest rehabilitation • Skilled technician on forest rehabilitation • Land for restoration • Dedicated section for forest rehabilitation • Forest Nursery - Seedlings
Opportunities	**Threats**
• Networking to global market • Carbon neutral • Green Employment/Job creation • Cooperation among stakeholders • Expansion of forest cover • Participation in project • Ecosystem improvement • Contribution to regional GDP	• Unsupportive political condition • Conflict with land use • Unwillingness of local people • Policy gap between economies • High tax by govt. • Forest fire, disease, pest • Encroachment • Natural disaster • Other competitive projects

Thank you!

Degraded Forest Rehabilitation: Embracing Collaborative Forest Management Approach in Bangladesh

Dipannita Bhattacherjee

Wildlife and Biodiversity Conservation Officer, Bangladesh Forest Department

Abstract: Bangladesh is a densely populated economy. People depend on the forest for a variety of forest products for food, fodder, agriculture, housing, and an array of marketable minor forest products which can potentially degrade forest if harvested unsustainably. The pattern of collection of these forest products and its impact on local forest determined that local livelihood dependence results in degradation. Increasing income inequality and vulnerability of the poor to shocks such as those from natural disasters, and environmental degradation and unsustainable use of the remaining natural resources are major areas of concern. The urgency of rehabilitating degraded forests has become particularly important in the context of climate change adaptation and mitigation to reduce carbon emission, a significant share of which is contributed by deforestation and forest degradation. Under current management authority the forests of Bangladesh have only been managed for 53 years. At present the forest policy of Bangladesh has turned away from a traditional production premises towards conservation. People's participation recognized as a paradigm shift within forest policy as a requirement in overall forest management. This paper elucidate the collaborative forest management program (a comprehensive program) that has taken by Bangladesh forest department under Sustainable forests and livelihood (SUFAL) project for rehabilitating and reforesting depleted areas including reserved forests and PA's as a new approach of forest management in Bangladesh.

1. Introduction

Bangladesh is a deltaic economy with one of the largest population densities in the world (1119 people per km2) (Statistical Yearbook Bangladesh 2022). The current estimate of 163 million people is expected to grow to 192 million by 2050 (UNDESA 2019). The high density of population has contributed to the intense exploitation and in many cases over-exploitation of natural resources. There has been an overall depletion in forest resources in all the major forests in the last three decades. From 2002 to 2023, Bangladesh lost 8.39 kha of humid primary forest, making up 3.5% of its total tree cover loss in the same time period. (Global Forest Watch-BGD).The contribution of natural resources to livelihoods and the economy is enormous, based mostly on fisheries, agriculture, and forestry. More than 80% of the rural population is directly or indirectly dependent on free access natural resources for subsistence.

2. Forest Resources

The total area of Bangladesh is 14.757 million hectares, of which agricultural land consists of 65% of the geographic surface; of which forest land area of the economy is 2.32 million hectares which accounts for about 15.58% of the total land area. The BFD manages about 1.6 million hectares of forests and which accounts for about 10.74% of the total land area of the economy. The remaining 0.7 million hectares is managed by Ministry of Land represented by the Deputy Commissioners of Chittagong Hill Tracts (CHT) (Totho konika,BFD-2024).

The forests of Bangladesh are broadly classified into (Table -1):-

1) Hill forest, 2) Sal forest, 3) Natural mangrove forest (Sundarbans),4) Coastal afforestation, and 5) Freshwater swamp forest.

Table- 1: Distribution of major forest ecosystem in Bangladesh (Source: GOB.2022)

Forest Ecosystems	Location	Area (million hectares)
Under Management of Forest Department		
Hill Forest	Eastern part extending over Sylhet, Moulvibazar, Habiganj, Ragnamati, Bandarban, Khagrachari, Chittagong and Cox's Bazar	0.664 (29%)
Natural Mangrove (Sundarbans)	South-west in Khulan, Bagerhat and Satkhira	0.602 (26%)
Coastal Afforestation	Along the Coastal zone	0.20 (0.09%)
Sal Forest	Chiefly in the Central region in Gazipur, Tangail, Comilla, Sherpur and Mymensingh. Small patches occur in Dinajpur, Rangpur, Thakurgaon, Naogaon and Panchagarh in the north-west region	0.12 (0.05%)
Fresh water Swamp Forest	Mainly in Sylhet and Sunamganj district in the north-eastern part	0.023 (0.01%)
Managed by Ministry of Land (represented by Deputy Commissioner)		
Hill forest legally termed as Un-classified State Forest (USF)	Chittagong Hill Tract Districts of Rangamati, Khagrachari and Bandarban	0.713 (31%)
	Total	**2.32**

3. State of Deforestation in Bangladesh

Management of forests in Bangladesh was once dominated by sustainable timber harvesting and has now transformed mainly into conservation, protection and plantation i.e., afforestation, reforestation and enrichment plantation, respectively in newly accreted land, deforested and degraded forests. To conserve the existing natural forest, the government has imposed a moratorium on tree felling in natural forests since 1990 and has since then focused its forestry activities on conservation, protection and plantation. This moratorium has been considered as a strategy to protect and conserve forests. However, a study (Sarker et. al., 2011) on existing logging bans in Bangladesh concludes that logging ban has not been able to contribute effectively in forest conservation. There has been an overall depletion in forest resources in all the major forests in the last three decades. The growing demands for food, energy, and timber put tremendous pressure on the remaining forests. Majority of the deforestation and forest degradation combined occurred in the Hill zone (86%), followed by the Sal zone (8%), the Coastal zone (4%) and the Sundarban (0.8%) and Village zone (1%) (Fig.1). Both deforestation and forest degradation are high in the Hill zone, respectively 89% and 84%. While forest degradation is prominent in the Sal zone, deforestation is the major threat in the Coastal zone. In Sundarbans and Village zones, both deforestation and degradation are very low (Table-2).

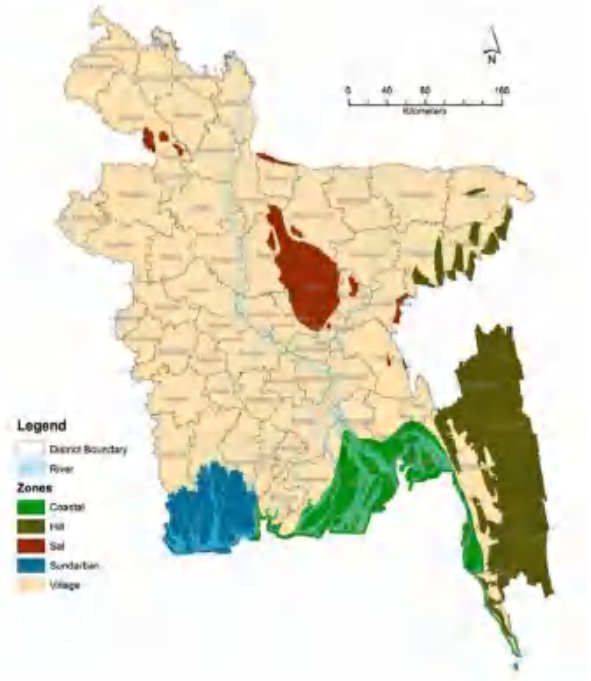


Figure 1: Bangladesh Forest Inventory (BFI) Zone Map

Table-2: Deforestation and forest degradation in the BFI zones within 2000-2015

Inventory Zones in Ha						
	Hill	**Sal**	**Coastal**	**Sundarbans**	**Village**	**Total**
Deforestation	134,447	2,080	11,715	2,363	1,306	151,911

Degradation	131,776	22,457	2,902	172	1,929	159,236
Total	266,223	24,537	14,617	2,535	3,235	311,147

(Data Source*:* MOEFCC 2018)

Permanent Crops covered half of the economy area and, although these areas are primarily used for agriculture, they still have an average tree cover of about 7% (Henry et al. 2021). Nationally, there was a net decrease in tree cover of 3.4% from 2000 to 2015 (GoB 2020b) (Fig. 2).

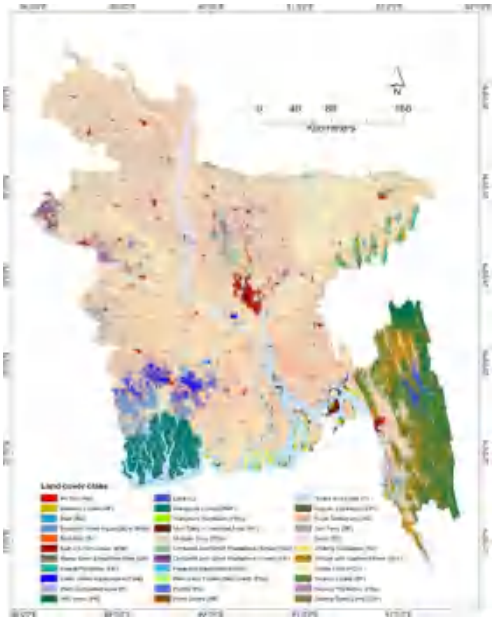
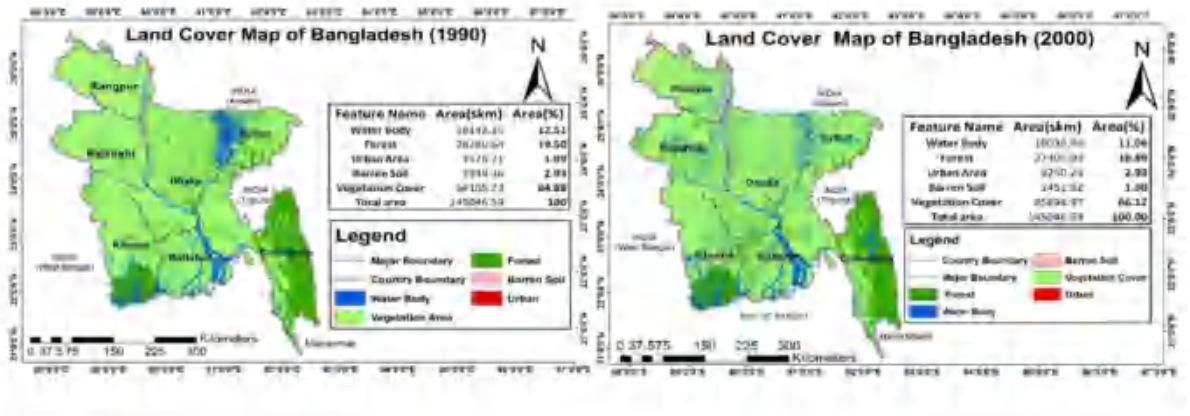


Figure 2: National land cover map 2015

Due to high population density, this economy's total land area is continually changed including losses of vast agricultural lands (Hossain *et al.*, 2020), waterbodies and forest areas for urban growth and development. Water body has decreased 3.53% from 1990 to 2019. After 29 years 5.18 % land had changed to urban area, which is 6.27 % of total area and vegetation cover had increased 3.36 %. In 1990, it was 64.88% and 2010 it has 68.24 % of total area (Fig.3 & 4).



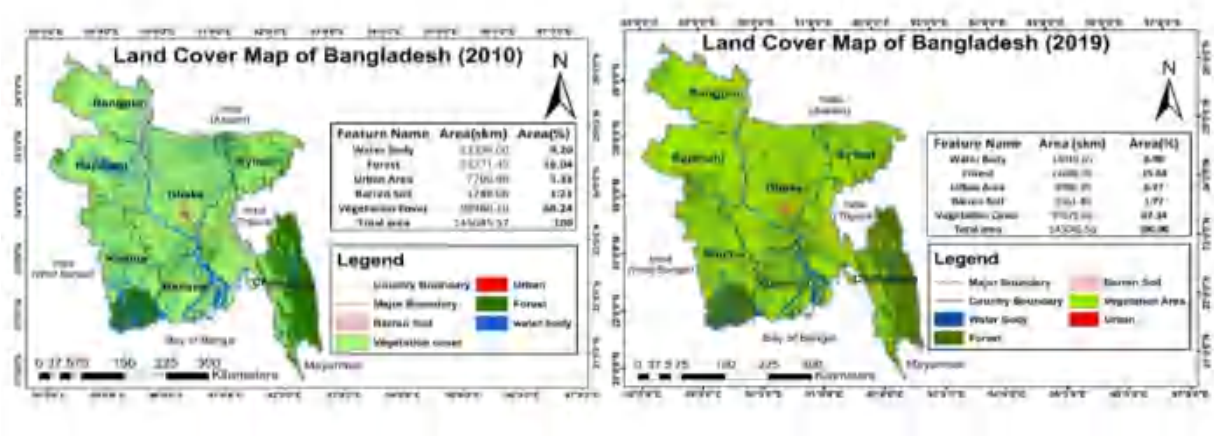


Figure 3: Land use and land cover map of Bangladesh (1990-2019)

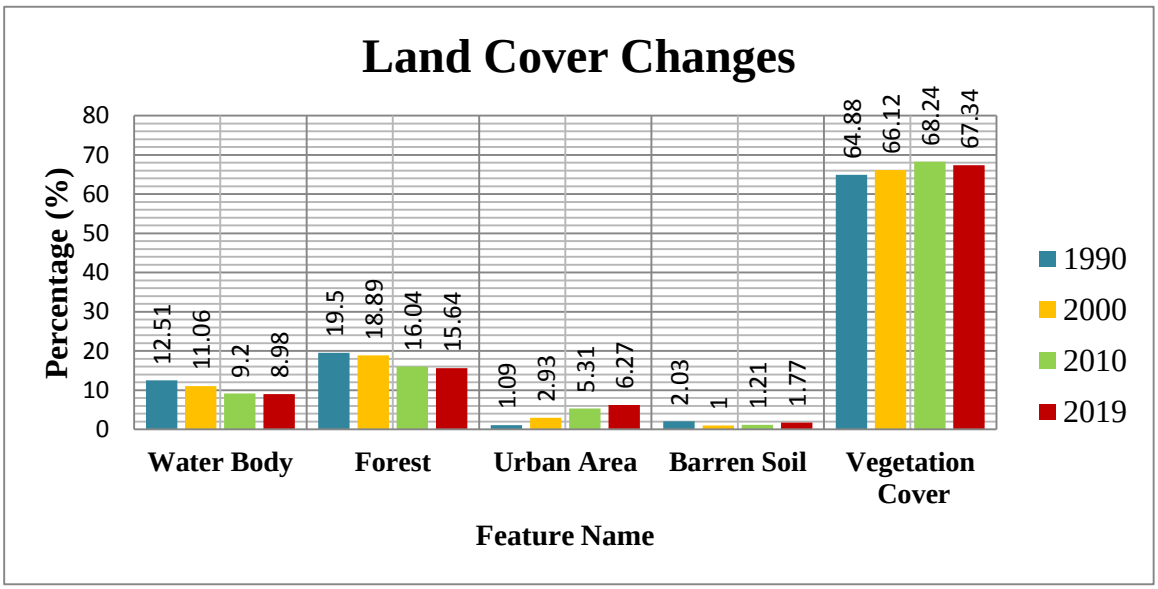


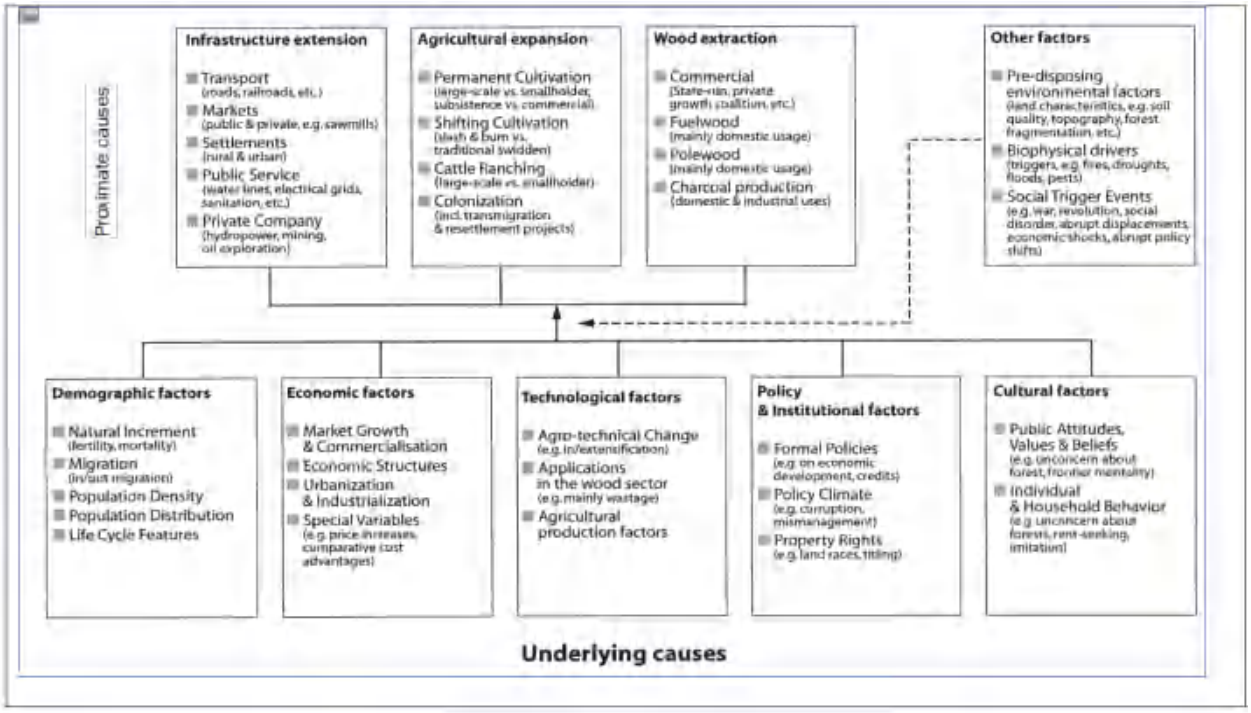
Figure 4: Land use and land cover change status over ten years' intervals in Bangladesh (Source:Hasan et al.2021)

Gradually the forest area has decreased 3.86% from 1990 to 2019. Various causes of forest cover deterioration have included; poverty, overpopulation growth, taboo felling, enhancement of agricultural land and lack of appropriate policy and implementation of policy (Lambin et al., 2001; Hansen et al., 2013; Hanewinkel et al., 2013).

4. Drivers of Forest Degradation

Drivers are processes that result in deforestation and forest degradation.

- Direct drivers, ('proximate causes'), human activities or immediate actions that directly impact forest cover and loss of carbon.
- Indirect drivers, ('underlying causes' or 'driving forces'), complex interactions of fundamental social, economic, political, cultural and technological processes (Fig. 5).



Source*:* Geist *et.al.* (2002).

Figure 5: Showing proximate & underlying causes or driving forces

5. Overview of Forest Rehabilitation Efforts

Over the time, Bangladesh's approach in forest management has evolved from Production forestry to Conservation forestry along with service forestry. The Bangladesh Forest Department (BFD) has embraced innovative Community-based participatory forest management strategies such as community forestry, participatory forestry, social forestry and co-management. The BFD's approach to community involvement in degraded and denuded forest lands through social forestry has been in implementation for over two decades. The Social Forestry Rules while providing clear guidance on benefit sharing, under this approach, have largely encouraged monoculture plantations of non-native species and have had less influence on improving the quality and stocking of natural forests. In Protected Areas, a platform of collaborative management of five protected areas was introduced through Nishorgo Network which was further strengthened in 17 PA's through Integrated Protected Area Co-management (IPAC) project (2009-20012). This approach has been extended in the rest of the PA's through Climate Resilient Ecosystems and Livelihoods (CREL) project (2013-2017). It is now institutionalized under the new Wildlife (Conservation and Security) Act-2012 and its PA Management Rules 2017. However, PA Management Rule 2017 does not apply in areas not legally notified as PA's. The Social Forestry Rules (revised in 2010) are designed for collaboration in raising plantations in already denuded or degraded government land. Neither policy is applicable in other forest areas where exploitation of timber and non-timber forest products continues to deplete the forests. A more comprehensive systematic approach is essential for BFD to work closely with communities to protect the remaining standing forests. In that reason the BFD has undertaken such a comprehensive program (Collaborative forest

management) through Sustainable Forests and Livelihoods (SUFAL) project for rehabilitating and reforesting depleted areas including reserve forests and Protected Areas.

6. Ongoing Forest Rehabilitation Effort through Sufal Project

The Bangladesh Forest Department (BFD), under the Ministry of Environment, Forests and Climate Change (MoEFCC), formulated the SUFAL project by the financial support from the World Bank and the project duration is July-2018 to December 2024. The Project will cover 211Upazilas (sub-districts) under 28 districts in three different ecosystems: plains, hills and coastal. The Total Project Cost is 15.523 billion BDT. The SUFAL project target groups of beneficiaries are the poor and extremely poor households of forests dependent community. The Main objectives of the Project are-

a) To improve organizational effectiveness by strengthening institutions, information systems and training to forest officials and staff.
b) To strengthen collaborative forests and Protected Areas management for enhancing forest restoration, Wildlife protection and biodiversity conservation and ecosystem services.
c) To increase access to AIGAs including forest extension service in ToF (Tree Out Side Forest) areas to reduce forest exploitation and improving environment.
d) To monitor forest restoration and enhanced tree cover in the ToF.

To achieve these goals some of the major activities that has been going on in field level are described briefly in this paper are as follows:

6.1 Site Specific Planning (Ssp) for Forest Restoration and Afforestation

All afforestation/reforestation activities under SUFAL project is preceded by Site Specific Planning (SSP) (Fig. 6). This SSP is prepared at forest beat level, in consultation with CMC (Co-management committee) and CFMC (Collaborative forest management committee). Concern BFD officials conducted and supervised the SSP preparation. Based on actual site requirements SSP were designed with necessary intervention for each site. It also serves as an entry point of consultation with local communities on the field forestry activities. SSP ensure stakeholder engagement for CFM and PA Co-management, addressing safeguard issues, Social and environmental impact screening (ESMF), Biodiversity conservation, Wildlife protection and sustainable use of natural resources and climate change risk. SSP is a platform for forest restoration initiative through community engagement. Already 93,818 hectares SSP has been done by SUFAL project.

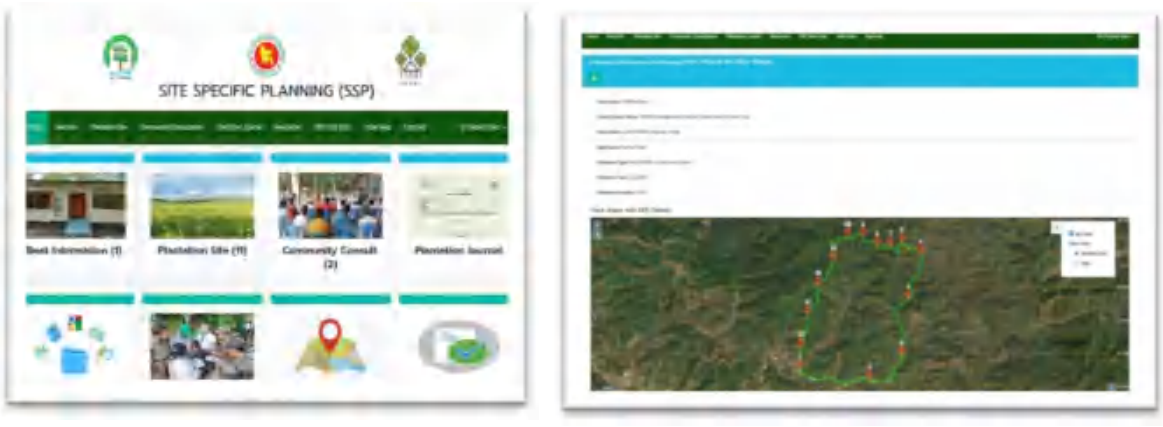


Figure 6: Data entry in SSP dashboard for site specific plantation.

6.2 Plantation Intervention

There are 32 types of plantation activities (Table-3) are performed all over Bangladesh through SUFAL project . BFD has planted site specific indigenous species during regular planting program. Already 90,438 hectares plantation has been completed by SUFAL project.

Table-3: Plantation Types under SUFAL Project

Forest type	Plantation types	Seedlings
Coastal Greenbelt and Mangrove plantation	1. Mangrove	4444/ha
	2. Enrichment	300/ha
	3. Golpata	1000/ha
	4. Mound	1500/ha
	5. Jhau	2500/ha
Hill areas	1. Assisted natural regeneration (ANR)	500/ha
	2. Stand Improvement	1500/ha
	3. Enrichment	1500/ha
	4. Mixed plantation with slow growing species	2500/ha
	5. Mixed plantation with fast growing species	2500/ha
	6. NTFP underplanting Medicinal plant	2500/ha
	7. Cane	1000/ha
	8. Rare and endangered species	2500/ha
	9. Bamboo	625/ha
	10. Murta	4444/ha
	11. Teak coppice	1000/ha
	12. Wildlife coridoor & habitat improvement in PAs.	1500/ha
	1. Enrichment	1500/ha

Plain Land (Sal)	2. Mixed Fast growing species	2500/ha
	3. Stand improvement	1500/ha
	4. Coppice management	1000/ha
	5. Rare & Endangered (Sal associates)	500/ha
	6. Murta	4444/ha
	7. NTFP underplanting Medicinal plant	2500/ha
	8. NTFP Cane	1000/ha
	9. Bamboo	625/ha
Tree outside forest (ToF)	1. Golpata	1680 ha
	2. Strip Plantation	3951 km
	3. Seedling raised for distribution	64.29 lac
	4. Improved prapagules plantation	1500/ha
	5. Strip plantation	1000/km
	6. Model upazila plantation	1 lac

(Source: BFD, 2024)

6.3 Community Engagement

The collaborative forest management (CFM) has been introduced in 615 forest conservation villages (FCVs) and they formed 615 nos. Collaborative forest management committee (CFMC) and 3075 nos. sub-committees under the CFMCs. Each CFMC is consisting of 5 types of sub-committees namely 1) Forest protection and conservation committee (FPCC) 2) Finance and Accounts committee (FAC) 3) Village credit and Savings Committee (VCSC) 4) Procurement Committee 5) Social Audit Committee (SAC) (Fig. 7).

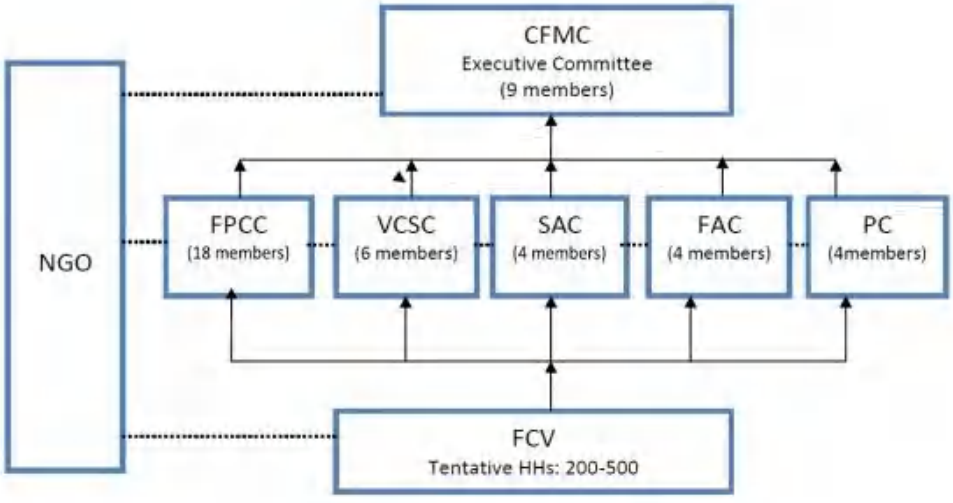


Figure 7: Diagram of village level institutions for CFM.

Community operations Manual (COM) with four (04) parts has been approved by the ministry of Environment, Forest and climate change. The COM is primarily a reference book that needs to be followed during the formation of village level institutions, selection of appropriate beneficiaries, implementation of different AIGAs and accounts maintenance, auditing and record keeping with information on what and how they will do in the project and sub-project activities. COM is a dynamic document until it becomes under the legal framework. It may be changed over the time; different items of the COM may be deducted if found inappropriate or more new items may be added when it will be operational (Fig. 8).

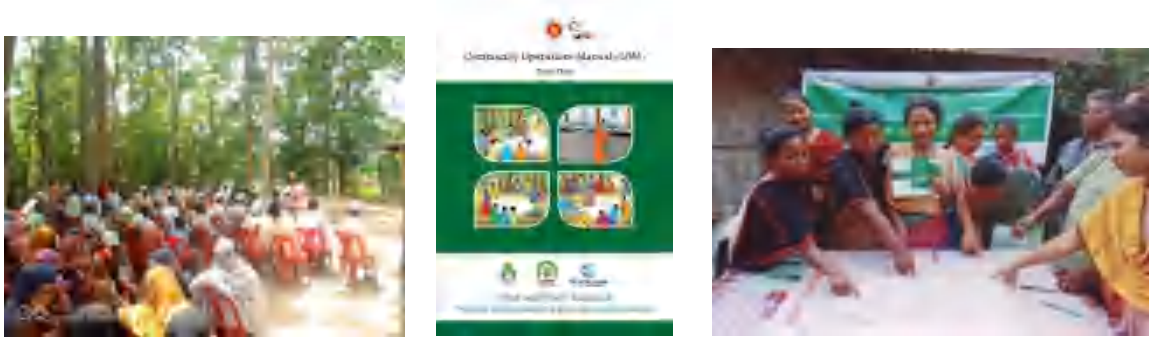


Figure 8: Community consultation regarding application of COM

Community financing process is carried out according to this COM. Community finance consists of following three elements- Savings, Internal Fund and LDF.

7. Savings

Each member of the selected community is saving a fixed amount regularly and deposited the savings amount according to number and rate of installments fixed as per group decision. The VCSC cashier is keeping up to date record of the savings collected from members and amount deposited to the VCSC Cashier. Members can withdraw up to 80 % of their savings to meet emergency needs. The VCSC Cashier will pay the amount and note it down in member's passbook.

8. Internal Fund

80% of the savings collected by the VCSC members can be given as loans to members to meet their urgent family needs; The CFMC will decide the amount of loan size for each member. The rate of service charge will be not more than 5% flat. At the end of each financial year, an income and expenditure statement as well as a balance sheet will be prepared and on the basis of this statement the annual net profit on internal loan activities and bank interest on deposited savings in the bank will be distributed as on 30th June each year. 100% of annual net profit of internal fund and savings activities entitled by the individual members will be credited to their respective pass book proportionately as per amount of savings.

8.1 Livelihood Development Fund (LDF)

A selected Community member who has deposited savings for consecutive 3 months will be considered for Livelihood Development Fund loan. The interested member will apply for loan

upon consensus decision of the Group. A Business Plan approved by the Group for the loan will have to be furnished. Respective Committee's Convener and Cashier will make a commitment on behalf of the borrower that they will make group pressure on the default borrower until repayment of the default loan installments and put their signature jointly on the loan application form. The selected community members who repay their borrowed loans on a regular basis will be considered for taking further livelihood development fund/internal fund loans. The maximum loan duration period will be 18 months. A member can receive more than one loan in a year depending on availability of funds, fulfillment of the group's loan requirements, the need and performance of an earlier loan.

8.2 AIGA Support and Development Activities for the Community:

There are 41000 households have been identified, trained and provided livelihood development funds to support the forest dependent vulnerable poor communities in their efforts to protect the forest, to improve the biodiversity following the community operations manual (COM) developed. Most of the households are going through livelihood transformation through these Livelihood Development Fund (LDF) initiatives (Fig. 9). Each beneficiary got BDT 42,000/- (0.042 million BDT) as AIGA support from the SUFAL project. So far BDT 139.97 crore (1.3997 billion BDT) has been distributed among 37,610 beneficiaries out of 41000 targeted households.

Figure 9: (a & b) Supply of necessary equipment for poultry farming to the Beneficiaries. (c) Supply of necessary equipment for Vegetable farming to the Beneficiaries. (d) Supply of necessary equipment for Cattle farming to the Beneficiaries

Forest dependent village community needs to develop infrastructures to improve their living condition, connectivity and ensure the basic services for the community people. The Community Development Fund (CDF), is to be used for the construction of physical infrastructures at small scale which is improving the quality of life and facilitate smooth

communication and marketing of the products to nearby market and growth centers (Fig.10,11). BDT 4,20,000/ (0.42 million BDT) - have been allocated for each project. So far BDT 23.74 crore (0.2374 billion BDT) has been distributed through 1652 small projects among 615 FCV.

Figure 10: (a) Construction of Passenger canopies (b) Installation of submersible pump for safe drinking water (c) Construction of Herring Bone Bond Road.

Figure 11: (d) Construction of culvert (e) Education equipment distribution

9. Innovative Approaches to Address Forest Degradation

9.1 Innovation in student engagement; Wildlife Olympiad

First ever Wildlife Olympiad in Bangladesh engaging one lac school and college level students throughout 64 districts. This initiative, under the slogan "Smart Tarunya Bachabe Aranya" (Wise youth will save the forest), aims to raise awareness about wildlife conservation among the students across the economy (Fig.12).

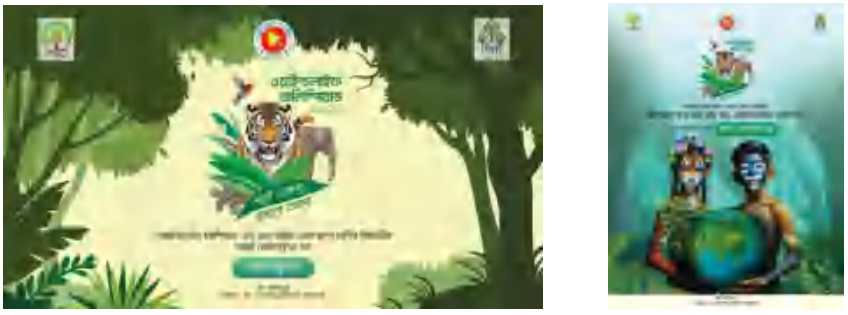


Figure 12: Wildlife Olympiad Campaign

9.2 Spatial Monitoring & Reporting Tool (SMART) patrolling in Forest management

SMART patrolling is a spatial information based monitoring platform that helps protect PAs effectively. Report generated from SMART pattrolling is much helpful to data reference and forest managers to take management decisions and this technique is much appreciated.

9.3 Ecosystem service valuation of natural resources

Valuation of ecosystem services is an economic process which assigns a value (either monetary,biophysical,or other) to an ecosystem or its ecosystem services. Valuation of ecosystem service survey work taken by the SUFAL project has been completed in Madhupur National Park, Teknaf wildlife sanctuary and Sitakunda Reserved forest which is new type of study in Bangladesh and the report will be published soon.

9.4 Initiated first ever Plant Red Listing and invasive alien species (IAS) control strategy

Developing Bangladesh National Red list of Plants and Developing management strategy of invasive alien species (IAS) of plants in selected PAs initiative was taken by BFD under SUFAL project. Over the last century Bangladesh has lost seven plant species that once occurred in the economy and now risks losing at least another five. In addition, out of 1,000 assessed flora species, 127 are considered endangered, 262 are vulnerable, 69 are near-threatened, 271 are considered of least concern, and for the remaining 258 species there's insufficient data to assess their conservation status according to the first-ever comprehensive assessment of the economy's plant life. A total of 44 invasive alien species (IAS) have initially recorded from 5 PAs. Under the project, a detailed Plant Red List Index will be prepared and Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) list of plants in Bangladesh will be updated based on the results of the developed Red List. Based on the surveys in five important protected areas of Bangladesh on identifying IAS of Plants, their extent of distribution, pattern of occurrence, and associated impacts on local forest biodiversity, the project will also prepare a set of recommendations to formulate an effective mechanism of preventing, controlling and managing the spread of IAS of Plants.

9.5 Innovation Grant for forestry and Wildlife Research

Innovation Grant Manual (IGM) prepared to guide SUFAL Innovation Grant (SIG). So far BFD SUFAL project is supporting 34 innovative research ideas on collaborative forest management, forest restoration and biodiversity conservation, forest governance and institutions, impacts of climate change on forest, forest species and biodiversity, wildlife management, choice of species for future adaptation and mitigation, habitat restoration/conservation etc. These innovative action research will build up knowledge based climate smart forest management, forestry science and technology. However, this research will improve the institutional research capacities of public and private universities and forestry research entities. There are number of studies going on.

9.6 Innovation in Financial Transaction

Bangladesh Forest Department driven 'Sustainable Forests and Livelihoods (SUFAL) Project beneficiaries paying through mobile banking which is a great initiative. A tripartite agreement was signed among Forest Department, Postal Department and NAGAD Limited. The beneficiaries (community patrolling team and watcher) who are involved in the project activities are getting their labor payment at home through NAGAD mobile banking. Till date

more than BDT 11.54 crore (115.4 million BDT) has been distributed to more than 16,235 project beneficiaries.

10. Success Achieved Against the Benefits Provided to the Beneficiaries So Far

Under this project afforestation and reforestation program has been launched from 2018-2019 FY. The role of the community Patrol Group (CPG) in the successful completion of this afforestation program is invaluable. The success of the afforestation program in such a short period of time bears witness to the sincerity and ownership of the CPG in protecting the forest resources. A glimpse of some such successful afforestation program is given below:

Figure 13: (a) Habitat improvement Plantation in PA (b) Mangrove Plantation (Golpata) in Coastal area (c) Coastal Plantations

Livelihood development program from SUFAL project has been started from 2022-2023 FY. As per COM, Livelihood support fund is a revolving fund and it will be used for improving the income of the forest dependent community. After getting their fund for desired alternative livelihood, within a year most of them got profit from their investment. A market chain also developed for some trade like, Naksikantha, Bamboo chatai, Bamboo basket, tailoring and so on. A glimpse of some such achievement is given below:

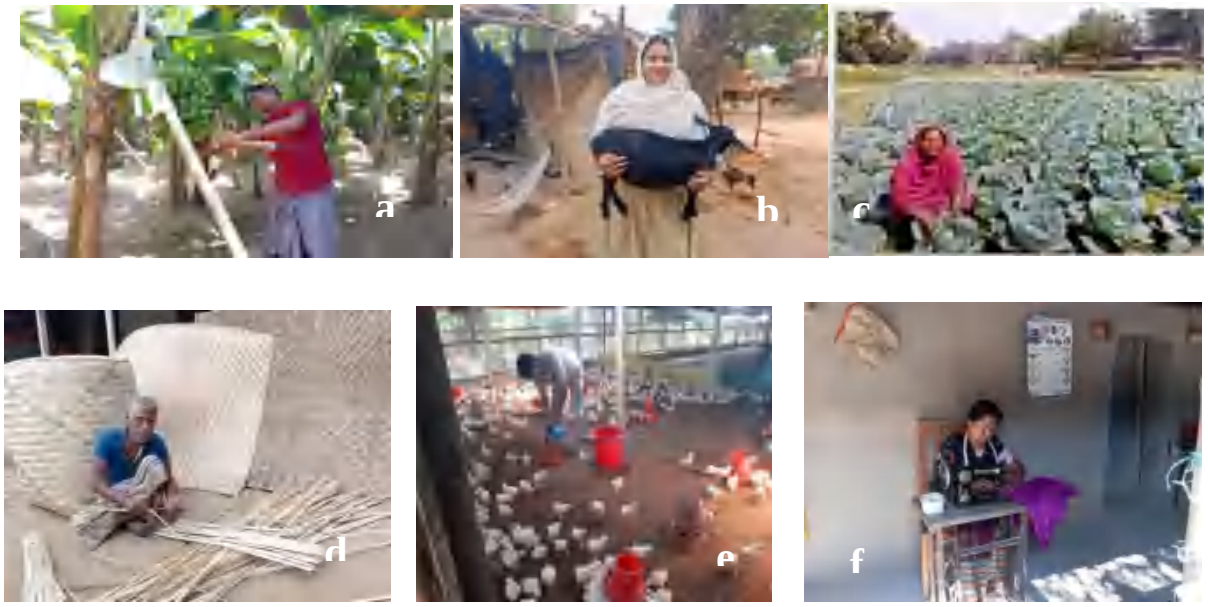


Figure 14: (a) Banana Cultivation (b) Goat Farming (c) Cabbage Cultivation (d) Making of Bamboo chatai (e) Poultry Farming (f) Tailoring (Source: BFD).

11. Epilogue

Proposed concept of collaborative forest management cannot be considered at its final shape during this project implementation period. Rather necessary adjustments will be required in the development of community engagement and benefit sharing modalities, institutional and/or committee formation, decision making processes and financial benefit sharing and sustainability. BFD should be allowed to give final shape of the collaborative forest and Protected Area management practices by bring necessary changes during the implementation process.

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Acronyms and Abbreviations

AIGA	Alternative Income generating Activities
ANR	Assisted Natural Regeneration
BDT	Bangladeshi Taka
BFD	Bangladesh Forest Department
BGD	Bangladesh
CPG	Community Patrol Group
CDF	Community Development Fund
CFM	Collaborative Forest Management
CFMC	Collaborative Forest Management Committee
CMC	Co-Management Committee
COM	Community Operations Manual
ESMF	Environmental & Social Management Framework
FCV	Forest Conservation Village
FY	Financial Year
LDF	Livelihood Development Fund
MOEFCC	Ministry of Environment, Forest & Climate Change
PA	Protected Area

SUFAL	Sustainable Forests & Livelihood

Flooded Forest Restoration Site Carbon Inventory Survey: Case Study at Tonle Sap Great Lake in Pursat Province

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1. Introduction

1.1 Overview of Flooded Forest

The Tonle Sap is one of the most ecologically diverse and hydrologically complex great lakes in the world. The flooded freshwater forests that surround it, the intricate movements and migrations of more than 200 species of fish through the forests and upstream to spawn - all support a cycle of productivity that has fed large human populations and sophisticated cultures for centuries. Although the flooded forests provide habitat and food sources for fish, the fish could not be exploited by anyone except the landowners. This provided little incentive for the local community to protect the flooded forests (FAO and Asia Forest Network, 2004). As the population grows, the lack of income opportunities leads to an increase in seasonal migration and the conversion of forests and wetlands into agricultural land. The demand for more agricultural land has led to deforestation of freshwater riparian forests, and the demand for fuelwood has led to unsustainable deforestation of riparian forests, resulting in degradation or loss of riparian forest habitat (MoE, 2009). This phenomenon has resulted in a wetland habitat with a great diversity of species such as fish, birds, reptiles, mammals, and a variety of plant species. The biodiversity of Tonle Sap includes over 200 species of fish, 42 species of reptiles, 225 species of birds, 46 species of mammals, and 200 species of plants. It has numerous ecological functions and provides particularly rich fishing grounds and fish breeding areas. The lake provides about 60 % to 75 % of all fish caught in Cambodia. A large area surrounding the lake in the dry season but flooded in the rainy season is a flood forest ecosystem. The flooded forest of Tonle Sap is rich in plant species such as trees, shrubs, lianas (climbing plants), grasses, and aquatic plants. Currently, the total area of temporarily flooded forest covers 647,406 ha in the five provinces around Tonle Sap (Kampong Chhang, Pursat, Battambang, Siem Reap, and Kampong Thom). It provides good conditions for ecosystem conservation, but the extent and quality of the forest is not well known.

The flooded forest degradation caused from several reason including forest fire, land encroachment, and other natural influence. To restore the flooded forest and fish habitat, the Tonle Sap authorities in collaboration with provincial and local authorities, relevant

government agencies, NGO and projects, including Conservation International, ADB, and other local NGOs have rehabilitated the flooded forest as piloting for restoration since 2005 in some part of Pursat province.

1.2 Objectives of the Study

The study aims to assess the above and below-ground carbon stored within flooded forest restoration pilot sites on the Tonle Sap Lake in Pursat province. The specific objective is to assess carbon stock in different flooded forest restoration pilot sites.

2. Research Methodology

To quantify C stocks, include above and below-ground in flooded forest, wetlands forest and mangrove forest are estimated from the different components (Figure 1). Since the largest carbon pool in these ecosystems is usually below ground, particular importance is given to the sampling methods used to estimate the C stocks in this pool. For more specific details, please refer to Kauffman, J.B., and D.C. Donato, 2012. Protocols for the measurement, monitoring, and reporting of structure, biomass, and carbon stocks in flooded forest, mangrove forest are detailed in Working Paper 86, CIFOR.

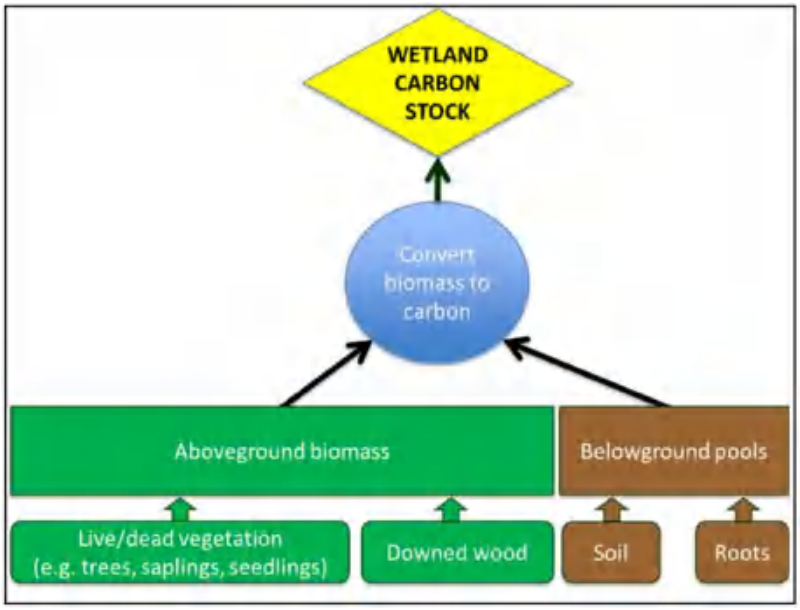


Figure 1: The different components of above and below-ground biomass measured by the protocol

2.1 Clusters and Plots Design

Random sampling was applied to set up clusters followed by SWAMP protocol. The clusters were selected for the study through the observation and Drone mapping for identifying the forest types. The different types of flooded forests were sampled representatively, starting from scattered to dense forests of the whole area. Plot marking using GPS, and other measurements were applied in such a way that re-measurement could be possible for quality control and future inventories. The SWAMP protocol (Kauffman & Donato 2012) has been applied in mangroves

globally and has been recognized by the IPCC as an approach that complies with its good practice guidelines. Each cluster is composed of five survey plots illustrated in Figure 2.

Figure 2: Map of the study sites

2.2 Sample Size

The study selected 24 clusters, and each cluster consists of 5 sub-plots (Table 1), and the total sub-plots are 120 in the target sites. Each sample are listed in the following table.

Table 1: List of site names

Site Name	Area (ha)	UTM_E	UTM_N	Year	Age at sampling	Treatment	Clusters	Plots
ADB	~5	411463	1393424	2005	18	Oldest	3	15
Kdat Taprum	20	411153	1393419	2010	13	Old	4	20
Knach Leap	20	411069	1393233	2012	11	Old	4	20
Khnach Leap_1	15	410381	1394027	2014	9	Medium	3	15
Khnach Leap_2	15	410381	1394027	2015	8	Medium	3	15
Kampong Prak_1	7	411072	1392814	2020	3	Young	3	15
Kampong Prak_4	15	411546	1392585	2020	1	control	4	20
Total							**24**	**120**

2.3 Field Sampling Protocol

Carbon stock assessment included the above and below-ground biomass, downed deadwood, and soil C pools with the SWAMP protocol developed by Kauffman and Donato (2012). Each

plot consists of a larger 0.5 ha (50 x 50 m) square plot and five smaller clustered 7 m radius, circular subplots (Figure 3-A and 3-B), at coordinates randomly selected in research site.

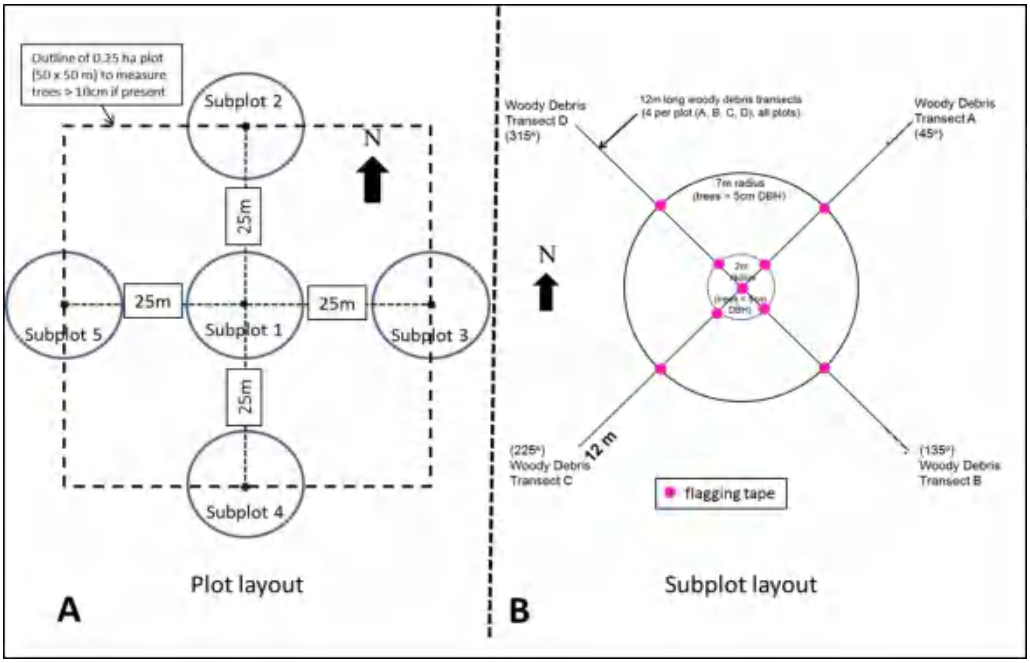


Figure 3: Plot layout

Trees, saplings, and seedlings are measured/counted in the 7m and 2m subplots depending on their DBH (Figure. 4). These measurements are then used to calculate above-ground biomass using allometric relationships which is later converted into above-ground carbon stock.

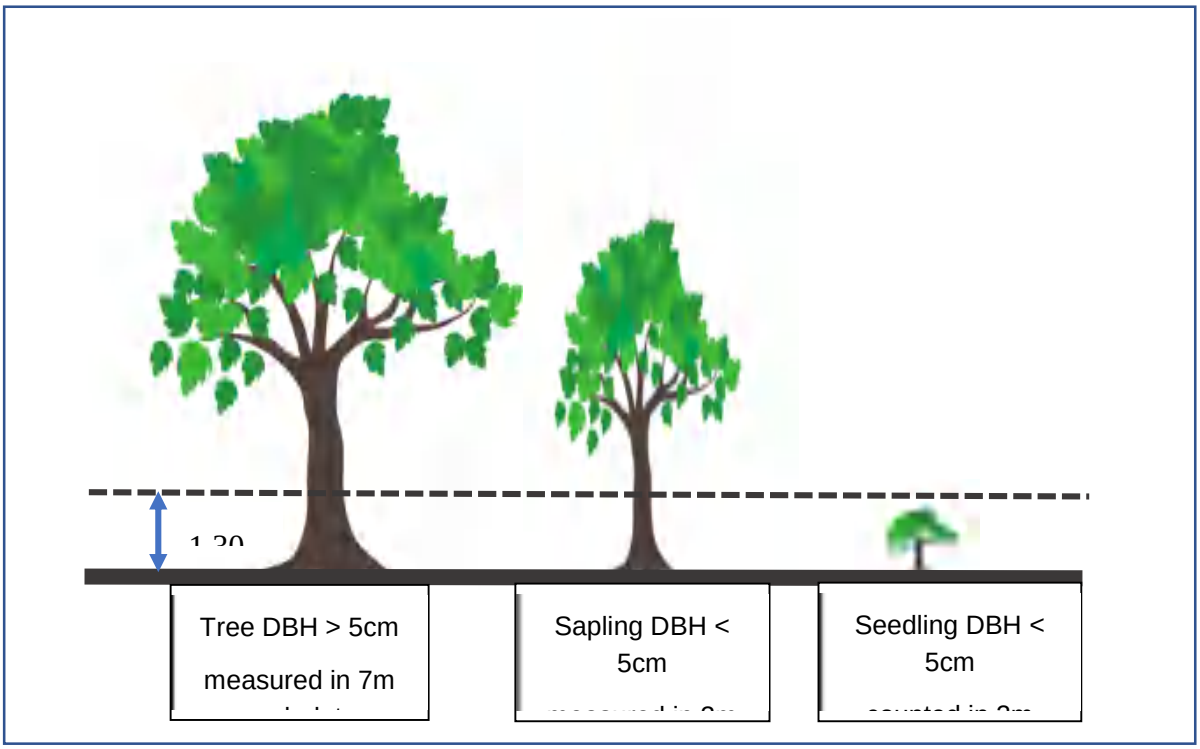


Figure 4: Measurement of tree, sapling, and seedling DBH.

All trees greater than 5 cm diameter at breast height (DBH) are measured within the 7m radius subplot (Figure. 3-B). A tree is included in the subplot if at least 50% of the main trunk is rooted inside the subplot. DBH is measured approximately 1.30 m above the ground using a tree caliper or DBH tape.

All trees with DBH less than 5cm are measured within the 2m subplot (Figure. 3-B) if at least 50% of the tree is in the subplot. Saplings are small trees greater than 1.30m in height and have a DBH <5cm (Figure. 4). All seedlings are also counted within the 2m subplot. Seedlings are trees that are less than 1.30m in height (Figure. 4).

Downed deadwood, including stem, branch, and prop root debris laid on the forest floor was measured using the planar intercept technique (Kauffman and Donato, 2012). This involves counting and measuring the widths of different size classes of dead and detached trunks, branches, prop roots and stems (Table 2) that are laying within 2 m of the ground surface and cross one of the four 12m long transects previously created (A, B, C, D in Figure. 3b). For 12-m line transects were established that intersected the midpoint of each subplot. Downed deadwood was classified into four classes based on their diameter (Table 2).

Table 2: Commonly used size classes of wood.

Size class	Debris width	Transect section
Fine	< 0.6 cm	10-12 m
Small	0.6–2.5 cm	7-10 m
Medium	2.5–7.6 cm	2 – 7 m
Large	>7.6 cm	0 – 12 m

Large woody debris is counted and measured along the entire 12m transect. The diameter of each large woody debris is also measured and recorded at the point where the transect line crosses the midpoint of the wood particle. The decay status is also recorded: sound (machete bounces off or only sinks in slightly when struck) or rotten (machete sinks in deeply and wood is crumbly with significant loss). Medium-sized debris is only measured from the 2-7m section of the transect. Small-sized debris is only measured from a 7-10m section of the transect. Fine-sized debris is only measured from the 10-12m section of the transect (Figure 5, Table 2). Medium, small, and fine pieces are only counted as the number of pieces that cross the transect tape. No diameter measurement is needed.

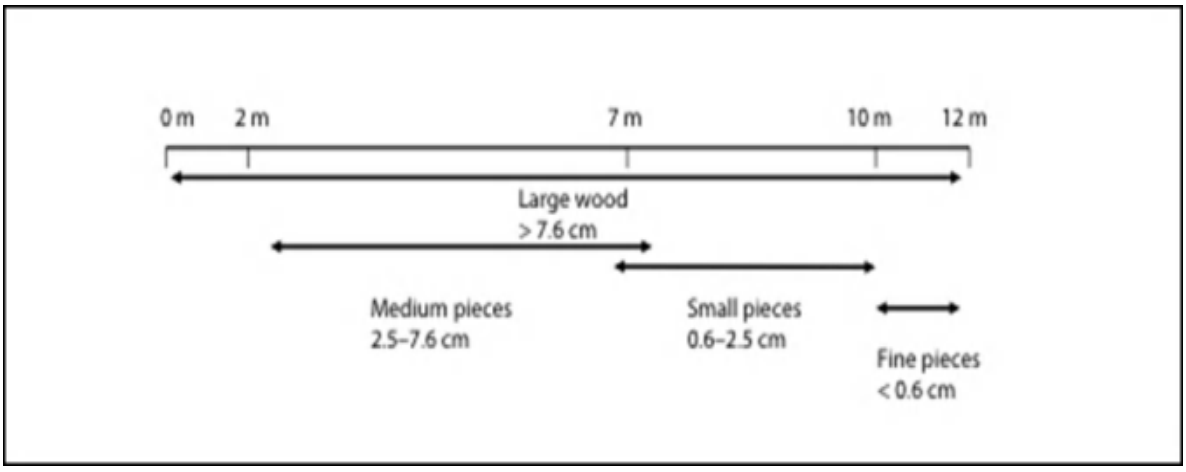
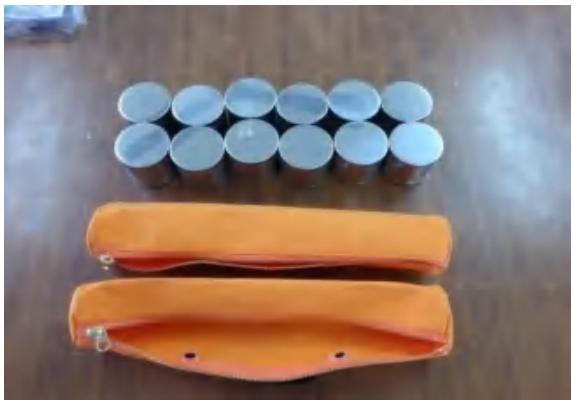


Figure 5: A woody debris transects for sampling downed wood using line intersect method

The soil sampling site was located 7 m on the line directing northeast (45^{o}) from the starting point (Figure 3-B) but could be shifted if required. However, the new location must not exceed ±10m from its initial coordinates. The soil sample was taken in each sub-plot of the cluster using the specialized soil auger for organic or peat soils. A 100 ml sample should be collected at each of the 7.5 cm, 22.5 cm, and 37.5 cm depths using the cylinder (Figure 6A). Soil samples in each sub-plot were collected when possible following consistent depth interval mid-point horizons of 0–15, 15–30, and 30–50cm (Figure 6-B).



A

B

Figure 6: Soil sampling cylinder – 100 ml (A) for sampling implementation in the field (B)

2.4 Lab Analysis

Soil samples were dried to a constant mass at 60 ^{o}C and weighed to the nearest 0.1g, ground into a fine powder using a mortar and pestle or a Whiley™ soil mill, and sieved through a 2-mm mesh sieve to remove any large pieces of wood or rocks. Bulk density was determined for each interval by dividing the total dry weight by the total sample volume. Each soil interval was then analyzed for total C using a Costech™ model elemental analyzer (Costech Analytical Technologies, Valencia, California). All laboratory analyses were conducted at the Soil Laboratory of the General Directorate of Agriculture (GDA) of the Ministry of Agriculture,

Forestry and Fisheries. Soil C stock (Mg C ha-1) was the final product of bulk density (g cm-3) x C content (%) x depth interval (cm).

2.5 Estimation of Carbon Stocks

- Biomass carbon

The study employed both species-specific and general allometric equations from published studies to calculate above-ground tree biomass and below-ground root biomass (Table 3). In case of general allometric equations we used wood density specific to species. To obtain biomass carbon stock per unit area (Mg C ha^{-1}), it is multiplied biomass by commonly used C proportions of 0.47 and 0.20 for above-ground trees and below-ground roots biomass per unit area, respectively.

- Dead wood carbon

The mass (kg) of dead and downed wood including stem, branch and prop root debris lying on the forest floor was measured by using the planar intercept technique. Dead downed wood biomass carbon stock was obtained by multiplying biomass (kg) with a C content correction value of 0.47 (Kauffman and Donato, 2012).

- Soil carbon

The soil samples were analyzed for bulk density and C concentration. Soil C density was obtained by multiplying soil bulk density by soil C concentration. Soil C pools at each sampled depth was obtained by multiplying C density with the depth interval.

- Ecosystem C stocks

The ecosystem C stocks were the sum of C pools in all components. To scale stand-level estimates to entirety of the site, it is multiplied the mean ecosystem C stocks by the areal extent of Cambodia flooded forest. To estimate the uncertainty in C stocks, the study used the 5th percentiles representing the lower end of our data set and 95th percentiles representing the upper end. The equation from Chave et al. (Jérôme Chave et al., 2014) was applied to flooded forest, the equation developed in Cambodia for flooded forest (Kim, Sola, et al. 2019) was used for flooded forest and non-forest.

Table 3: Allometric equations used to determine tree mass and each carbon pools of the forest types encountered in the study areas

Forest types/Pools	**Equation**	**References**
Flooded forest (Mult-species Model)	AGB = 3238.2787 * (1 - exp (-0.00000837 * D2H))	Kim et al. 2019
Dead Wood	$Woody\ debris\ biomass\ \left({}^{Mg}/_{ha}\right) = Volume_{DWD}\ \left({}^{m^3}/_{ha}\right) x\ Wood\ density\ \left({}^{g}/_{cm^3}\right)$	Kauffman & Donato, 2012

Note: AGB = Above-ground biomass (kg); BGB = Below-ground biomass (kg); DBH = Diameter at breast height (cm); WD= wood density (g/cm^3)

The above-ground biomass was summed to plot level and converted to ton per hectare. Given that most projects covered different areas, a simple average was used. A 95 % confidence interval was calculated with the forest type average above-ground biomass. The carbon stocks were finally calculated as the sum of above-ground and below-ground biomass multiplied by conversion factors:

Equation Conversion from AGB &BGB to Carbon Stock

C stock= AGB*(1+RS) *CF*44/12

Where:

- RS: Root-to-shoot ratio. Different root-to-shoot ratios were applied to the different forest types: 0.37 for evergreen forest (IPCC 2006) and 0.2 for all other types (IPCC 2006).
- CF: Carbon fraction, using the carbon fraction value 0.47 (IPCC 2006)
- 44/12: Atomic mass conversion from carbon to CO_2

➢ Uncertainty in component pools

To estimate uncertainty in each component pool, the study calculated the 95% confidence interval (CI) for each (i.e., trees, downed wood, soil, etc.) as following equation. The 95% CI half-width is used to express the uncertainty as a percentage of the mean.

95% CI half-width = 2 * SE.

Uncertainty (%) = 100* (95% CI half-width)/mean.

➢ Uncertainty in total stand-level carbon stock

Total carbon stock is the sum of all the carbon pools (trees, wood, soils, etc.), each of which has its own uncertainty. Calculating uncertainty for the total carbon stock requires accounting for the uncertainty of each of the component pools. Uncertainty in total stand-level carbon stocks is characterized by the 95% Confidence Interval (CI) half-width. The 95% CI half width is calculated as follows:

95% CI half width for total carbon stock = SQRT [(95% CI_{C1})^2 + (95% CI_{C2})^2 + (95% CI_{C3})^2]

where 95% CI_{C1} is the 95% CI half-width for pool 1, (e.g., tree carbon mass), pool, and so on for all pools measured in the plots.

Wood density refers to the amount of wood in a unit, per volume of wood. Based on a previous study conducted by (Kim et al., 2019), the wood density was determined in the laboratory using the water replacement method. The finding indicates the wood density (WD) of 8 flooded forests (See Table 4). Wood density for each tree was based on species if available in the Global Wodd Data base, genus if species were not available, or a default value of 0.57 g/cm3 if both species and genus were unknown, not recorded, or not in the data.

Table 4: Wood density of flooded forest species.

No	Khmer Name	Species	Wood density
1	Rang Toek	*Barringtonia acutangula*	0.493
2	Phtorl	*Diospyros cambodiana*	0.538
3	Chrokeng	*Mallotus anisopodus*	0.484
4	Taor	*Terminalia cambodiana Gagnep*	0.880
5	Nhor Toek	*Morinda persicaefolia Ham.*	0.49
6	Phnom Pneng	*Hymenocardia wallichii Tul.*	0.702
7	Thngan	*Crateva adansonii*	0.460
8	Tros	*Combretum triforatum vent*	0.582

3. Results and Discussion

3.1 Main Tree Species

The tree species with DBH≥5 cm was found 9 species such as *Barringtonia acutangula, Diospyros cambodiana, Combretum trifoliatum, Terminalia cambodiana Gagnep, Gmelina asiatica, Acacia Caesia, Bobach (Scientific name not found), Crateva adansonii,* and *Flueggea virosa.* However, only three main species composition was recorded in the research sites, such as *Barringtonia acutangula, Diospyros cambodiana,* and *Combretum trifoliatum*. Totally, these species: *Diospyros cambodiana* 229, *Barringtonia acutangula* 125, *Combretum trifoliatum 23 were recorded in all clusters respectively*.

The study also found 21 species of sapling with DBH<5 cm, while 6 main species were found such as *Combretum trifoliatum, Barringtonia acutangula, Bobach (Scientific name not found), Ixora cuneifolia, Hydroleazeylanica,* and *Schoutenia godefroyana.* The detailed result is showed in Table 5.

Table 5: Number of main species in tree layer and sapling of each restoration site

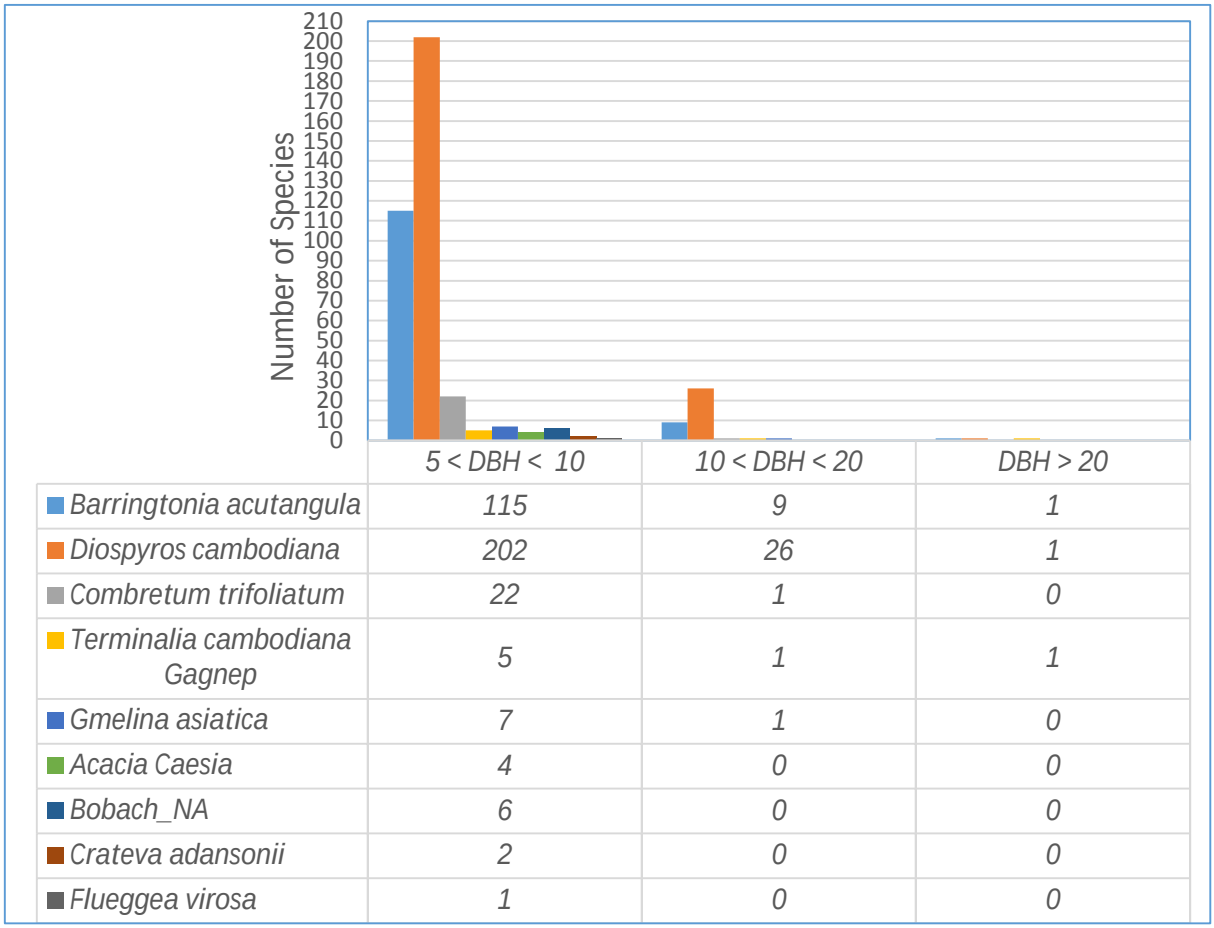
No	Khmer name	Species	ADB	KL	KL1	KL2	KTP	KP1	KP4	Total	Constan	Freque	Class
Tree Layer													
1	កាំងទឹក	*Barringtonia acutangula*	70	2	2	2	45		4	125	6	86	1
2	ផ្ទោល	*Diospyros cambodiana*	220	2			6		1	229	4	57	2
3	វល្លិ៍ត្រស់	*Combretum trifoliatum*	7	2			14			23	3	43	3
4	ន្លក	*Terminalia cambodiana Gagnep*	5	1					1	7	3	43	3

5	អញ្ចាញ	*Gmelina asiatica*				8				8	1	14	5
6	កំព្រាម	*Acacia Caesia*	4							4	1	14	5
7	បរបាច	*Bobach*							6	6	1	14	5
8	ថ្កាន់ទឹក	*Crateva adansonii*							2	2	1	14	5
9	លាជផ្ទុះ	*Flueggea virosa*	1							1	1	14	5
Sapling Layer													
1	រល្នើត្រស់	*Combretum trifoliatum*	78	104	17	8	13	1	3	224	7	100	1
2	រាំងទឹក	*Barringtonia acutangula*	65	10	6	17	96	1	16	211	7	100	1
3	បរបាច	*Bobach*	4	5		46		17	2	74	5	71	3
4	ធ្លើមអណ្តើក	*Ixora cuneifolia*	27	5	37	23		1		93	5	71	3
5	ទៀនព្រៃ	*Hydroleazeylanica*	74			88	73	6	1	242	5	71	3
6	រញ្ជា	*Schoutenia godefroyana*	41		2	3	10		1	57	5	71	3
7	ធ្នេញត្រី	*Bridelia ovata*	4		3		1		1	9	4	57	7
8	បន្លាឃ្មុន	*Mimosa pigra*	4		2	18			4	28	4	57	7
9	អញ្ចាញ	*Gmelina asiatica*				38		1	10	49	3	43	9
10	ដែប៉័រ	*Raphanus sativus*		5		6		4		15	3	43	9
11	ភ្នំអ័ង្គង	*Hymocardia wallichii*			6	20			3	29	3	43	9
12	ផ្ទោល	*Diospyros cambodiana*	21				4			25	2	29	12
13	សង្ឃ័រ	*Zizyphus oenoplia*					3		4	7	2	29	12
14	ត្នូ	*Terminalia cambodiana Gagnep*				1				1	1	14	14
15	ថ្កាន់ទឹក	*Crateva adansonii*		4						4	1	14	14
16	ធ្នុងត្រីកញ្ចុះ	*Oxyceros longiflora*		2						2	1	14	14
17	ញស្សាត	*Morinda persicaefoia*				3				3	1	14	14
18	ទ្រាលស្សាតស្វា	*Uvaria rufa*						10		10	1	14	14
19	ពភ្លា	*Poplear_NA*						10		10	1	14	14
20	កំព្រាម	*Acacia Caesia*								1	1	1	20
21	លាជផ្ទុះ	*Flueggea virosa*								1	1	1	20

3.2 DBH Distribution by Species

There was a considerable difference in tree species abundance at different size classes based on the combined data from all cluster plots (Figure 7). The DBH of *Diospyros cambodiana* was

recorded as the highest number of trees (202) with a 5-10 cm DHB range, followed by *Barringtonia acutangular* (115) and *Combretum trifoliatum* (22) in all clusters across the restoration sites. In short, it was found that the size of class distribution at DBH was dominated by the above-mentioned tree species in the restoration flooded forest sites.



	5 < DBH < 10	10 < DBH < 20	DBH > 20
Barringtonia acutangula	115	9	1
Diospyros cambodiana	202	26	1
Combretum trifoliatum	22	1	0
Terminalia cambodiana Gagnep	5	1	1
Gmelina asiatica	7	1	0
Acacia Caesia	4	0	0
Bobach_NA	6	0	0
Crateva adansonii	2	0	0
Flueggea virosa	1	0	0

Figure 7: DBH distribution by species

3.3 AGB and BGB Carbon Pools

3.3.1 Tree layer

Figure 8 describe AGB and BGB carbon pool in flooded forest by different restoration site. The AGB and BGB in each plot was different depending on the number of trees. The average AGC and BGC of the tree layer at ADB site is 5.74.69 Ct/ha which is significant higher that other plots. In ADB cluster, only the plot ADB_2025_2 has a considerable higher AGB biomass and carbon stock. According to the field observation, this plot was dominated by *Barringtonia acutangula* and *Diospyros cambodiana* and in good condition. However, Kdat Taprum site was 0.7 Ct/ha, followed by Kampong Prak 4 was 0.43 Ct/ha, respectively due to the sites considered as higher natural and regenerated plants, compared to restoration sites of Knach Leap and Knach Leap 2 is approximately 2.00 Ct/ha.

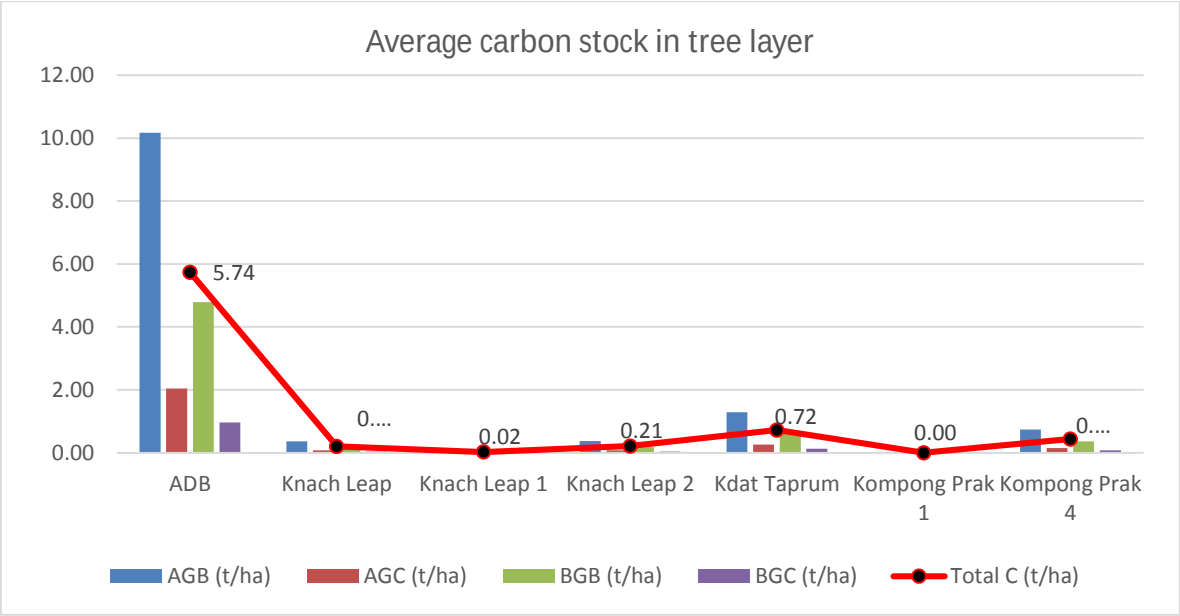


Figure 8: Average carbon stock in tree layer of each target sites

3.3.2 AGB and BGB Sapling layer

Figure 9 describe AGB and BGB carbon pools of sapling species in flooded forest by different restoration site. Most sapling species are also found in the ADB cluster due to the number of trees presented with DBH< 5 cm, and the other sites are recorded grasses species and vegetations with DBH<1 cm. The average AGC and BGC of the sapling layer at the ADB site is 4.99 Ct/ha, considered higher than other sites including Kdat Taprum (1.93 Ct/ha), Knach Leap 2 (1.93 Ct/ha), Knach Leap (1.31 Ct/ha), Kompong Prak 1 (0.30 Ct/ha), Kompong Prak 4 (0.20 Ct/ha), respectively in all clusters across the restoration sites.

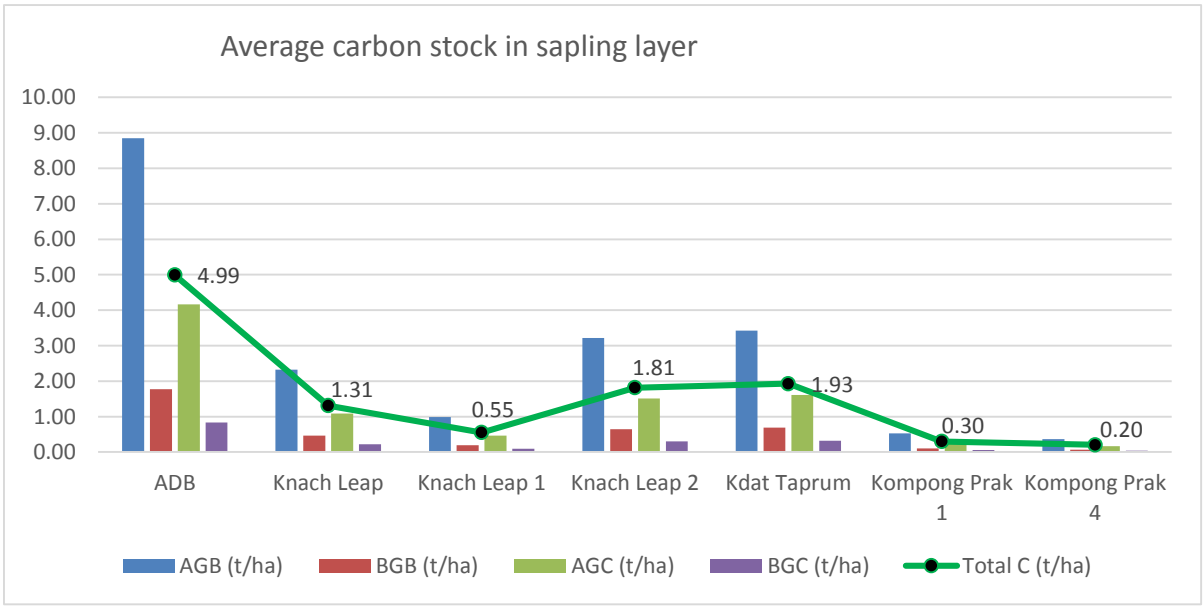


Figure 9: Average carbon stock in sapling layer of each target sites

3.4 Dead wood/Woody Debris Biomass

Based on the results, woody debris comprised the largest total biomass stock by different plots across the site was KL1_2014_1 (8.44 Ct/ha), followed by KP4_2020_3 and KP1_2020_1, 7.67 Ct/ha, and 7.17 Ct/ha, respectively. The other plots recorded a bit different average biomass across restoration sites (Table 6). By including the biomass from deadwood in the estimation, the total carbon stock in different restoration sites was Kampong Prak 4 (6.05 Ct/ha), Kampong Prak 1 (5.10 Ct/ha), Knach Leap 1 (4.03 Ct/ha), Kdat Taprum (3.58 Ct/ha), Knach Leap 2 (3.09 Ct/ha), ADB (2.70 Ct/ha) and Knach Leap 1.92 (Ct/ha), respectively.

Table 6: Woody debris biomass carbon pool

Plot	Plot Avg Large Sound C (t/ha) (>7.6 cm)	Plot Avg Large Rotten C (t/ha) (>7.6 cm)	Plot Avg Medium C (t/ha) (2.54-7.7 cm)	Plot Avg Small C (t/ha) (0.64-2.54 cm)	Fine Plot Avg C (t/ha) (<0.64 cm)	Total (Ct/ha)
ADB_2005_1			0.80	1.20	0.40	2.40
ADB_2005_2			0.63	1.08	0.16	1.87
ADB_2005_3	0.32		0.04	3.19	0.29	3.84
					Average	**2.70**
KL_2012_1		0.12	0.22	1.07	0.20	1.61
KL_2012_2			0.04	0.65	0.28	0.98
KL_2012_3			0.22	2.12	0.67	3.02
KL_2012_4			0.27	1.55	0.23	2.05
					Average	**1.92**
KL1_2014_1			3.04	4.87	0.53	8.44
KL1_2014_2			0.45	1.49	0.40	2.34
KL1_2014_3			0.00	1.17	0.15	1.31
					Average	**4.03**
KL2_2015_1			0.31	1.98	0.66	2.96
KL2_2015_2			0.22	2.42	0.39	3.03
KL2_2015_3			0.22	2.50	0.56	3.29
					Average	**3.09**
KTP_2010_1			1.07	3.87	0.27	5.21
KTP_2010_2	0.38		0.09	0.98	0.26	1.71
KTP_2010_3			0.22	1.86	0.27	2.36
KTP_2010_4			1.30	3.30	0.45	5.05
					Average	**3.58**
KP1_2020_1			2.15	4.64	0.38	7.17
KP1_2020_2			0.09	1.22	0.48	1.79

KP1_2020_3			0.00	5.28	1.05	6.33
					Average	**5.10**
KP4_2020_1			2.37	3.60	0.34	6.32
KP4_2020_2	0.79	1.09	2.46	0.64	0.28	5.26
KP4_2020_3	2.16		1.79	2.95	0.78	7.67
KP4_2020_4	1.15		1.61	1.89	0.28	4.94
					Average	**6.05**

3.5 Soil Organic Carbon

Figure 10 shows the total soil organic carbon stock of flooded forests by restoration sites. The results found that the KL_2012_2 is the highest SOC (152.42 Mg/ha), followed by KP1_2020_3 (152.13 Mg/ha), respectively. High SOC can be found in sites where high vegetation cover predominance and covered with peat soil. Soil is the largest pool of organic carbon in the terrestrial biosphere, and minor changes in soil organic carbon (SOC) storage can impact atmospheric carbon dioxide.

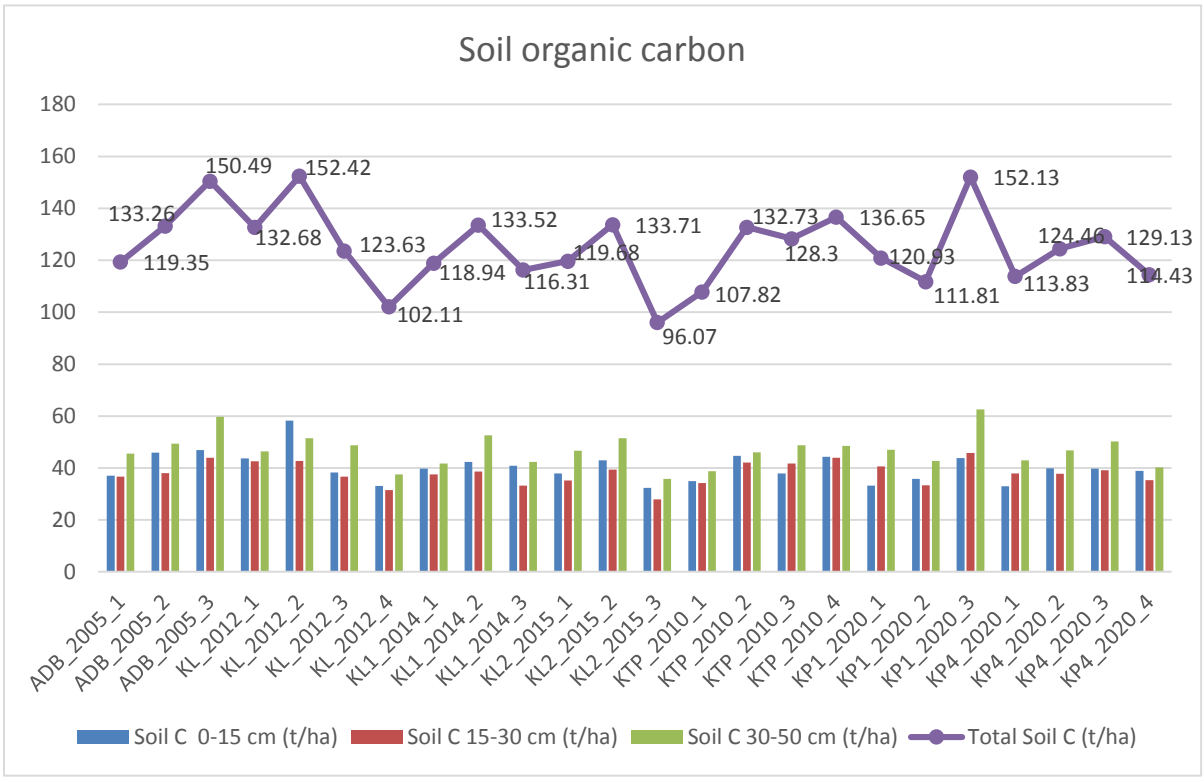


Figure 10: Soil organic carbon stock in each target sites

3.6 Total Ecosystem Carbon Stock

The mean C stock measured from the ADB site (147.84.8±7.08 Ct/ha equal to 542.08 CO2eq), was greater than other vegetated ecosystems (Table 7), while the lowest in KTP (122.23±5.43 Ct/ha equal to 448.18 CO2eq). The difference appeared to be made by the period of regenerated plants and available natural trees in the areas, particularly during the dry season when the field

survey. As a result, the above-ground tree (AGB) biomass in each plot was also different depending on the number of trees present in the plots and forest types.

Table 7: Carbon pools divided into discrete ecosystem components from different restoration sites

Sites	ADB (t C ha)	KP_4 (t C ha)	KP_1 (t C ha)	KTP (t C ha)	KL (t C ha)	KL_1 (t C ha)	KL_2 (t C ha)
Carbon in trees, saplings							
Trees (> 5 cm)	4.78±1.97	0.36±0.43	0±0	0.6±0.52	0.17±0.16	0.02±0.03	0.17±0.19
Saplings & (< 5 cm)	4.2±2.25	0.2±0.16	0.2±0.35	1.6±0.93	1.1±1.27	0.5±0.54	1.5±1.46
Carbon in downed woody debris							
Large sound (>7.6 cm)	0.1	0.0	0.0	0.0	0.1	0.0	1.0
Large rotten (7.6 cm)	0.0	0.0	0.0	0.0	0.0	0.0	0.3
Medium (2.54-7.7 cm)	0.5	0.2	1.2	0.3	0.7	0.8	2.1
Small (0.64-2.54 cm)	1.8	1.4	2.5	2.3	2.5	3.7	2.3
Fine (<0.64 cm)	0.3	0.4	0.4	0.5	0.3	0.6	0.4
Downed wood carbon	2.7	1.9	4.0	3.1	3.6	5.1	6.1
Total above-ground carbon	11.68±2.99	2.48±0.46	4.23±0.35	5.29±1.07	4.85±1.28	5.62±0.54	7.72±1.47
Below-ground carbon in roots							
Trees (>5cm)	0.96±0.39	0.07±0.09	0±0	0.12±0.1	0.03±0.03	0.004±0.01	0.03±0.04
Saplings (<5cm)	0.8±0.45	0.03±0.03	0.05±0.07	0.32±0.19	0.22±0.25	0.09±0.11	0.3±0.29
Soil carbon by depth below-ground							
0-15 cm	43.3±3.1	43.3±3.49	41±4.37	37.7±3.54	40.4±5.11	37.6±2.69	37.9±5.45
15-30 cm	39.5±2.99	38.4±2.01	36.5±5.03	34.1±2.58	40.5±3.39	39.9±2.92	37.6±4.75
30-50 cm	51.5±4.72	46±3.25	45.5±5.56	44.7±3.03	45.5±4.11	50.8±5.56	45±5.6
Soil carbon	134.4±6.39	127.7±5.17	122.9±8.67	116.5±5.32	126.4±7.38	128.3±6.83	120.5±9.15
Total below-	136.16±8.49	127.8±6.43	122.95±11.46	116.94±6.64	126.65±9.1	128.394±9.28	120.83±11.73

ground carbon							
Total ecosystem carbon	147.84±7.08	130.28±5.19	127.18±8.68	122.23±5.43	131.5±7.49	134.0±6.85	128.55±9.27
CO_2 e of the ecosystem	542.08	477.69	466.33	448.18	482.17	491.38	471.35

3.7 Uncertainty in the Carbon Stock Estimate

The total ecosystem C stock of the ADB site was 147.84 Ct/ha, with a 95% CI of 9.51 which resulted in 138.33 Ct/ha. The uncertainty in the estimate was 5.6%. In contrast, the other total ecosystem C stocks were the same as the above-mentioned indicated in Table 11, accordingly. Based on the estimation of AGB (t/ha) by forest types in Cambodia of the first Forest Reference Level (FAO, 2019 cited in RGC, 2022), the flooded forest was AGB (79.73 t/ha), BGB (15.95 t/ha), and C stock (44.97 Ct/ha) equal to 164.88 CO2 t/ha. Overall, the uncertainties in the total ecosystem C stock estimate were around 10% (Figure 11).

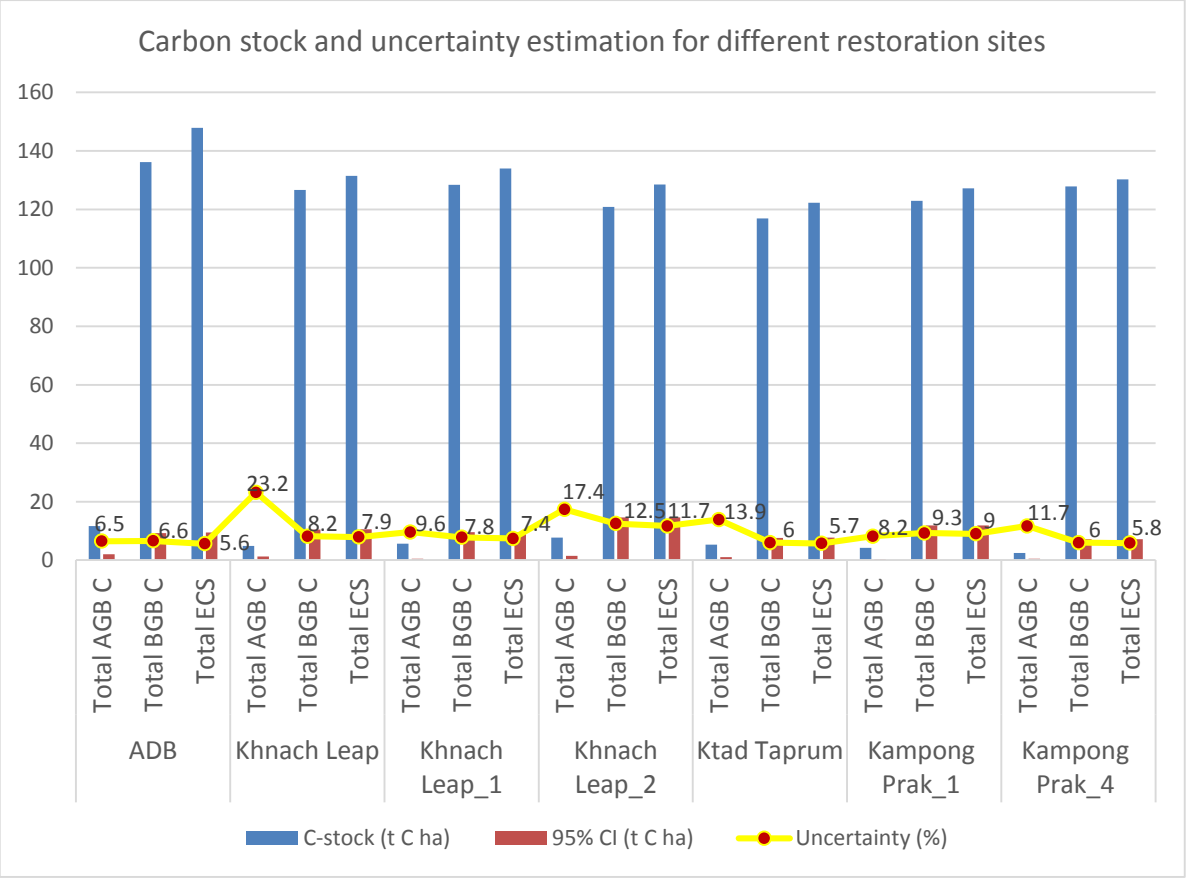


Figure 11: Carbon stock and uncertainty estimates in target sites

4. Conclusion

The study used the SWAMP protocol developed by Kauffman and Donato (2012) for estimation the flooded forest biomass and carbon stock in the all of forest types in the restoration sites. A

total of 24 clusters equal to 120 permanent sample plots with all forest types in flooded forests of the restoration were assessed. The results found that the flooded forest played a key role in C stock among other dominant vegetated ecosystems surrounding Tone Sap Great Lake. The tree species with DBH≥5 cm was found 9 species including *Barringtonia acutangular, Diospyros cambodiana, Combretum trifoliatum, Terminalia cambodiana Gagnep, Gmelina asiatica, Acacia Caesia, Bobach, Crateva, adansonii, and Flueggea virosa.*

Overall, each carbon pool of a total CO_2 equivalent of the ecosystem indicated that the ADB site (542.08 CO_2 t/ha) is the highest in restoration sites, followed by Knach Leap 1 (491.38 CO_2 t/ha) and Knach Leap (482.17 CO_2 t/ha), Kompong Prak 4 (477.69 CO_2 t/ha), Knach Leap 2 (471.35 CO_2 t/ha), Kompong Prak 1 (466.33 CO_2 t/ha), Kdat Taprum (448.18 CO_2 t/ha), respectively. Finally, the ADB site has a total CO_2 equivalent that is the highest, compared to other clusters across all sites.

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Degraded Forest Rehabilitation and Sustainable Forest Management in China

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1. Current Status of Deforestation and Forest Degradation in China

China has made significant progress in increasing its forest cover in recent decades [1]. According to the 2022 China Land Greening Status Bulletin, China has around 231 million ha of forest (Fig. 1), covering about 24.02% of its land area in 2022 (https://www.forestry.gov.cn/main/6246/20230314/164636667716389.html). Between 1973 (the first national forest inventory) and 2022, the forest coverage rate increased from 12.07% to 24.02%, and the forest volume increased by 11.48 billion m^3 (Figs. 2 and 3). Notably, China's forest area and volume have maintained "dual growth" for 30 consecutive years since the late 1980s, making it the economy with the largest increase in global forest resources [2]. These results indicate that China's forest resources have entered a positive development trajectory, exhibiting continuous increases in both quantity and quality, and function enhancement. This progress reflects the economy's extensive efforts in afforestation and reforestation.

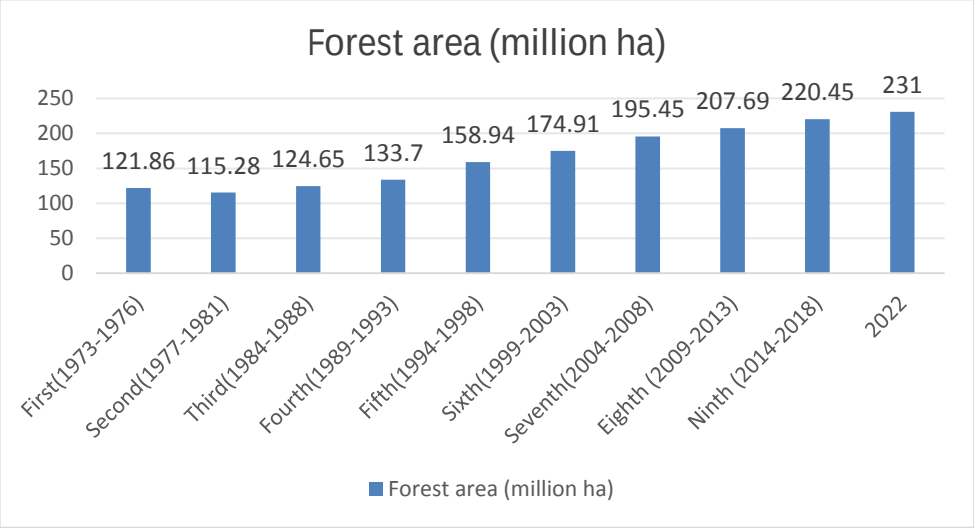

Figure 1: Forest area during 1973-2022. The 9 national forest resource inventories conducted from 1973 to 2018[2], data for year 2022 was accessed from "2022 China Land Greening Status Bulletin" (https://www.forestry.gov.cn/main/6246/20230314/164636667716389.html)

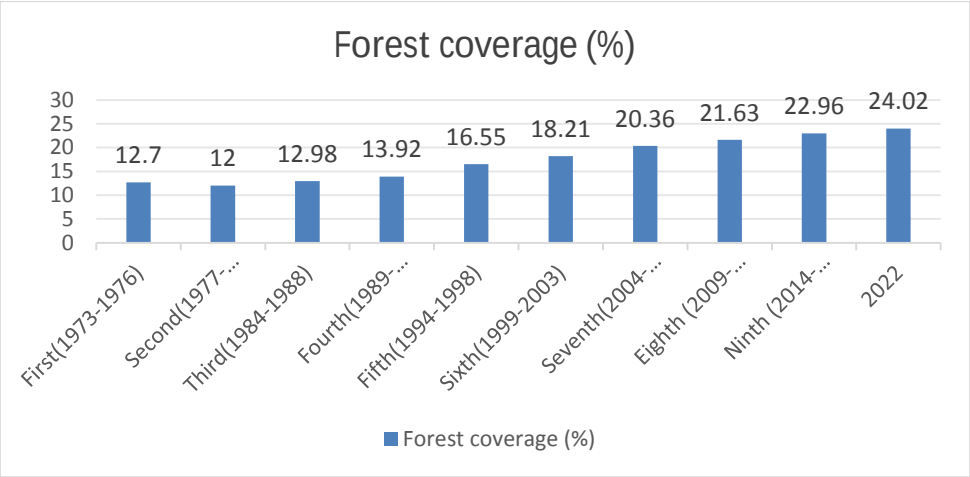

Figure 2: Forest coverage during 1973-2022.

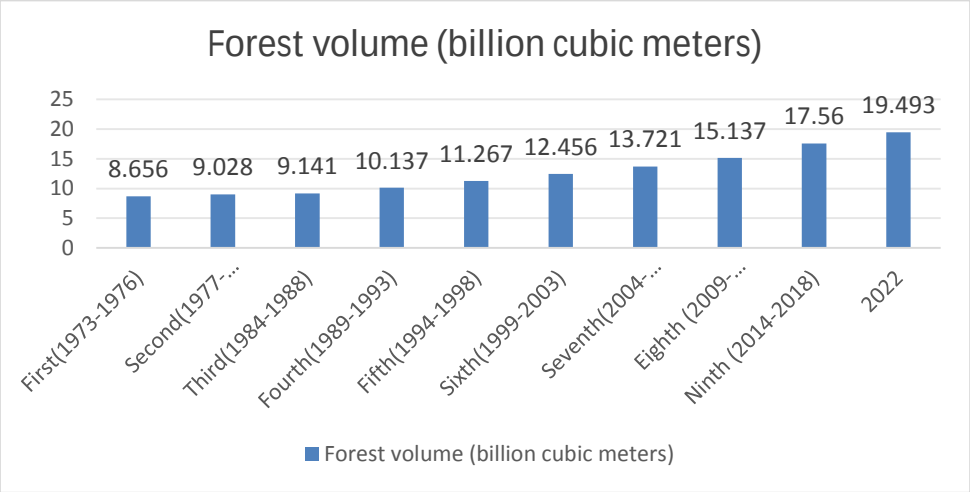

Figure 3: Forest volume during 1973-2022.

China has made significant progress in forest rehabilitation, but it still faces the challenge of forest degradation in some regions. China's forest coverage rate decreased from 50% over two thousand years ago to 16.55% in the 1990. Global Forest resources assessment indicated that China has lost 12.1 million ha of forest between 2001 and 2023, a total of 977,000 ha of forest cover was reduced due to fire, while other reduction drivers accounted for 11.1 million hectares[1]. The main drivers of deforestation and forest loss include agricultural expansion, land use change, infrastructure development, unsustainable logging, quarrying and mining activities, as well as natural disturbances like wildfires, pests, and diseases[4].

Since 2018, the National Forestry and Grassland Administration (NFGA) has taken strong measures to address forest degradation, including supervisory actions in 51 regions with serious forest and grassland resource damage, oversight of 67 typical cases of deforestation and grassland destruction, public reporting of 59 typical problems, and issuing warnings and summoning 41 responsible government officials. The forestry and grassland authorities at all levels have investigated and handled a total of 493,600 administrative cases in the forestry and grassland sectors. These cases involved the illegal occupation of 1.599 million mu (approximately 106,600 ha) of forest and grassland areas, as well as 18,000 mu (approximately

1,200 ha) of protected areas or habitats. Additionally, the cases involving the illegal logging of 805,100 m^3 of timber. These actions have effectively promoted the investigation and rectification of these cases, forming a strong deterrent effect (https://www.forestry.gov.cn/lyj/1/slzyjd/20240724/578370.html).

To address the forest degradation caused by human activities, the NFGA has improved the system for protecting forest and grassland resources, innovated law enforcement and supervision methods, organized special campaigns, severely reducing illegal deforestation and grassland destruction, and resolutely safeguarded the bottom line of forest and grassland resource security. Additionally, China has made efforts to improve disaster prevention and response capabilities to address deforestation caused by natural disturbances, including enhancing early warning, emergency response, and post-disaster recovery mechanisms for forest and grassland ecosystems. While China has made significant progress in increasing its overall forest cover, it still faces challenges in managing the competing demands for land use and ensuring the long-term sustainability of its forest resources.

2. Forest Rehabilitation Approaches Overview

In the late 20th century, land use activities in China were constantly intensified, and unreasonable land development activities often came at the expense of the environment. The reclamation of forests and grasslands in the north led to the aggravation of wind and sand and soil erosion. The major floods in 1998 further highlighted the adverse impact of regional development on the ecology. To improve the deteriorating ecological situation in China, the State Council approved the implementation of the “Six Key Forestry Projects” in early 2001, and included them in the "Tenth Five-Year Plan". The Six Key Forestry Projects namely: 1) Natural Forest Resources Protection Project (NFRPP)[5], 2) Return Farmland to Forests Project (RFFP, Fig 4)[6], 3) Key Shelterbelt Construction Program in North, Northeast and Northwest China and the Lower-Middle Reaches of the Yangtze River[7], 4) Beijing-Tianjin Sandstorm Source Control Project[8], 5) Wildlife Protection and Nature Reserve Development Program, 6) Fast-Growing and High-Yielding Timber Base Construction Program in Key Areas (Table 1).

Figure 4: Return Farmland to Forests Project in Hezhen Town, hezhang County, Bijie City, Guizhou Province. Photo credited to Kuang Huabin.

Table 1: The Six Key Forestry Projects promote the forest rehabilitation in China

ID	Project/Programme	Period	Objective	Target area
1	Natural Forest Resources Protection Project (NFRPP)	Phase I (2000-2010) Phase II (2011-2020)	To solve the problems of natural forest rehabilitation and development in China through measures such as banning the felling of natural forests, natural forest rehabilitation, and planned resettlement of forestry workers in forest areas.	The upper reaches of the Yangtze River (with the Three Gorges Reservoir area as the boundary) include the provinces (autonomous regions and municipalities) of Yunnan, Sichuan, Guizhou, Chongqing, Hubei, and Tibet. The middle and upper reaches of the Yellow River (with the Xiaolangdi Reservoir area as the boundary) include the provinces (autonomous regions) of Shaanxi, Gansu, Qinghai, Ningxia, Inner Mongolia, Henan, and Shanxi. The key state-owned forest areas in Northeast China and Inner Mongolia include Inner Mongolia, Jilin, Heilongjiang, Hainan, and Xinjiang (including the Xinjiang Production and Construction Corps), a total of 17 provinces (autonomous regions and municipalities), involving 724 counties, 160 key enterprises, and 14 nature reserves.
2	Return Farmland to Forests Project (RFFP), also known as the Sloping Land Conversion Program and the Grain for Green Program	Phase I (1999-2006) Phase II (2014-now)	The aim is to stop cultivating sloping farmland that is prone to soil erosion, and based on the principle of planting trees suitable for the local conditions, plant trees and restore forest vegetation accordingly. This project has two main aspects: 1) Retiring sloping farmland and returning it to forests; 2) Afforestation of suitable barren mountains and wastelands.	(i) Areas with severe soil and water loss; (ii) Areas with serious desertification, salinization, and rocky desertification; (iii) Areas with important ecological status but low and unstable food production.
3	Key Shelterbelt Construction Program in North, Northeast and Northwest China and the Lower-Middle Reaches of the Yangtze River	(1) Key Shelterbelt Construction Program in North, Northeast and Northwest China. Objective of this program is to fundamentally change the situation of wind and sand hazards and soil and water loss in the northwestern, northern, and northeastern regions of China. The construction area of the Three-North Shelterbelt Program extends from Binxian County in Heilongjiang Province in the east to the Wuzhibie Lishan Pass in Xinjiang in the west, and is bounded by the national border in the north, and Tianjin, the Fenhe River, the Weihe River, the Taohe River, the Buchanghan Mountains, and the Karakoram Mountains in the south, covering a distance of 4,480 kilometers east to west and a width of 560-1,460 kilometers north to south. The geographical location is between 73 °26'-127 °50' E and 33 °30'-50 °12' N. It includes 551 counties (banners, cities, and districts) in 13 provinces (autonomous regions and municipalities) including Shaanxi, Gansu, Ningxia, Qinghai, Xinjiang, Shanxi, Hebei, Beijing, Tianjin, Inner Mongolia, Liaoning, Jilin, and Heilongjiang. The Three-North Shelterbelt Program is planned to be implemented from 1978 to 2050, lasting 73 years, and divided into three stages and eight phases. The first stage is from 1978 to 2000, divided into three phases: Phase I: 1978-1985; Phase II: 1986-1995; Phase III: 1996-2000. The second stage is from 2001 to 2020, divided into two phases: Phase		

		IV: 2001-2010; Phase V: 2011-2020. The third stage is from 2021 to 2050, divided into three phases: Phase VI: 2021-2030; Phase VII: 2031-2040; Phase VIII: 2041-2050. The current phase under construction is Phase V. (2) Key Shelterbelt Construction Program in the Lower-Middle Reaches of the Yangtze River. The objective of this program is to improve the increasingly deteriorating ecological environment in the Yangtze River basin. Phase I (1989-2000) focused on the restoration of vegetation, covering 271 counties (cities and districts) in 12 provinces (autonomous regions and municipalities) in the middle and upper reaches of the Yangtze River, including Anhui and Jiangxi. Phase II (2001-2010) expanded the construction area to the Yangtze River and Huai River basins, involving 1,035 counties (cities and districts) in 17 provinces (autonomous regions and municipalities), including Shanghai, Jiangsu, Zhejiang, Anhui, Jiangxi, Shandong, Henan, Hubei, Hunan, Chongqing, Sichuan, Guizhou, Yunnan, Tibet, Shaanxi, Gansu, and Qinghai. Phase III (2011-2020) continued the construction scope of Phase II, involving 1,026 counties (cities and districts) in 17 provinces (autonomous regions and municipalities).		
4	Beijing-Tianjin Sandstorm Source Control Project	Phase I (2000-2012) Phase II (2013-2022)	Through measures such as vegetation protection, tree and grass planting, returning farmland to forests, small watershed and grassland management, and ecological migration, a high-quality and highly stable ecological protection system will be built. This will optimize the ecological environment of the capital and surrounding areas, enhance Beijing's international status, realize a green Olympics, and ensure the coordinated economic and social development of this region.	Phase I covered 75 counties (banners and districts) in 5 provinces (autonomous regions and municipalities) including Beijing, Tianjin, Hebei, Shanxi, and Inner Mongolia, involving 7 districts in Beijing (Mentougou, Fangshan, Changping, Pinggu, Huairou, Miyun, and Yanqing). Phase II expanded the program nationwide, adding Shaanxi Province, and including the Daxing District in Beijing. It now covers 138 counties (banners and districts) in 6 provinces (autonomous regions and municipalities). The construction involves forestry, agriculture, water conservancy, and relocation projects.
5	Wildlife Protection and Nature Reserve Development Program	Phase I (2001-2010) Phase II (2011-2030)	To further strengthen the protection and management of wild animals and plants and their habitats, enhance public awareness of wildlife conservation, increase investment in wildlife protection and nature reserve construction, and promote their sustainable, stable, and healthy	According to the distribution characteristics of state-protected wild animals and plants, the overall planning for the protection of wild animals and plants and their habitats is divided into 8 construction regions geographically: Northeastern mountain and plain region, Mongolian-Xinjiang highland and desert region, North China Plain and Loess Plateau region, Qinghai-Tibet Plateau cold region, Southwestern mountainous and canyon region, Central and Western hilly and mountainous region, Eastern hilly and plain region, Southern low mountain and hilly region

		Phase III (2031-2050)	development, so that they can play a greater role in the national ecological environment and economic construction.	
6	Fast-Growing and High-Yielding Timber Base Construction Program in Key Areas	Stage I (2001-2005) Stage II: Phase I (2006-2010) Phase II (2011-2015)	The main purpose of this project is to: Optimize the timber resource structure, Improve the timber supply capacity, meet the growing production and living needs of the people, Protect the ecological environment, Improve land use efficiency, Promote agricultural economic development	Based on the principles of forest zoning, the project will primarily focus on establishing fast-growing, high-yield timber plantations in the following regions: East of the 400mm rainfall line, prioritizing the areas east of the 600mm rainfall line, where natural conditions are favorable, site conditions are good (with a site index generally above 14), terrain is relatively flat, and the risk of soil erosion and impact on the ecological environment is low. This includes the Guangdong-Guangxi-Hainan-Fujian region in the tropical and subtropical zones, the middle and lower reaches of the Yangtze River region in the northern subtropical zone, and the middle and lower reaches of the Yellow River (including the Huai River and Hai River basins) in the temperate zone, as well as the Northeast and Inner Mongolia region in the cold temperate zone. The specific construction scope involves 1,000 counties (cities and districts) in 18 provinces and regions, including Hebei, Inner Mongolia, Liaoning, Jilin, Heilongjiang, Jiangsu, Zhejiang, Anhui, Fujian, Jiangxi, Shandong, Henan, Hunan, Hubei, Guangdong, Guangxi, Hainan, and Yunnan.

In February 2019, the U.S. National Aeronautics and Space Administration (NASA) released a satellite image of the Earth and proudly announced that the forest coverage has increased by 5% over the past 20 years since 2000. This increase is equivalent to the total area of the Amazon rainforest, and at least 25% of this achievement can be attributed to China. Which could be due to the fact that, since 1990s, China has been actively implementing large-scale afforestation and reforestation programs as mentioned above.

Figure 5: Planted forests in Inner Mongolia, China (https://www.apfnet.cn/project/projects/4486.html)

During the implementation of these programs, China has adopted a range of rehabilitation approaches, including natural regeneration, enrichment planting, and the establishment of diverse, mixed-species forests (Figure 5). In order to achieve simultaneous economic and ecological growth, single-objective forest management is also shifting towards multi-functional forest management in recent decades. China has also strengthened the coordination between different government agencies, such as the forestry, agriculture, and environmental sectors, to enhance the effectiveness of forest rehabilitation efforts. Policies and laws is the foundation and prerequisite for achieving forest rehabilitation and conservation (Table 2). These revisions in policies, laws, and institutional arrangements have contributed to significant progress in forest rehabilitation in China, leading to an increase in forest cover and the improvement of forest ecosystem services. Meanwhile, China has significantly increased its investment in forest rehabilitation, with annual spending on afforestation and reforestation reaching over $9 billion in recent years.

Table 2: Laws/regulations related to forest rehabilitation

ID	Laws/regulations	Promulgated/revised year	Objective
1	Regulations on Conversion of Farmland to Forest	2003	standardize the activity of returning farmland to forests, protect the legitimate rights and interests of those who return farmland to forests, consolidate the achievements of returning farmland to forests, optimize the rural industrial structure, and improve the ecological environment.
2	Forestry Law of the People's Republic of China	revised in 2019	provides the legal framework for forest management, protection, and rehabilitation
3	Law of the People's Republic of China on the Protection of Wildlife	revised in 2018	supports biodiversity conservation in forest ecosystems
4	Land Administration Law of the People's Republic of China	revised in 2019	regulates the use and protection of land resources, including forest land
5	Decision on Accelerating Forestry Development	2003	accelerate forestry development, achieve the grand goal of beautiful mountains and rivers, and promote national economic and social development
6	Reform of Collective Forests	2008	clarifying and defining property rights of forest resources to promote responsible and sustainable management, improving economic returns for local communities by enhancing their ownership and control over these resources, and promoting sustainable forestry practices that balance ecological health with economic growth.

3. Case Study-The Natural Forest Resources Protection Project (NFPP)

In an effort to improve the environmental conditions and enhance the well-being of its population, China has implemented one of the world's largest ecological rehabilitation projects of the early 21st century: the Natural Forest Protection Program (NFPP). This program is the first and only super-scale ecological project in the world that primarily aims to prevent deforestation and conserve natural forests through a ban on logging. With substantial central government financing, the NFPP has had profound global ecological and socioeconomic impacts. The NFPP has completed its phase II, the experience of during the implementation period can provide valuable insights for other economies grappling with urgent environmental

challenges. By critically examining both the strengths and limitations of this large-scale ecological rehabilitation program, policymakers and researchers can derive meaningful lessons to inform more effective and balanced approaches to environmental conservation and sustainable development.

Figure 6: Distribution of Natural Forests in China (left) and the Planned Project Area of NFPP (Right). Source from online resources published by China Green Watcher

Project background. Natural forests constitute the core of China's forest resources. Enhancing their protection is vital for conserving biodiversity, ensuring national ecological security, and fostering sustainable socio-economic development. China's natural forests currently cover an area of 2.08 billion mu (approximately 138.7 million ha), with a standing timber volume of 13.67 billion m^3. These natural forests, representing 64% of the economy's total forest area and 80% of its forest stock volume, play an irreplaceable role in maintaining ecological equilibrium and safeguarding national land security (Fig. 6). Over a long period, the state-owned forest regions in Northeast China, Inner Mongolia, the upper reaches of the Yangtze River, and the middle and upper reaches of the Yellow River have provided vast amounts of timber to support the economy's construction and people's livelihoods. However, this has also led to a sharp decline in natural forest resources, a forest resource crisis in state-owned forest areas, and economic difficulties for forest communities. The ecological environment in these regions has deteriorated continuously. In the 1990s, the upper reaches of the Yangtze River and the middle and upper reaches of the Yellow River alone saw over 2 billion tons of sediment entering the rivers each year due to soil erosion. This has resulted in increasing siltation and rising water levels in the downstream rivers and lakes, exacerbating flood disasters that have severely impacted the production and lives of the general public. After the major flood disaster in 1998, the Central Committee of the Communist Party of China and the State Council made the strategic decision to implement the NFPP to address these pressing environmental challenges. The launch of the NFPP marked a historic shift in China's forestry sector, transitioning from a primary focus on timber production to prioritizing ecological conservation and restoration. In accordance with the spirit of the "Opinions of the Central Committee of the Communist Party of China and the State Council on Post-disaster Reconstruction, Comprehensive Management of Rivers and Lakes, and Water Conservancy Construction," which called for a "comprehensive ban on the logging of natural forests in the upper and middle reaches of the Yangtze River and Yellow River basins, and the transformation of forest enterprises towards forest management

and protection," the National Forestry Administration formulated the "Implementation Plan for the Natural Forest Protection Project in the Upper Reaches of the Yangtze River and the Middle and Upper Reaches of the Yellow River" and the "Implementation Plan for the Natural Forest Protection Project in the Key State-owned Forest Regions of Northeast China and Inner Mongolia." The State Council held two executive meetings to review the above plans, and in October 2000, the implementation plans were approved, officially launching the NFPP.

Figure 7: NFPP project area in Xuanyi Hubei Province (left) and Shanxi Province (right). Figures sourced from https://new.qq.com/rain/a/20210630A05NRW00

Main achievement: The implementation of the NFPP has brought about tremendous ecological, economic, and social benefits, making it one of the major achievements of the reform and opening-up process. The NFPP in China began with pilot projects in 1998 and was fully launched in 17 provinces (autonomous regions and municipalities) in 2000. By 2010, the first phase of the project was completed, and the second phase was implemented from 2011 to 2020.

Figure 8: NEPP in Hainan Province (source: https://www.fx361.com/page/2019/1231/6249051.shtml). For severely degraded habitats or forest areas where natural regeneration is difficult, this type of forest often suffers from severe soil erosion, leading to thin and poor soil.

After more than 20 years of protection and cultivation, the state has invested 508.3 billion yuan in the NFPP, which has cumulatively completed the establishment of 306 million mu of public welfare forests, the cultivation of 165.1 million mu of reserve forest resources, and the tending of 273 million mu of forests. Effectively protecting 1.944 billion mu of natural forests. China's total forest vegetation carbon storage reached 9.186 billion tons, of which more than 80% originated from natural forests. The implementation of NFPP has achieved the following Six major accomplishments:

Forest Resource Restoration and Enhancement. The forest resources in the NFPP areas have achieved restorative growth. Through the cessation of excessive logging and effective protection, the trend of long-term over-exploitation of forest resources in the project areas has been effectively curtailed, and the total forest resource has continued to increase, with a significant improve in natural forests quality.

(2) Ecological Benefits. The water conservation and soil retention capacity of natural forest areas has been significantly enhanced, and biodiversity has become increasingly rich. Rare wildlife such as the Siberian tiger, Siberian leopard, giant panda, crested ibis, and golden snub-nosed monkey have seen their populations increase.

(3) Economic and Industrial Transformation. The economic structure of the forest areas has been adjusted, with surplus workers being resettled. The traditional forestry management model focused on timber production has been realigned, and the development of non-timber and non-forestry industries has been actively promoted, cultivating new economic growth initiatives. This has accelerated the construction of deep processing of timber products, the development of green food, animal husbandry and traditional Chinese medicine industries, as well as other industries such as forest tourism, wind and hydro-power, and green energy, marking a shift from a "single-pillar" to a "multi-pillar" forestry economy and from a "forestry economy" to a "forest-based economy".

(4) Institutional Reform and Governance. The project has also promoted the transformation of forestry enterprises towards the modern enterprise system. Regions have actively explored paths for natural forest protection and forest-based economic development suited to local characteristics. Forestry enterprises have gradually shifted from a traditional management system centered on timber to a market-oriented operation and management approach, strengthening their roles and responsibilities in forest management and protection.

(5) Ecological Civilization Awareness. The implementation of the NFPP has also significantly raised the public's ecological awareness. The project units have widely publicized the significance and achievements of the NFPP through various media, fostering a favorable atmosphere of attention, support, and participation in natural forest protection across the economy, and promoting the formation of an ecological civilization concept.

(6) Livelihood Improvement. The project has also effectively improved people's livelihoods. In terms of social insurance for workers, it has covered basic pension, basic medical care, unemployment, work injury, and maternity. In state-owned forest areas, housing construction for workers has been implemented through the renovation of shanty towns, with government

subsidies and enterprise contributions. The project has also provided employment opportunities, creating 205,300 jobs in the upper reaches of the Yangtze and Yellow Rivers, and 443,200 jobs in the key state-owned forest regions of Northeast China and Inner Mongolia.

4. Lessons That Could Be Learnt from This Project/Programme

NFPP have adopted a comprehensive approach by integrating forest management, ecological restoration, livelihood support, and stakeholder engagement, which has been crucial for achieving sustainable outcomes. One of the key elements of success is the adaptive management strategy, where China has shown the ability to adjust its policies and implementation strategies based on monitoring and evaluation of past experiences. This adaptive management approach allows for continuous improvement and refinement of the programs. Additionally, balancing conservation and development has been a critical component. Efforts like the "Grain for Green" program aimed to balance forest conservation with local economic development needs, addressing the requirements of diverse stakeholders, including local communities, which is essential for the long-term success of these initiatives.

The success of NFPP can also be attributed to several key elements, including a strong policy and legal framework. Forestry Law and Wildlife Protection Law provide a solid foundation for protection efforts, with periodic updates addressing emerging challenges. Institutional coordination among various government agencies, such as those overseeing forestry, agriculture, and environment, is essential for integrated land-use planning and execution. Local government involvement strengthens the implementation and monitoring of efforts. Moreover, enhancing technical capacity through investments in scientific research, technology development, and capacity building of forest management personnel improves technical expertise, while knowledge sharing facilitates the adoption of best practices. Financial mechanisms, including substantial investments from both government and international sources and innovative financing like payments for ecosystem services, support the scaling up of protection programs.

Stakeholder engagement is pivotal for the success of natural forest protection efforts. Effective collaboration with local communities, the private sector, and civil society organizations enhances the initiatives' success. By incorporating local traditional knowledge and involving stakeholders in decision-making, the relevance and sustainability of initiatives are improved.

Despite significant progress, challenges remain, such as addressing the underlying drivers of deforestation, ensuring long-term resilience of rehabilitated forests, and better integrating forest management with other land-use activities. Additionally, further research is still needed in the following areas regarding the implementation of the existing Natural Forest Protection (NFP) policies, the appropriate scale for natural forest protection, the ecological compensation mechanism for natural forests, the rehabilitation of degraded natural forests, and the sustainable management of natural forests.

5. Recommendations

China's expansive landscape, characterized by numerous rivers, lakes, and intersecting mountain ranges, along with its intricate and varied land-forms and diverse climatic conditions influenced by latitude, longitude, and altitude, has resulted in a multifaceted natural geographic environment that fostering rich biodiversity and a wide variety of forest vegetation types. The NFPP is a complex social system project that has involved the implementation of a series of regulations and policies. Which is not only strictly protects natural forest resources, but also includes rehabilitation of natural forests, reducing timber production, relocating surplus employees from enterprises, and addressing the reduced fiscal revenue for local governments' issue. Thus, NFPP practices of China cannot be directly and simply applied elsewhere, there are still some opportunities for replicating and scaling up to other economies, for example, adaptive management strategy, the biodiversity protection and sustainable management planning techniques, stakeholder engagement, a strong policy and legal framework and finance support.

China's forest restoration work has been continuously updating and evolving. With the promulgation and implementation of the "Natural Forest Protection and Restoration System Plan" in 2019, China's natural forest protection has transitioned from a previous project-based approach to a long-term strategic focus. The protection strategy has also shifted from being government-led to one that involves broader participation of various social stakeholders. In addition, "The 'General Plan for Major Projects in the Protection and Restoration of Important National Ecosystems (2021-2035)' in 2020" is grounded in the national ecological security strategy and emphasizes ecological support for key national initiatives. It outlines a comprehensive framework for significant projects aimed at protecting and restoring vital ecosystems (integrating the ecological elements of mountains, rivers, forests, farmland, lakes, and grasslands) across the economy. Which indicated that China has transitioned from forest rehabilitation to a stage of integrated management.

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Status Report on the State of Degraded Forest Rehabilitation and Sustainable Forest Management in Lao PDR

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Abstract: The Lao People's Democratic Republic (Lao PDR) faces threats to its vast forest habitats due to deforestation and degradation caused by factors like agricultural expansion, illegal logging, and infrastructure development. The government, international partners, and local communities are implementing initiatives to rehabilitate degraded forests and promote sustainable management. This report assesses the current state of forest degradation, analyzes primary drivers of deforestation, examines progress in restoring areas, and highlights best practices for future efforts. It concludes with recommendations for strengthening forest governance, improving rehabilitation strategies, promoting sustainable practices, and enhancing community involvement in conservation.

1. Introduction

The Lao People's Democratic Republic is home to some of the most ecologically diverse and endangered terrestrial and aquatic habitats and species in the world. It is situated at the convergence of four significant ecoregions. It is composed of four physiographic zones with fundamentally varied agro-climatic features, and has exceptionally high biodiversity values: (i) the Northern Highlands - a rugged mountainous region with a dry sub-tropical climate; (ii) the Annamite Range - a mountainous topography with high monsoonal rainfall; (iii) the Indo-Chinese karst landscapes of Central Lao PDR; and (iv) the Mekong Plain - an alluvial plain along the Mekong and its larger tributaries with a tropical monsoon climate and variable rainfall. Lao PDR is known for its high biodiversity and diverse production systems for food, fiber, and medicines. It supports a rich diversity of floral and faunal species, including 8,000-11,000 economically valuable flowering plants, and 150-200 reptiles, amphibians, birds, bats, large mammals, and fish. However, more species are being discovered, and reptiles, insects, and rodents are poorly documented[1].

Lao PDR, endowed with rich biodiversity and extensive forest cover, faces significant challenges in preserving its natural heritage. Deforestation, forest degradation, and the ensuing loss of ecosystem services have become pressing concerns. This report presents an assessment of the current state of degraded forest rehabilitation and sustainable forest management in Lao PDR. However, over the past few decades, Lao PDR has faced significant challenges related to

[1] Lao Biodiversity: a Priority for resilient Green Growth. World Bank (2020)

deforestation and forest degradation. These challenges have been driven by various factors, including agricultural expansion, illegal logging, infrastructure development, and shifting cultivation practices[2]

This report is also to provide an overview of the nation's progress in restoring degraded forests, implementing sustainable forest management practices, and addressing the underlying drivers of forest loss. It also analyze the underlying factors driving deforestation and degradation, poverty, and weak governance. Furthermore, the report will explore a key output, challenges, and lesson learnt of some forest management and rehabilitation project and program.

In response to these challenges, the government of Lao PDR, in collaboration with international organizations and local communities, has initiated various programs and policies aimed at rehabilitating degraded forests and promoting sustainable forest management. These efforts are crucial not only for restoring ecological balance but also for enhancing biodiversity, mitigating climate change, and supporting the livelihoods of rural communities[3].

2. Status of Forest Management in Laos

Laos, a landlocked economy in mainland Southeast Asia, is known for its hot spots and rich and diverse forest resources. Laos aims to increase forest cover to 70% of its land area by 2035 and sustainable forest landscapes contribute to broader economic development. In the early 21st century, the forestry sector generated nearly **half** of the economy's **Gross Domestic Product (GDP)**. Laos' forest resources have supported several important **wood-processing industries**[4]. But the challenge lies in balancing resource extraction with sustainability [5] . Approximately **67%** of the Lao population resides in rural areas and **depends on forests** for their livelihoods. Forests serve as a **supermarket, pharmacy, and bank** for these communities. "Forests are a significant contributor to poverty alleviation with two-thirds of the population relying on forests for food, fuel, fiber, and medicine, and more than 39 percent of rural family income is derived directly from Non- Timber Forest Products (NTFPs)"[6]. NTFPs contribute significantly to rural family income, accounting for 39% of GDP in 2010 [7]. The forest sector provides employment opportunities, especially among the rural poor. Jobs related to timber, NTFPs, and sustainable forest management contribute to local economies.

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[6] World Bank Document.
[7] Greener Growth through Good Wood: Sustaining Forest Landscapes and Local Livelihoods in Lao PDR (worldbank.org)

According to the Forestry Law of 2019, the government has divided the national forest into three categories: protection forest area, production forest area, and conservation forest area (protected area)[8].

(i) **Conservation forestland areas**, also known as Protected Areas (PAs) in English, include 4.7 million hectares, or 20% of the nation's total land area[9]. They are managed to preserve biodiversity. A comparative advantage for tourism exists in the globally significant biodiversity and habitat integrity found in many of these Protected Areas. Three provincially protected areas have been upgraded to National Protected Areas (NPAs), and six NPAs rich in ecosystems and a unique landscape have been upgraded to National Parks in the past five years[10].

(ii) **Protection forest area:** The main goals of protection forest areas (PtFA) are to safeguard watersheds, reduce the likelihood that natural resources and disasters will harm essential infrastructure and other assets, and support NTFPs and national security. They comprise the largest forestland by area, covering 7.9 million ha or one-third of the total land area of the Lao PDR. They contain only about 57 percent forest cover, the rest being agricultural land and other land uses.

(iii) **Production forest area (AFAs)** covering 51 PFAs, or 3.1 million ha of the total economy's land area. PFAs are managed primarily for the harvesting of wood, fiber, fuel, and non-timber forest products (NTFPs). However, the PFAs are currently subject to a logging ban introduced by the government in 2013.

Laos still boasts a relatively high forest cover compared to many Southeast Asian nations. Natural primary forest areas and trends over time are among the key biodiversity and conservation[11]. Forest resources play a crucial role in the livelihoods of many communities, that rely on the forests for timber, non-timber forest products, and subsistence agriculture, the national economy, and the overall environmental balance. These forests provide valuable ecosystem services, such as carbon sequestration, biodiversity conservation, and watershed protection. The government is trying to increase the forest cover to 70% of the economy's total land area in 2035[12,13]. However, natural primary forests are under increasing pressure from a range of threats including, but not limited to, agricultural expansion, climate change and natural disasters, population growth, overexploitation, illegal logging, and infrastructure development [14].

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2.1 Forest and Land Use Cover Change in Laos

In 2000, the total natural forest area of Laos was estimated at 14 million hectares, which is 61% of the total land area and has slightly decreased to 57% of the economy's land area in 2015[15]. The natural forest cover includes mixed deciduous forests, dry dipterocarp, evergreen, coniferous, and mixed coniferous and broadleaved forests[16]. In 2005, the area of these natural forests covered 60% and in 2022, the area of these natural forests covered 56% of the economy's total land area (Table1 & Figure1)[17,18].

Table 8: Land and forest cover in Laos from 2000 to 2022 (Unit: ha)

Land/forest classification			2000	2005	2010	2015	2019	2022
Level 1	Level 2							
Current Forest	Evergreen Forest	EG	2,617,238	2,618,169	2,613,226	2,605,557	2,594,961	2,563,808
	Mixed Deciduous Forest	MD	9,832,953	9,684,854	9,487,839	9,205,036	9,036,767	8,896,793
	Coniferous Forest	CF	135,510	134,055	125,229	124,772	124,009	123,048
	Mixed Coniferous and Broadleaved Forest	MCB	142,323	142,458	108,567	107,880	106,848	106,229
	Dry Dipterocarp Forest	DD	1,304,130	1,272,006	1,215,712	1,188,198	1,171,873	1,156,563
	Forest Plantation	P	17,889	23,880	110,024	137,965	213,585	295,598
Potential Forest	Bamboo	B	64,662	68,989	91,143	88,900	84,561	79,132
	Regenerating Vegetation	RV	6,166,200	6,090,500	5,840,908	6,073,581	6,087,141	6,166,361
Other Vegetated Areas	Savannah	SA	107,024	105,861	103,253	102,110	69,918	68,936
	Shrubs	SR	27,374	27,472	26,784	26,637	26,391	26,355
	Grassland	G	271,819	269,652	255,834	254,376	250,603	249,481
Cropland	Upland Crop	UC	192,130	208,264	205,272	150,519	132,892	137,919
	Agriculture Plantation	AP	49,526	52,297	81,981	83,306	83,072	74,417
	Rice Paddy/Other Agriculture	RP/OA	1,571,698	1,798,362	2,157,207	2,252,472	2,378,434	2,402,282
Settlement	Urban Areas	U	63,252	64,355	73,296	75,638	100,994	104,003

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Land/forest classification			2000	2005	2010	2015	2019	2022
Level 1	Level 2							
Other Land	Barren Land and Rock	BR	186,366	186,088	185,956	186,157	185,954	185,790
	Other Land	O	17,833	17,673	22,204	31,289	22,319	25,655
Above-ground Water Source	Wetland (Swamp)	SW	10,809	10,425	9,957	9,561	6,072	6,127
	River (Water)	W	275,523	278,892	339,866	350,304	377,863	385,760
Sum			**23,054,258**	**23,054,258**	**23,054,258**	**23,054,258**	**23,054,258**	**23,054,258**

Source data: Department of Forestry, MAF, 2024[19].

2.2 Current State of Deforestation and Forest Degradation

Based on the forest cover data in Table 1 above, the natural primary forest (Evergreen Forest, Mixed Deciduous Forest, Coniferous Forest, Mixed Coniferous and Broadleaved Forest, Dry Dipterocarp Forest) cover decreased from 14 million hectares in 2000 to 12.8 million hectares in 2022 (Figure 1).

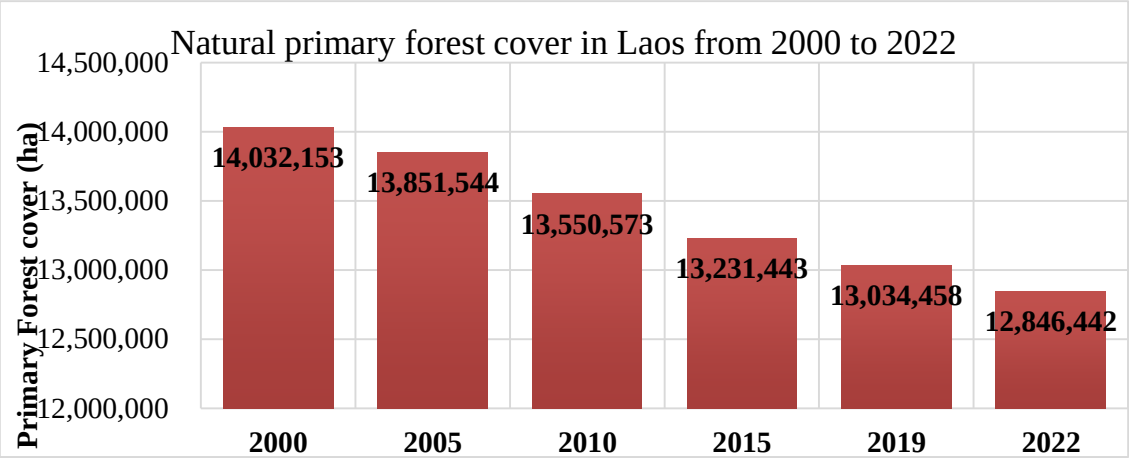

Figure 12: Natural Forest Cover in Laos from the year 2000 to 2022

The Global Forest Watch Data shows that from 2001 to 2023 (Figure 2) Laos lost 1.18 million ha of humid primary forest, making up 24% of its total tree cover loss in the same period. The total area of humid primary forest in Laos decreased by 14% in this period[20].

[19] Department of Forestry, MAF. Laos - National Forest Monitoring System, 2024. Data can be access via https://nfms.maf.gov.la/

[20] Laos Interactive Forest Map & Tree Cover Change Data | GFW (globalforestwatch.org)

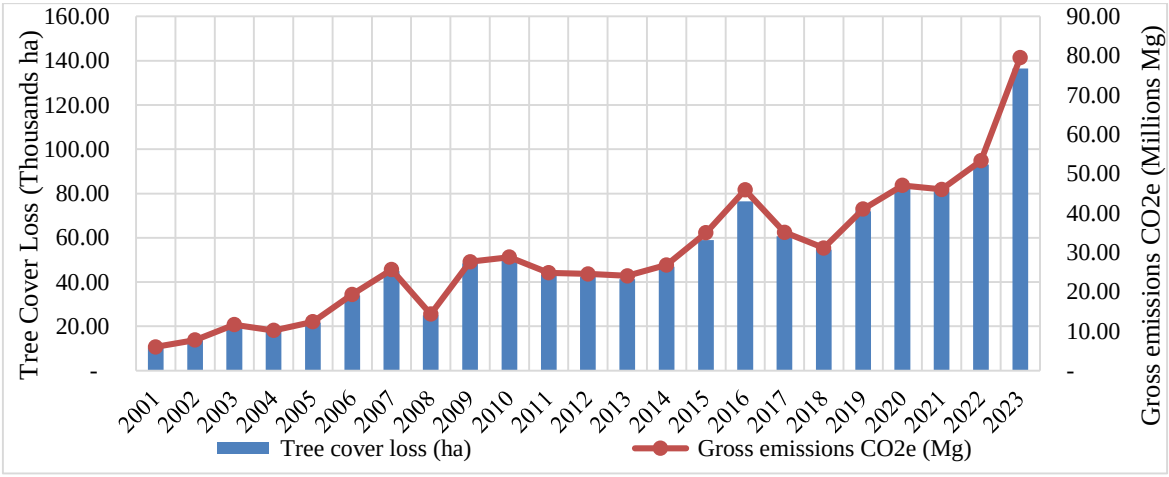

Figure 13: Loss of Primary Forest in Laos from 2001-2023

2.2.1 Drivers of Deforestation and Forest Degradation

Deforestation and forest degradation in Laos are driven by a combination of economic, social, and environmental factors [21, 22]. The primary drivers include agricultural expansion, infrastructure development and hydropower construction, logging, mining, practices, shifting cultivation, inappropriate farming, climate change, wildlife and timber trade and unsustainable land use practices[23].

Shifting cultivation: a traditional practice of slash-and-burn agriculture can lead to forest degradation, particularly in upland areas. A recent study using Landsat data from 1991 to 2020 revealed that shifting cultivation has been the leading cause of forest disturbance in Laos over the past 30 years. It affected 33% of Laos during the study period[24]. While this practice can be sustainable if implemented correctly, rapid population growth, increased food demand and inadequate land use planning have led to more cleared forests for cultivation, resulting in extensive deforestation [25].

Infrastructure development such as the construction of roads, dams, and other infrastructure projects fragment ecosystems, disrupt natural habitats and open up access for illegal activities[26]. Roads built to facilitate transportation and connectivity have opened up previously inaccessible areas to logging, agriculture, and settlement, leading to increased deforestation. Hydropower dams are being built to generate electricity for domestic consumption and export, often leading to the flooding of large forested areas and disrupting ecosystems[27].

Agricultural Expansion: The conversion of forests to agricultural land is a significant factor. Small-scale subsistence farming, commercial agriculture, and industrial plantations contribute

[21] World Bank Document
[22] https://openknowledge.worldbank.org/server/api/core/bitstreams/f7433ace-8a79-54a8-b555-6aef18facb29/content
[23] DOF (2021). The National REDD+ Strategy to the year 2030.
[24] Shifting Cultivation in Laos (nasa.gov)
[25] Laos-PDF (usaid.gov)
[26] Development in Laos risks extensive deforestation (mekongeye.com)
[27] PG47_Page_04_13_KOCH.pdf (giz.de)

to land clearance for commercial or large-scale plantation like rice, cassava, rubber, coffee and other cash crops[28]. These monoculture plantations can have negative ecological consequences[29].

Unsustainable Harvesting: Inefficient and unsustainable logging and extraction techniques have contributed to the degradation of forest resources. Timber extraction for domestic consumption and export markets has led to the depletion of valuable timber species and degradation of forest ecosystems, and result in the loss of valuable forest cover. Illegal logging, often driven by demand from neighboring economies, poses a serious threat to the economy's forests. Weak law enforcement, corruption, inadequate monitoring and control mechanisms have allowed for the overexploitation of timber and non-timber forest products and illegal logging to thrive in Laos[30]. Furthermore, fuelwood remains a significant energy source, accounting for 46.1% of total final energy consumption in 2018. Overharvesting of trees for fuelwood reduces forest cover and affects biodiversity. Fuelwood is mainly self-collected, especially in rural areas, while in urban areas, its purchase has a slightly higher share than self-collected fuelwood[31]. Charcoal is another common source of energy, with most urban households buying it.

Illegal Wildlife Trade: Laos is a hotspot for illegal wildlife trade, with endangered species being poached and trafficked for their parts. This threatens biodiversity conservation efforts and undermines the integrity of protected areas. Due to its strategic location, Laos is known as a transit and distributing hub for illegal wildlife trafficking. Endangered species such as tigers, pangolins, rhinos, elephants, bears, turtles, and tortoises have been reported as being illegally traded domestically and trafficked internationally[32].

Mining development in Laos has been a significant sector of the economy's economy, especially since the early 2000s. The mining sector is poised for growth, with the government actively seeking to attract more investment while ensuring sustainable practices. However, mining activities have had significant impacts on forest areas, biodiversity loss and threatening the habitat of many unique species. Mining activities for minerals like gold and bauxite contribute to forest degradation through land clearing, pollution, disrupting ecosystems and habitat destruction[33]. For instance, over 840,000 people in over 1,200 villages are situated within or on the boundary of 23 national protected areas, and their well-being is heavily dependent on the sustainable use of natural resources within these reserves[34]. According to the mining vision and strategy (MEM, 2023), from 2001 to 2010, 175 companies were licensed to conduct business related to mining. 135 companies in the process of mineral exploration cover about 3,679,928 hectares, and 40 companies in the process of mining operations cover 253,061

[28] Laos Deforestation Rates & Statistics | GFW (globalforestwatch.org)
[29] Ref…
[30] Leaked report reveals huge scale of Laos illegal logging - EIA (eia-international.org)
[31] Establishment of Energy Statistic Regulation in Lao PDR (eria.org)
[32] The Illegal Wildlife Trade: The Greatest Direct Threat to Species? — Wildlife & Welfare (wildlifeandwelfare.org)
[33] Is Laos mining itself into a crisis? (thinkchina.sg)
[34] https://openknowledge.worldbank.org/server/api/core/bitstreams/f7433ace-8a79-54a8-b555-6aef18facb29/content

hectares. In total, the mining concession area is about 3,932,989 hectares or 16% of the territory of the Lao PDR. From 2010 to 2020, 176 companies were licensed to conduct business related to mining. 94 companies in the process of mineral exploration cover about 6,852,808 hectares, and 82 companies in the process of mining operations cover 210,353 hectares. In total, the mining concession area is about 7,217,621 hectares or 30% of the economy's total area[35].

Climate Change: Increasing climate variability patterns can exacerbate forest degradation through increased fire frequency, pest outbreaks, and other stressors[36]. Changes in temperature and rainfall have altered the availability of soil water, which has reduced natural forest regeneration, reduced biodiversity, and reduced ecosystem services[37]. On the other hand, the estimated greenhouse gas (GHG) emissions from deforestation from 2005 to 2015 were about 41 million tCO2e per year, while GHG removals from forest restoration and plantation were about 7.5 million tCO2e per year[38].

Forest Fires: Both natural and human-induced forest fires degrade forests. Slash-and-burn agriculture, coupled with dry conditions, can lead to extensive forest fires. Between 2014 and 2022, over 320,000 hectares were destroyed by wildfires in Laos, primarily due to annual slash-and-burn practices[39].

Unsustainable Land Use Practices: such as overgrazing and the expansion of monoculture plantations (rubber and eucalyptus) contribute to forest degradation in Laos. Overgrazing by livestock results in soil erosion, compaction, and loss of biodiversity, leading to degraded forest ecosystems. Moreover, forest land concession permits that have been approved by the government during the period 2013-2022 have a total of 306 projects, with an area of approximately 610,149 hectares[40].

2.2.2 Underlining Cause of Deforestation and Forest Degradation

The main underlying drivers of deforestation and forest degradation can be grouped as follows:

Population Growth and Poverty: Poverty drives local communities to exploit forest resources for survival. Rapid population growth and high levels of poverty in rural areas put pressure on forests as communities rely on forest resources for their livelihoods[41]. Subsistence farming, fuelwood collection, and NTFPs extraction are common practices among rural communities,

[35] MEM (2023). the National Mining Vision to the year 2040 and the Mining Development Strategy for the year 2030. Ministry of Mining and Energy.
[36] World Bank Document
[37] MONRE (2023). (Draft) First National Adaptation Plan (NAP) for the Lao People's Democratic Republic: Version 3 (30th October, 2023).
[38] GoL. (2023). National Strategy on Climate Change of the Lao PDR to the year 2030. Available online at: 697_2_lao_nrs_final_2021_eng.pdf (unfccc.int)
[39] Department of Forestry (DOF) (2023). A Forestry Sector Report and Plan. The National Forestry Conference. 6th February 2023.
[40] Department of Forestry (DOF) (2023). A Forestry Sector Report and Plan. The National Forestry Conference. 6th February 2023.
[41] materials_03.pdf (jica.go.jp)

leading to deforestation and forest degradation[42]. Most upland people are still poor and lack livelihood alternatives other than shifting cultivation. In addition, inadequate land tenure security drive communities to exploit forests unsustainably, further exacerbating the problem. Land allocation and planning to accommodate population growth and investment have not been completed, which in many cases has allowed encroachment into forestland.

Weak Law Enforcement and Governance[43]: The economy's high levels of forest cover, rural poverty, and biodiversity make forest governance a sensitive and crucial topic[44]. The formulation of policies for the development of relevant sectors is not yet centralized, consistent or inclusive. Inadequate enforcement of forest protection laws allows illegal logging, land and forest encroachment, and other destructive activities to persist. Limited institutional capacity and resources have hindered the effective implementation and enforcement of forest management policies and regulations, coupled with governance issues, hampers effective forest management[45].

Sustainable Forest Management Practices: Lack of funding makes it difficult to apply sustainable forest management practices, conservation initiatives. Problems with human resources, technical expertise, and institutional ability also hinder effective forest management planning, implementation, and monitoring at various levels of government and in local communities. In addition, it is more difficult to effectively enforce forest regulations and combat illegal logging when monitoring and surveillance systems are inadequate.

Land Tenure and Resource Rights: Unclear land tenure and ambiguous resource rights have led to conflicts between different stakeholders, including local communities, private companies, and the government[46]**.** Land Law of 2019 provides some level of recognition and protection for customary tenure but makes no mention of the recognition and protection of customary rights to collective land areas, community forests, or any other forms of customary land[47]. Currently, the government is processing the policy and action for community land tenure recognition in three categories of forests[48]. The government requested the National Assembly for principal approval on agricultural and building land titling for the villagers inside three categories of forest land. In principle, there are 3,176 villages located inside three forest categories. In total, 2,900 villages have updated forest management and allocation plans, and the villagers and individuals who have used the land for more than twenty years following the land law will be

[42] Greener Growth through Good Wood: Sustaining Forest Landscapes and Local Livelihoods in Lao PDR (worldbank.org)
[43] Hoare, A, (Ed.) (2020), 'Chatham House Forest Policy Assessment, Lao People's Democratic Republic, available at Forest-Policy-Assessment-Lao-PDR.pdf (chathamhouse.org)
[44] recoftc-0000237-0009-en.pdf
[45] RECOFTC (2018). Assessing Forest Governance in Laos PDR: Identifying key Challenges and Intervention Strengthen Governance. The Center for People and Forests. recoftc-0000237-0009-en.pdf
[46] VFTenure_Dwyer_FAO-Final (2) (405493).pdf (un-redd.org)
[47] Briefing-Note-2_Customary-Tenure-Final-3.pdf (mrlg.org)
[48] MONRE (2023). Report No: 3372/MONRE, (dated 20 November 2023) MONROE has reported to the Prime Minister's Office on the recognition of local people land in forest areas. Which based on the Land Law Article 44 and the piloting results in Khammuane Province.

eligible for land registration and land titling[49]. The national assembly standing committee has organized the meeting and issued a resolution on recognition of the land use right in the forest area[50].

Limited Community Participation: The top-down approach to forest management has often excluded local communities, who have traditional knowledge and a vested interest in the sustainable use of forest resources. Inadequate involvement of local stakeholders in decision-making and management processes has hindered the development of effective and inclusive forest management strategies. Inadequate involvement of local communities, indigenous groups, and other stakeholders in decision-making processes related to forest management can lead to ineffective policies and projects that do not address the needs and priorities of those directly dependent on forest resources. Low public awareness about the importance of sustainable forest management and the threats posed by deforestation can hinder efforts to achieve lasting change.

2.3 Forest Management and Rehabilitation

Lao PDR has made significant strides in forest management and rehabilitation, but challenges persist, this includes: **Community Forestry:** This model has shown promise in involving local communities in forest management. It has led to improved forest conditions, increased livelihoods, and reduced deforestation rates in some areas; **Reforestation and Afforestation:** Large-scale efforts have been undertaken to restore forest cover. While these initiatives have increased forest areas, the long-term success and ecological effectiveness of these plantations are still under evaluation; **Policy and Legal Framework:** The government has implemented policies and laws to protect forests and promote sustainable management. However, enforcement remains a challenge, and illegal logging and forest encroachment continue to be significant issues; **Economic Development:** The push for economic growth has led to increased pressure on forest resources. Balancing development needs with forest conservation is a complex challenge; **Climate Change:** The impacts of climate change, such as changing rainfall patterns and increased frequency of extreme weather events, are affecting forest ecosystems and hindering rehabilitation efforts.

In addition, the challenges in forest management in Laos included: (i) There is insufficient staffing at the local level and an incomplete organizational structure for forest management, particularly across all forest categories; (ii) Limitation in participatory planning for each forest category to implement sustainable forest management in a systematically and effectively ways. The work of demarcating forest areas and utilizing each forest category is complex and demanding, requiring substantial financial resources; (iii) Utilization of forest lands for the development of infrastructure connected to sustainable development and poverty alleviation requires a comprehensive development plan; and (iv) Limitations in land use and forest allocation plans, sustainable livelihood development plans, and budgets for most ethnic communities that live close to forests[51].

[49] PM (2024). Prime Minister Request Letter to the National Assembly (GOL, 2024 PM Letter No.10/GoL, Dated 30 January 2024) on principle approval of land title registration of building land and agriculture land for the local people in three categories of forest based on Article 44 of the Land Law.
[50] National Assembly Standing Committee Resolution number 57/CPC, dated 31 May 2024.
[51] DOF (2021). The National REDD+ Strategy to the year 2030.

2.3.1 Barrier Needs to Be Overcome

Weak cross-sectoral coordination, limited land use planning capacities: Efforts to halt deforestation and degradation of primary forest landscapes are underway, but most national forestry legislation lacks cross-sectoral collaboration. Ineffective national and provincial coordination and limited capacities to plan, implement, monitor, and enforce existing policies hinder multisector dialogue and decision-making. The lack of effective protection, including the allocation of resources, and the unfinished demarcation of village lands have hindered local support for forest conservation. A broader landscape planning approach and spatial planning tools are needed to facilitate integrated and inclusive planning and economic development.

Low agricultural productivity and limited opportunities for green value chains contribute to forest degradation: The increasing demand for agricultural products in domestic and external markets is causing low efficiency in production due to traditional methods and poor upland people. This has led to deforestation, forest degradation, and other factors like agricultural expansion, encroachment, illegal logging, and infrastructure development. Local villagers' rights to agricultural land within the three forest categories are a long-standing issue. The government's reluctance to identify alternative options may be due to extensive areas and limited capacity to guide development. The lack of capacity for planning local sustainable nature-friendly livelihoods and engagement of Indigenous Peoples (IPLCs) in green value chains could help alleviate pressure from shifting cultivation within forest categories.

Inadequate financing; carbon stocks in primary forest landscapes not recognized among; lack of ecosystem valuation approaches: There is insufficient government financing to manage the forest area effectively and there is Insufficient enabling conditions to increase public-private financing for forests. There Is also weak enabling environment for private companies to invest in forest conservation and forest SMEs. Public financing for monitoring and law enforcement, extension, and activities that have potential to leverage financing from the private sector. There is the need to seize untapped opportunities to benefit from PES schemes for hydropower and other sectors, REDD+ and carbon finance.

Lack of regional vision and cooperation: The government's forest agenda requires improved human and financial resources, effective governance, increased budget, and stronger teams. However, institutional capacities are limited, especially with donor support. The government has recognized private sector participation, but a shift towards a transparent forest economy requires enhanced administration capacity. Lack of knowledge on integrating primary forest landscapes in planning and promoting nature-friendly livelihoods is a constraint.

Lack of capacity for integrated planning: Forests and productive ecosystems are closely linked, but there is a lack of capacity to consider the complex geological, geomorphological, and climatic realities. Lack of understanding of spatial planning tools, technical knowledge, and decision-making systems hinders the transition to nature-based solutions. There is also a lack of guidelines for utilizing primary forest ecosystem information in land allocation. Institutional deficiencies can lead to ineffective planning, environmental subsidies, and conflicting policies. Low awareness about biodiversity and forest protection is also lacking.

2.3.2 Addressing Deforestation and Forest Degradation

The Government has taken several positive steps, targeting illegal logging and trade, including the Prime Minister Order (PMO) 15 of 2016 to suspend the export of logs and timber harvested from natural forests that is said to have achieved a 75% reduction in illegal logging between 2016 and 2017.[52] The government has also put in place regulations to mitigate the negative environmental and social impacts of mining. This includes conducting the environmental and impact assessment (ESIA), creating environmental and social management and monitoring plans, plans for resettlement of impacted people, rehabilitation of mined-out areas, and compensation for damages incurred from mining operations[53]. Likewise, in 2023, the government has stepped up in the protection of forests as PMO Number 11 to enhance the management, conservation development, use of forests and forestland, prevention of forest and forestland encroachment, and forest fire control. PMO 11 restricts individuals and entities from occupying forest land, conducting illegal logging, and expanding agricultural and mining activities, especially in protected areas[54].

Nonetheless, at the same time, the government has also supported the policy formulation on mining development[55]. Mining activities are one of the main causes of deforestation and forest degradation. Therefore, there might be a contradiction between the policy and the strategy of mining and the forest conservation policy and program. Mining development will continue posing pressure on the primary forest land in several parts of the economy. For instance, mining can lead to habitat loss and degradation, which is particularly concerning in Laos given its rich biodiversity and the presence of many endangered species. The economy's biodiversity is concentrated in four ecologically diverse regions, all of which are affected by mining operations[56].

Addressing the drivers of deforestation and forest degradation in Laos requires a multi-faceted approach that involves policy interventions, sustainable land use practices, community engagement, and international cooperation. Some strategies to mitigate deforestation and promote forest rehabilitation include:

Strengthening Legal Frameworks: Enhancing laws and regulations related to forest management, land tenure, and wildlife protection is crucial for addressing deforestation in Laos. Implementing stricter enforcement mechanisms, increasing penalties for illegal logging, and

[52] Kukkonen, M., and A. Langner. 2017. Assessment of Forest Degradation Monitoring Methods in Lao PDR Technical Report. SUFORD-SU. Vientiane, Lao PDR.
[53] NA (2017). Law on Minerals (2017 Ed.) (Law No. 31/NA) dated 03 November 2017. National Assembly (NA). Available online at http://laoofficialgazette.gov.la/

[54] Prime Minister order number PMO11/PM. Dated July 21, 2023: Enhance the management, conservation development, use of forests and forestland, prevention of forest and forestland encroachment, and forest fire control. And MAF instruction number 3573/MAF, dated August 10, 2023.

[55] NA (2023). National Assembly Resolution Number 95/NA, dated July 18, 2023, on the National Mining Vision to 2040 and the Mining Development Strategy for the year 2030.
[56] https://openknowledge.worldbank.org/server/api/core/bitstreams/f7433ace-8a79-54a8-b555-6aef18facb29/content

promoting sustainable land use practices can help combat deforestation. Likewise, enhancing the policy sequencing by introducing interventions in a strategic order, starting with government commitment and command-and-control measures, followed by incentives and support for supply chain initiatives[57].

Addressing the Governance Issues: by enhancing the enforcement of laws and policies related to forest management. Providing economic incentives for conservation, such as payments for ecosystem services, to encourage sustainable practices. Enhanced Land Use Planning (LUP), implementing land zoning to promote reforestation and encourage alternative agricultural practices that are less harmful to forests. Involving local communities in forest management, such as through the establishment of seedling nurseries and planting initiatives, can help restore forests. Strengthening the capacity of government and local communities to manage forests sustainably. And raising awareness about the importance of forests and the benefits of sustainable forest management (SFM) to ensure long-term conservation efforts. Promote Transparent Law Enforcement that adopts transparent policies and reinforces their commitment to law enforcement can positively influence forest stewardship[58].

Stakeholder Coordination: Support the effective forum for collaboration between private-sector managers, public-sector administrators, and policymakers is essential for the implementation of facilitation measures[59]. Support for coordination and dialogue among various levels of government and stakeholders are crucial, but they must be backed by political will and institutional capacity[60].

Promoting Sustainable Agriculture: Encouraging sustainable agricultural practices, such as green and sustainable agriculture (GSA)[61], good agriculture practice (GAP), agroforestry, organic farming, and land use planning, can help reduce the pressure on forests. Providing technical assistance, training, and incentives to farmers to adopt sustainable practices can lead to improved productivity while conserving forests.

Enhancing Monitoring and Enforcement: Strengthening monitoring systems through the use of remote sensing technologies, satellite imagery, and community-based monitoring can help track deforestation activities and identify hotspots. Working with local communities, law enforcement agencies, and international partners to combat illegal logging and land clearance is essential for protecting forests. In addition develop Early Warning Systems (EWS), which use satellite data to rapidly identify forest changes and prioritize areas for investigation and enforcement[62].

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[57] Policy sequencing to reduce tropical deforestation | Global Sustainability | Cambridge Core.
[58] The Challenges of Forest Law Enforcement | Forest Governance and Legality | Chatham House
[59] brief7.pdf (unescap.org)
[60] Inter-sectoral and multilevel coordination alone do not reduce deforestation and advance environmental justice: Why bold contestation works when collaboration fails (cifor-icraf.org)
[61] MAF (2021). Green and Sustainable Agriculture Framework for Lao PDR to 2030. "Green agriculture for a healthy society". Towards inclusive green growth through sustainable agriculture production and environmental management.
[62] Early Warning Systems for Deforestation: An Explainer | Global Forest Watch Blog

Supporting Community-Based Conservation: Empowering local communities through community forestry programs, land tenure rights, and sustainable livelihood opportunities can help reduce reliance on forest resources and promote conservation efforts. Engaging communities in forest management decision-making processes can foster stewardship and long-term sustainability[63]. And locals can help monitor forest resources and assist in the enforcement of conservation regulations. Also, providing alternative livelihoods that are sustainable and do not harm the forest ecosystem can reduce the pressure on forests[64].

Promoting Sustainable Development Practices: Integrating sustainable development principles into infrastructure projects, land use planning, and economic development initiatives can help balance conservation and development objectives in Laos. Implementing green infrastructure designs, promoting renewable energy sources, and supporting sustainable tourism can contribute to forest conservation efforts.

3. Project and Program Related to Forest Rehabilitation

There are several notable projects and programs focused on forest rehabilitation in Laos. Here are a few key initiatives:

1) Village-based Forest Rehabilitation in Lao PDR (AFoCO) [65]

This project, running from 2016 to 2025, aims to increase forest cover by restoring degraded forest areas. It involves local communities in forest management and provides direct income to villagers through activities like seedling production and forest patrolling. The project is funded by the Korea Forest Service and implemented by the Asian Forest Cooperation Organization (AFoCO).

The project aims to restore degraded forest areas and improve local livelihoods. The project successfully established ex-situ conservation plantations and conducted enrichment planting in degraded forest areas. This included the production and distribution of quality seedlings to local communities. Local villagers were actively involved in seed collection, seedling production, and forest patrolling, fostering a sense of ownership and responsibility towards forest conservation. Training programs were conducted to enhance the skills of villagers and local authorities in forest management and rehabilitation techniques.

2) Community-based Forest Restoration and Management for Livelihood (WWF-Laos)[66]

Implemented in partnership with the Provincial Agriculture and Forestry Department (PAFO) of Sekong and Salavan provinces, this project focuses on enhancing community participation in forest management. It aims to rehabilitate and protect forests while improving the livelihoods of forest-dependent communities through sustainable use of forest resources. The project focuses on rehabilitating and protecting forests while enhancing the livelihoods of local communities in the Central Annamites Landscape. The project successfully planted thousands

[63] Local community engagement in conservation management - Blog | IUCN
[64] Tropical Forest Ecosystem Services in Improving Livelihoods For Local Communities | SpringerLink
[65] https://afocosec.org/project/008/
[66] https://www.wwf.org.la/projects/forest_restoration_and_management_/

of native tree seedlings, restoring nearly 40 hectares of forest. Local communities, including ethnic minority groups, actively participated in forest restoration activities, such as seedling planting and forest patrolling.

3) A model for restoring forests and improving livelihoods in Lao PDR[67]

The FLOURISH project, implemented by RECOFTC in Lao PDR, Thailand, and Viet Nam from 2018 to 2022, aimed to restore forest landscapes and improve local livelihoods through production-driven partnerships between forest communities and the private sector. The project successfully restored forest landscapes by planting native tree species and promoting sustainable forest management practices. Local communities were actively engaged in forest restoration activities, including planting and managing forests.

Other related forest landscape management and rehabilitation projects are listed as follows:

Table 9: List of the forest management and rehabilitation related projects in Laos

Name of Project	Duration		Project Budget			Donor
	Start	End	Nat'l Budget	ODA (Grant)	Total	
Sustainable micro-Watershed Management in the North of Laos	01/07/2023	30/06/2027	420	6,000	6,420	AFD
Village based Forest Rehabilitation Project	2016	2025	-	1,500	1,500	AFoCO
Integrated Village-Driven Forest Rehabilitation and Livelihood Improvement Project (VFRL)	2021	2026	106	1,088	1,194	AFoCO
AFoCO project management in Mekong region (KMFCC)	01/06/2022	31/05/2024	23	120	143	Korea-Mekong Forest Cooperation Center (KMFCC)
Village Forest Management Project (VFMP)	2019	2025	760	7,000	7,760	KfW Development Bank
Climate Protection through Avoided Deforestation and Implementation of the	6/1/2020	12/31/2024	13,073	-	25,330	
			-	12,257*	-	

[67] https://www.recoftc.org/sites/default/files/publications/resources/recoftc-0000412-0001-en.pdf

Name of Project	Duration		Project Budget			Donor
	Start	End	Nat'l Budget	ODA (Grant)	Total	
Governance, Forest Landscapes and Livelihoods (CliPAD/I-GFLL) (I-GFLL)						
Lao Landscapes and Livelihoods Project (LLL)	23/03/2021	30/09/2027	-	34,000*	57,367 - -	Internal Development Association
			-	16,000*		Canada Clean Energy Clean and Forest Climate Facility
			-	7,367		Global Environment Facility
Integrated Conservation of Biodiversity and Forests (ICBF)	01/06/2015	29/02/2024	2,163	16,716	18,879	KFW
Governance, Forest Landscapes and Livelihoods in Northern Lao PDR (GFLL)	30/12/2020	30/12/2023	-	42,000	42,000	WB/FCPF
Korea-Laos Joint REDD+ Project	2019	2024	-	1,200	1,200	Korea Forest Service (KFS)
Forest Law Enforcement, Governance and Trade. Financial Cooperation (FLEGT-FC)	01/09/2022	31/12/2027	5,599	27,994	33,593	KfW Development Bank (EURO)
Forest Restoration for Economic Outcomes (FREO)	5/10/2023	31/12/2028	-	2,731	2,731	ACIAR

Remark: * Loan agreement funding

Source data: Department of Planning and Cooperation (MAF, 2024).

4. Conclusion and recommendations

This report evaluates the state of degraded forest rehabilitation and sustainable forest management in Lao PDR, a economy facing significant challenges due to deforestation and

forest degradation. Factors such as agricultural expansion, illegal logging, infrastructure development, and shifting cultivation practices have contributed to these issues.

The report provides an overview of the nation's progress in restoring degraded forests, implementing sustainable management practices, and addressing the drivers of forest loss. It also analyzes factors such as poverty, weak governance, and deforestation. The report explores key outputs, challenges, and lessons learned from forest management projects and programs.

Addressing deforestation and forest degradation requires a holistic approach considering economic development, social dynamics, and environmental conservation. By implementing sustainable land use practices, strengthening legal frameworks, engaging local communities, and promoting international cooperation, Laos can work towards achieving forest conservation goals and preserving valuable forest ecosystems for future generations.

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Restoration, Reclamation and Rehabilitation of Degraded Forest Areas in Peninsular Malaysia

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Abstract: Forest restoration and rehabilitation initiatives have been ongoing in Malaysia to address deforestation and forest degradation, supported by numerous national policies for sustainable development. Since the 1990s, Malaysia has been working on restoring and rehabilitating degraded forests. In the past two decades, the focus has shifted from sustainable high-value timber production to enhancing ecosystem services and addressing climate change mitigation. A notable ongoing initiative is the Restoration, Reclamation and Rehabilitation of Degraded Forest Areas in Peninsular Malaysia Programme (3RSM). This programme support Malaysia's international commitment to maintain that at least 50% of its land area is under forest and tree cover. This paper highlights the execution of the 3RSM and identify gaps in its policies and implementation in addressing forest degradation issues. Key lessons from the program's implementation include the importance of policy support, substantial funding, continuous monitoring and adaptive management, an integrated participatory approach, and careful species selection and consideration. To enhance restoration and rehabilitation efforts, it is recommended to establish wildlife corridors at potential sites, explore alternative planting methods, and use IoT applications.

1. Introduction

Malaysia is a tropical economy that covers an area of about 33 million hectares, which is divided into two major geographical areas separated by the South China Sea: West Malaysia (bordered by Thailand in the North and Singapore in the South) and East Malaysia (the northern part of Borneo Island, bordered with Indonesia in the South and Brunei in the North). Malaysia consists of three regions: the Peninsular Malaysia, Sabah and Sarawak, which comprise 13 states and three federal territories.

Malaysia is recognised as one of the 17 megadiverse economies worldwide for its remarkable biodiversity and natural resources. According to the National Biodiversity Index, based on estimates of economy richness and endemism in four terrestrial vertebrate classes and vascular plants, Malaysia is ranked 12th in the world (NRES, 2015). Malaysia has an estimated 15,000 species of vascular plants, 306 species of mammals, 742 species of birds, 654 species of amphibians and 506 species of reptiles, as well as 2,068 species of freshwater and marine fish (NRECC, 2022).

Malaysia considers natural forests essential and valuable resources that significantly benefit the nation's socio-economic and environmental well-being. It is committed to maintain at least 50%

of its land area as forests and tree cover, as pledged during the Earth Summit in Rio de Janeiro, Brazil in 1992. Malaysia has devised strategies to fulfil this commitment through various means, including integrating forest restoration and rehabilitation with sustainable forest management (SFM).

2. Forest Resources in Peninsular Malaysia

As of 2020, Malaysia retains a large tract of natural tropical rainforest covering about 18.05 million hectares, or 54.6% of its total land area. Peninsular Malaysia covers an area of 5.695 million hectares, Sabah covers an area of 4.68 million hectares, and Sarawak covers an area of 7.671 million hectares (NRES, 2023).

The main forest types in Malaysia are inland forests, mangrove forests, and peat swamps. The majority is made up of inland forests, consisting of lowland and hill dipterocarp forests. Inland forests are highly complex and rich in a variety of species of flora and fauna. Mangrove forests are located in coastal areas, while peat swamp forests are found in inland swampy areas.

Peninsular Malaysia is blessed with tropical rainforests covering 43.0% of 13.2 million hectares of its total land area as of 2020. These include 4.81 million hectares of Permanent Reserved Forest (PRF) or 84.4% of the forested areas, 0.28 million hectares of State Land Forest (SLF) or 4.95% of the forested areas, and 0.61 million hectares of Alienated Lands and other reserve/protected areas or 10.65% of the forested areas.

In Peninsular Malaysia, for management purposes, 2.97 million hectares or 61.7% have been classified as production forests, and 1.84 million hectare or 38.3% have been classified as protection forests (FDPM, 2020). PRFs that have been categorised as production forests are commercially harvested under sustained yield, while protection forests are managed for environmental stability, biological diversity, and societal well-being.

3. Forest Governance

The land administration structure in Malaysia demarcates the power to manage land to the State Authority because land is a state matter according to the Federal Constitution of Malaysia. Under Article 74(2) of the Federal Constitution, the forest is under the respective State Government's jurisdiction. Therefore, each state is empowered to enact laws and manage forestry policies in their respective states independently. The executive authority of the Federal Government is limited to provide advice and technical assistance to states, maintenance of trail stations and demonstration stations, training and research.

The Ministry of Natural Resources and Environmental Sustainability (NRES) is responsible for overseeing the forestry sector in Malaysia. Forestry in Peninsular Malaysia is divided into two levels: Federal and State. The administration and management of forests are overseen by the Forestry Department of Peninsular Malaysia (FDPM) at the Federal level and by the State Forestry Departments (SFDs) at the State level. This is regulated by the National Forestry Act 1984 and guided by the Forestry Policy of Peninsular Malaysia.

The FDPM is entrusted with the important role of formulating policies and procedures related to the regulations, providing consultation and technical services to the SFDs with regard to forest planning, management and development, forest harvesting and wood-based industries, training and human resource development.

At the state level, the SFDs are responsible for administering and regulating forest harvesting, collecting forest revenues, and developing state forest resources. Forest management and administration at this level are governed by the State Forests Enactments, State Forests Rules, and the Wood-Based Industries Enactment.

4. Sustainable Forest Management (SFM)

Malaysia is committed to the implementation of Sustainable Forest Management (SFM), which enables the economy to enjoy the continuous benefits of forests. Sustainable Forest Management (SFM) is defined as the process of managing permanent forest land to achieve one or more specified objectives of management with regard to the continued production of forest products and forest-based services without undue undesirable effects on the physical and social environment (International Tropical Timber Organization [ITTO], 1992 as cited in Malaysia Policy on Forestry, 2021). All PRFs are gazetted and legally secured by the National Forestry Act 1984 and prudently managed under SFM to the benefit of present and future generations.

5. Changes of Forest Cover

Malaysia has seen significant declines in primary forest loss in recent years. According to World Resources Institute's Global Forest Watch (WRI) and University of Maryland Global Land Analysis and Discovery (UMD GLAD) (2023), Malaysia has successfully managed to reduce its primary forest loss by 57% as of 2022, placing it fourth among the top 10 economies for reduction in primary forest loss.

The deforestation rates in Malaysia decreased from 0.3% to 0.1% between 1990-2000 and 2001-2010, respectively. This decline is attributed to improved forest management and the enhancement of agricultural crop production under the 3rd National Agriculture Policy (NAP3: 1998-2010). The NAP3 emphasized new approaches to increase productivity and utilise natural resources on a sustainable basis, limiting the expansion of agricultural areas.

Changes in forest cover in Peninsular Malaysia have increased and then stabilised primarily due to the strengthening of policy and legal framework over the past decades. Peninsular Malaysia has lost almost half of its natural forests due to industrialisation, urbanisation, mining, and the clearing of forests for agriculture. Figure 1 shows the changes in forest cover in Peninsular Malaysia from 1990 to 2022.

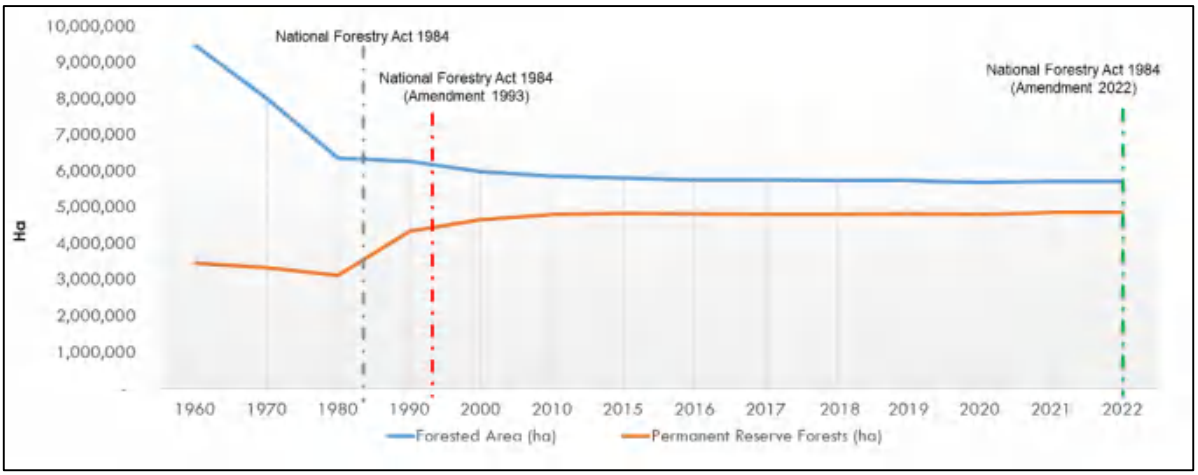

Figure 1: Changes in forest cover in Peninsular Malaysia from 1990 to 2022

The National REDD Plus Strategy document has identified three main drivers of deforestation in Malaysia: (i) expansion of settlements and infrastructure development, (ii) population growth, and (iii) agricultural expansion.

The decline in forest cover is inevitable as new land will be needed for the expansion of settlements and for new infrastructure development to meet the demand of the economy's population, which is currently about 34 million and is estimated to reach nearly 40 million by 2040 from the population of 25.5 million in 2004. The infrastructure development includes highways, gas pipelines, reservoirs, power lines, etc. Construction of roads and highways can indirectly lead to higher deforestation rates by enabling colonisation and opening up remote forest areas. The growing population puts tremendous pressure on land and biological resources, with high demands for food, housing, water, energy, transportation, and other infrastructure.

The agricultural land in Malaysia increased drastically from 3.08 million hectares in 1961 to 6.72 million hectares in 1989. The expansion slowed down, with the total reaching 8.57 million hectares by 2018. The agricultural sector in Malaysia is predominantly characterised by oil palm and rubber production, both of which are crucial to the economy's economic growth. Malaysia is the world's second-largest producer and exporter of palm oil and ranks the sixth-largest producer of natural rubber in the Asia Pacific region (Statista, 2024). As of 2022, oil palm cultivation in Peninsular Malaysia covered 2.54 million hectares, representing 44.8% of the nation's total oil palm area of 5.67 million hectares. Meanwhile, natural rubber plantations in Peninsular Malaysia spanned 772,100 hectares, making up 68% of the economy’s total rubber area of approximately 1.14 million hectares.

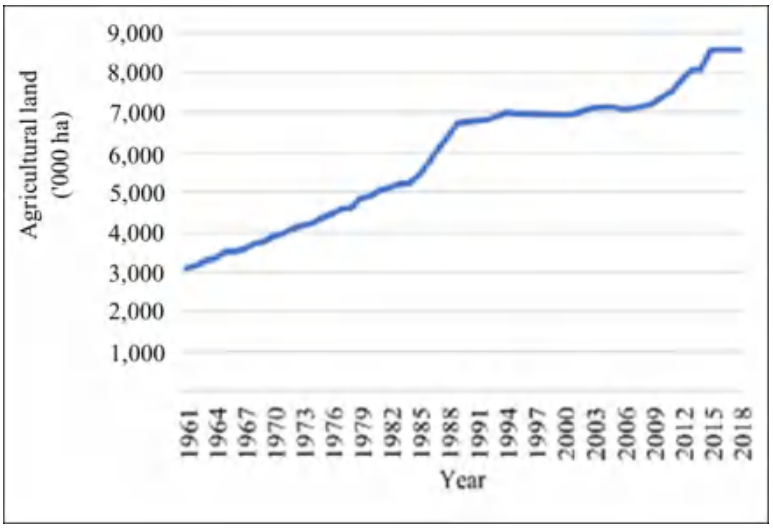

Figure 2: Annual trend of agricultural land in Malaysia. Source: World Bank (2021) as cited in Raihan et al. (2022)

Forest degradation is the reduction of a forest's capacity to provide goods and services, which involves a change process that negatively affects the forest's characteristics, leading to a decline in the value and productivity of its goods and services (FAO, 2024). It is closely linked to the progressive loss of forest resources in the context of biodiversity and the degradation quality of forest stocking and other ecosystem components such as flora, fauna, soil, and water (Malaysia Policy on Forestry, 2021).

Forest degradation can result from both natural disturbances (such as sea level rise, floods, or landslides) and human activities (such as road construction or shifting cultivation) or a combination of both. Often, natural and human-induced degradation are interrelated: human actions can increase a forest's vulnerability to natural events, while natural disturbances can exacerbate human-induced disturbances. The main factors of forest degradation in Malaysia are: (i) forest fragmentation, (ii) encroachment from past activities like agriculture and settlements, and (iii) legacy issues from past management and shifting cultivation.

Human intervention for commercial purposes has led to the clearance of forest lands for agriculture, settlement, and infrastructure development, resulting in forest fragmentation. This fragmentation breaks up continuous forest areas into isolated patches separated by non-forested lands, restricting the mobility of fauna and flora, causing habitat destruction, and a decline in biodiversity.

Large areas of natural forests in Malaysia have historically been cleared for agricultural and settlement development, leading to increased access to exploitation and encroachment. While Malaysia has a long history of forest management, some areas have suffered degradation due to past management practices. Climate change has further highlighted the issue of this legacy, which is the drained peatlands. In the 1960s and 70s, peatlands were drained to increase productivity. Additionally, shifting cultivation, or slash-and-burn agriculture, was used to clear forest land for agriculture, often leading to land degradation over time.

6. Policy Governing Forest Restoration and Rehabilitation

In order to address the challenges associated with forest loss, Malaysia has implemented policies promoting sustainable land management. The framework began with the National Forest Policy, first formulated as an Interim Forestry Policy in 1952 and officially adopted as the National Forestry Policy (NFP) in 1978. It was revised in 1992 to address global concerns about biodiversity conservation, sustainable use of genetic resources, and the role of local communities in forest development. This policy is implemented through the National Forestry Act of 1984 (NFA 1984).

The adoption of the Sustainable Development Goals (SDG) 2030 by Malaysia in 2015, resulted in a trickling effect on national policies and legislation. Recognizing forests as more than timber sources for socio-economic development, the Government updated policies to address new emerging issues like livelihoods, food security, biodiversity conservation, environmental stability, cultural preservation, and climate change.

The Malaysia Policy on Forestry, which substituted the NFP 1978 (Revised 1992), was approved by the 78th National Land Council Meeting on 29 January 2021. It incorporates key elements from the forest policies of Peninsular Malaysia, Sabah, and Sarawak, providing guidance for these regions to formulate their respective forestry policies and strategies. This policy aims to secure sufficient forest areas for ecosystem services, biodiversity conservation, environmental protection, and sustainable resource use for socio-economic development and the well-being of present and future generations. It emphasizes forest rehabilitation, as stated in its second objective: "Manage, conserve and rehabilitate the permanent reserved forests or forest reserves or permanent forests based on the principles of Sustainable Forest Management."

Alongside this, the Forestry Policy of Peninsular Malaysia has stipulated an increase in tree planting programmes and restore the degraded forest area in order to increase carbon absorption as part of Strategy 2: Enhancing the Forest Capacity in Reducing Climate Change Impacts under Thrust 3: Sustainability.

In 2022, amendments to the NFA 1984 were made to enhance the implementation of new comprehensive policies. The NFA 1984 (Amendment 2022) introduces stricter procedures for the degazettement of PRFs, which mandates a public inquiry before any PRF can be degazetted and requires simultaneous replacement of any degazetted PRF with an equivalent forest area to safeguard PRF areas and prevent further forest loss.

The first National Policy on Biological Diversity (NPBD) was launched in 1998 and was subsequently revised for 2016-2025 to conserve biological diversity and ensure sustainable use of natural resources. It was further updated as the NPBD 2022–2030 to address current national needs and the global biodiversity agenda. This policy provides a framework to conserve its biodiversity, promote sustainable use, and ensure fair and equitable sharing of benefits from biological resources, aligning with the SDGs and the Kunming-Montreal Global Biodiversity Framework (KMGBF).

Under the Twelfth Malaysia Plan (2021-2025), the Government has committed to continuous ecosystem conservation, ensuring natural habitats are protected and ecologically connected. This involves intensifying forest restoration, rehabilitation, and enrichment through multi-stakeholder collaboration.

7. Restoration and Rehabilitation of Degraded Forest Initiatives in Peninsular Malaysia

Malaysia is committed to ensuring that natural resources are protected, managed sustainably, and used responsibly. Rehabilitation of degraded forests is not new to Malaysia as replanting have been ongoing for decades throughout the economy to meet the demand for timber and non-timber products as well as to nurture degraded forest areas. Initially, the primary objective of rehabilitation was focused on the sustainable production of high-value timber, while other non-timber products and forest services were accorded secondary importance. Early rehabilitation efforts were driven by concerns over declining commercial timber volumes.

Enrichment planting has been a key forest rehabilitation measure in Peninsular Malaysia. It has been taking place since the 1900s and has been actively implemented since the mid-1960s in the PRFs. In 1978, it became the routine silviculture intervention for logged forests with poor natural regeneration under the practice of Selective Management System (SMS), which is prescribed after the Post-Felling inventory analysis. Enrichment planting involves introducing valuable selected timber species into degraded forest areas without removing the existing timber trees in any single forest stand. It is implemented in logged-over forests to supplement natural regeneration with planting seedlings of commercial species, usually indigenous. Over the years, large extents of logged-over forests have been planted through enrichment planting, and this practice continues today.

In the past two decades, the focus of forest restoration and rehabilitation has shifted to the provision of ecosystem services. Moreover, there is increasing global awareness of the crucial role of ecosystem services in mitigating climate change. Recognising the vital role of forests in offering various ecosystem services essential for human well-being, environmental health, and economic sustainability, the Government has strengthened efforts in reforestation and rehabilitation to meet national agenda and global commitments. Current efforts aim to integrate ecosystem, economic, and social objectives for comprehensive and sustainable outcomes. Numerous restoration and rehabilitation of degraded forest initiatives have been carried out across the economy within and outside of PRFs to fulfil multiple objectives.

8. Restoration, Reclamation and Rehabilitation of Degraded Forest Areas in Peninsular Malaysia Programme (3rsm)

The Restoration, Reclamation and Rehabilitation of Degraded Forest Areas in Peninsular Malaysia Programme (3RSM) is a significant ongoing initiative aimed at restoring and rehabilitating degraded forests throughout Peninsular Malaysia. This high-impact programme seeks to address forest degradation resulting from natural disasters and anthropogenic disturbances.

The programme was initiated in response to severe natural disasters in 2014, including mud floods and landslides in Cameron Highlands and Janda Baik in Pahang, as well as in Kuala Krai and Gua Musang in Kelantan. In addition to the ongoing heavy downpours, the catastrophe has been largely attributed to forest encroachment, land clearing for agriculture, and uncontrolled development. These catastrophes have caused loss of life, property damage, economic loss, and environmental destruction. The 2014 Flood Disaster Special Forensic Committee estimated the losses at about RM2.8 billion, affecting over 300,000 victims who suffered damage or loss of homes.

In 2015, the Cabinet of Malaysia approved the Ministry of Water, Land and Natural Resources (now Ministry of Natural Resources and Environmental Sustainability, NRES) to oversee the implementation the 3RSM through its agency, Forestry Department Peninsular Malaysia (FDPM) under the Eleventh Malaysia Plan as an initiative to halt future incidents. The program focuses on planting trees not only in the PRFs affected by these disasters but also extends to other forested areas, including those outside the PRFs.

The objectives of this programme are: (i) to restore an area of 1,640 hectares of degraded forests that were affected by natural disasters or anthropogenic disturbances through the planting of a total of 1,025,000 trees, (ii) to carry out silvicultural treatment on a total of 1,025,000 trees planted according to the silvicultural treatment regime, (iii) to upgrade the infrastructure of the Lentang Seed and Plant Material Procurement Centre in Pahang State and nine nurseries of SFDs, and (iv) to produce high-quality plant material to support the implementation of forest conservation and preservation activities.

The 3RSM employs an Integrated Participatory Approach involving of multi stakeholders, including Central Agencies, State Agencies, research institutes, institutions of higher learning, Non-Governmental Organisations (NGOs) and local communities. To ensure effective implementation of the program, three committees have been established: (i) Technical Committee, generally responsible for setting the strategic direction of the programme, (ii) Working Committee, focuses on overseeing and monitoring the progress of on-the-ground implementation; and (iii) Research and Development (R&D) Committee which is tasked with conducting research, offering technical advice, and driving innovations.

From 2016 until 2023, the Government of Malaysia has allocated RM67.8 million through development expenditure under the five-year Malaysia Plan, from the Eleventh Malaysia Plan (2016 – 2020) to the Twelfth Malaysia Plan (2021 – 2025) for this programme. The allocation has been used for planting and silvicultural treatment on degraded forests, research and development (R&D), infrastructure maintenance and improvement, capacity building and awareness activities.

As of June 2024, 1,235 hectares of degraded forest areas have been restored with the planting of 731,176 trees of various indigenous species. Monitoring and evaluation are being conducted at the planting sites to assess the survival rate of the planted trees, habitat restoration progress, and socio-economic benefits.

9. The Gaps in Forest Policy and Implementation

The 3RSM is fully funded by the Federal Government. It involves tree planting and silviculture treatment carried out in selected degraded forest areas over a span of two years. The subsequent maintenance of the restoration site falls to the State Governments, mainly through SFDs. However, due to high costs, most restoration sites lack continued maintenance. This highlights gaps in policy and implementation to effectively address forest degradation, as State Governments are unable to fulfil their crucial role in forest restoration and rehabilitation efforts because of funding and willingness constraints.

The conversion of forest land remains a persistent issue for policymakers and managers. Although the NFA 1984 (Amendment 2022) tightened the procedures for the degazettement of PRFs, it does not restrict the conversion of forested areas in State Lands. Restoration sites within State Lands are at risk of being converted for alternative forms of land development at the discretion of State authorities. State Governments may prioritise land conversion for urbanisation, industrial, agricultural, and other developments over conservation due to the potential for higher financial returns. This legal loophole can undermine restoration and rehabilitation efforts if these lands are converted for other uses.

One effective method to address these gaps is through innovative financing mechanisms. For instance, the Ecological Fiscal Transfer (EFT), introduced in 2019, provides financial incentives to State Governments based on their conservation performance. By linking fiscal transfers to ecological outcomes, this mechanism motivates States Governments to prioritise conservation efforts and fill funding gaps by providing necessary financial resources.

Degraded forests are highly susceptible to encroachment. Several restoration sites under the 3RSM have experienced encroachment and vandalism. This issue suggests potential weaknesses in enforcement mechanisms, a lack of resources, existing conflicts, or insufficient awareness.

Addressing the issue of land conversion and encroachment can be significantly improved by engaging stakeholders and raising awareness about forest restoration and rehabilitation efforts. Involving various levels of stakeholders in the decision-making and educating them about conservation can build strong support, resolve conflicts, enhance compliance with regulations, and secure the necessary resources for sustainable outcomes. Strengthening enforcement through better coordination among agencies and using technology like satellite monitoring can also help prevent encroachment.

10. Lesson Learned

The 3RSM is currently underway and is making steady progress towards its main objective, which is to restore 1,640 hectares of degraded forest areas. It is expected that this goal will be successfully achieved by the end of 2025. The program has yielded several important lessons, including:

10.1 Policy Support

The 3RSM aligns with national policies that ensure restoration and rehabilitation activities support broader environmental and economic goals. Policy support is crucial, as it provides the necessary framework, resources, and motivation to achieve desired outcomes. Without strong policy backing, the program may lack direction, resources, and coherence, potentially leading to less effective results.

10.2 Substantial funding

Forest restoration and rehabilitation are long-term processes that demand sustained commitment, funding, and management over time to achieve desired outcomes. The significant funds allocated by the Federal Government through under the Malaysia Plan ensure that adequate resources, including workforce, equipment, and materials, are provided throughout the implementation of restoration project. The funding also guarantees that resources are available for the maintenance necessary to sustain the restored areas.

10.3 Continuous Monitoring and Adaptive Management

Continuous monitoring of restoration and rehabilitation sites is important to assess progress, adapt management strategies, and address site-specific challenges. This allows for adjustments based on what works and what doesn't because different areas require different approaches.

10.4 Integrated Participatory Approach

The success of the 3RSM largely depends on the Integrated Participatory Approach, which combines various strategies and actively involves stakeholders. This approach emphasises collaboration among government agencies, NGOs, and research institutions to leverage resources, knowledge, and expertise effectively.

10.5 Species Selection and Consideration

Selecting plant species that are well-suited to the specific environmental conditions or species site matching of a restoration site is important for restoration and rehabilitation efforts to be success. Using native species supports local biodiversity and leads to a healthier and more resilient ecosystem. However, accurately assessing site conditions and obtaining suitable planting materials pose significant challenges due to their complexity.

11. Recommendation for the Way Forward

The implementation of 3RSM has demonstrated that forest reforestation and rehabilitation, through the provision of vegetation structure, support the recolonisation of mammals. Studies at 3RSM sites in Cameron Highlands, Pahang indicate that restoration and rehabilitation have the potential to reverse defaunation. Ongoing restoration and rehabilitation and wildlife monitoring further promote the recovery of mammal habitats in these areas. Therefore, it is recommended that wildlife corridors be established at potential forest restoration and rehabilitation sites.

Planting activities carried out under the 3RSM have been successful in restoring degraded forest areas. However, the current planting methods used still rely on conventional techniques, which are time-consuming for large degraded forest areas. It is important to adopt new and more effective technologies to improve efficiency and accelerate the restoration. Therefore, it is recommended to explore alternative planting methods, such as using machinery or drones to speed up the planting process.

A monitoring system using IoT applications, known as the Smart Forest Monitoring System (SFOMOS), has been developed under the 3RSM to monitor environmental parameters crucial for forest restoration and management. It employs sensors and remote monitoring tools to collect real-time data on soil moisture, water levels, and other key indicators. For example, SFOMOS used in Raja Musa Forest Reserves aids peat swamp forest restoration by providing real-time ecosystem health insights, facilitating adaptive management strategies, and preventing forest fires. Although its usage is still under study and not yet widely implemented, it is recommended that this system be used at other restoration sites to test its effectiveness and expand its use. This is to encourage the use of IoT in forest restoration efforts.

12. Conclusion

The restoration and rehabilitation of degraded forest initiatives is a long-term commitment to address deforestation and forest degradation. The 3RSM program is a significant initiative in this effort, supporting Malaysia's international commitment to maintain that at least 50% of its land area is under forest and tree cover and in line with SDGs. Key lessons from the 3RSM implementation highlight the need of robust policy support, substantial funding, continuous monitoring and adaptive management, integrated participatory approach, and careful species selection. It is recommended to establish wildlife corridors at potential sites, explore alternative planting methods and use IoT application to enhance restoration and rehabilitation efforts.

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Degraded Forest Rehabilitation and Sustainable Forest Management: Opportunities and Challenges in Scaling up Forest Rehabilitation Efforts in Myanmar

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Abstract: Myanmar is located in Southeast Asia. The topography of Myanmar can roughly be divided into four parts: namely the Western Hills Region, the Central Valley Region, the Eastern Hills Region and Tanintharyi Coastal Strip. Myanmar possesses three distinct seasons; hot season, rainy season and cold season. Myanmar is well endowed with diverse flora and fauna due to the ecological diversity. Myanmar is blessed with high forest cover of 42.19% of the economy's total area. Myanmar possesses great variation in topography and climatic conditions, and six major forest types can be found in the economy, ranging from mangrove forests in the coastal region and dry forests and deciduous dipterocarp in the central region to hill and temperate forests in the northern part of the economy. Nowadays, forests are increasingly threatened by a wide range of pressures, including deforestation, land-use change, agricultural expansion, human encroachment, illegal logging, invasive alien species, severe droughts and wildfires. Myanmar is currently facing challenges in management of forests on a truly sound and sustainable basis. This paper shows current status of deforestation; the extent of forest cover changes in 10-years intervals from 1990 to 2020 in Myanmar according to FRA(Forest Resource Assessment) data and the important major driver of deforestation. This report also highlights policies, laws, instructions and institutional arrangement approached to forest management and forest rehabilitation in Myanmar and also highlights the conflict of land-use between departmental instruction and goals due to political and economic transitions. To restore and rehabilitate the degraded forests for climate change mitigation and adaptation as well as to enhance ecosystem services in Myanmar, the Forest Department launched the Myanmar Reforestation and Rehabilitation Programme (MRRP) in 2017. This report describes the implementation activities of MRRP and discusses some lessons learned by analyzing the factors contributing to the success and failure of this programme after 6 year. The results relating to the experience and lessons learned will also be useful as the basic information for the government and other related agencies to be replicated and scaled up to other places or programme planning.

Keywords: Ecological Diversity, Deforestation and Forest Degradation, FRA, MRRP

1. Introduction

The Republic of the Union of Myanmar is located in Southeast Asia between latitudes 9 °32' N and 28 °31' N and longitudes 92 °10' E and 101 °11' E. Myanmar is bordered by China, Laos,

Thailand, Bangladesh and India. The total area of Myanmar is 676,577 km^2, stretching for 936 km from east to west and 2,051 km from north to south. The topography of Myanmar can roughly be divided into four parts: namely the Western Hills Region, the Central Valley Region, the Eastern Hills Region and Tanintharyi Coastal Strip.

Myanmar has three distinct seasons; hot season, rainy season and cold season. The Central Myanmar has an annual rainfall of less than 1,000 mm while the Rakhine coast receives more than 5,000 mm. Besides, the average highest temperature in the Central Myanmar is about 43.3 ° C while in Northern Myanmar, it is about 36.1 ° C and on the Shan Plateau, between 29.4 ° C and 35 ° C.*(https://mcgkolkata.org/economy-information-2)* Due to these ecological diversity, Myanmar is well endowed with diverse flora and fauna and providing enormous ecosystem services from these diverse ecosystems. Therefore, sustainable management and conservation of these natural resources play an important role for the sustainable use not only for the present but also for future generations.

Naturally, forests provide a wide range of ecosystem services like provisioning services, regulating service, cultural services and supporting services. Forests can initiate the ecosystem service for raising the tourism industry dubbed as the smokeless industry. As such, the conservation of forests can directly or indirectly create job opportunities for communities in various regions. Conservation of forests is not only a cost-effective way to mitigate climate change, but also means that many other benefits including biodiversity, soil and water resources, pollination are provided to local communities and a wider society. Myanmar is blessed with high forest cover of 42.19% of the economy's total area.

Nowadays, forests are increasingly threatened by a wide range of pressures, including deforestation, land-use change, agricultural expansion, human encroachment, illegal logging, invasive alien species, severe droughts and wildfires. Myanmar is currently facing challenges in management of forests on a truly sound and sustainable basis. The challenge to effectively manage forests on a truly sound and sustainable basis has been particularly urgent in Myanmar as other developing economies which are encountering high population and development pressures.

2. Current Status of Deforestation and Forest Degradation

2.1 Forest Resources and Forest Cover Status

Myanmar is rich in natural resources thanks to its various types of forests and diverse biological resources. About 42.19% of the economy's land area is still covered by forest resources, accounting for 28.5 million hectares (FAO, 2020).

Myanmar possesses great variation in topography and climatic conditions, and six major forest types can be found in the economy, ranging from mangrove forests in the coastal region and dry forests and deciduous dipterocarp in the central region to hill and temperate forests in the northern part of the economy (Figure 1). Of these, mixed deciduous forests and hill and temperate evergreen forests are the major forest types, covering an area of 38.20% and 26.92%, respectively (Figure2). Myanmar's forests play an important role in contributing to the nation's

economy and supporting the socio-economic and well-being of the local people. Over 70% of the economy's population resides in rural areas and mainly depend on forest resources for food, fodder, shelter, and fuel (*2014 Myanmar Population and Housing Census).*

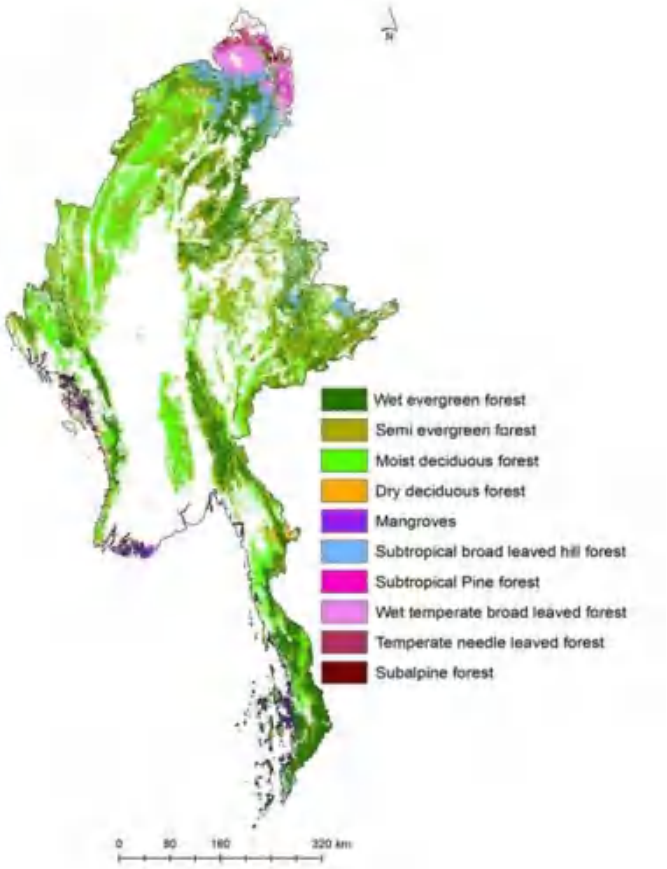

Figure 1: Forest types in Myanmar (Source: C. Sudhakar et al., 2019)

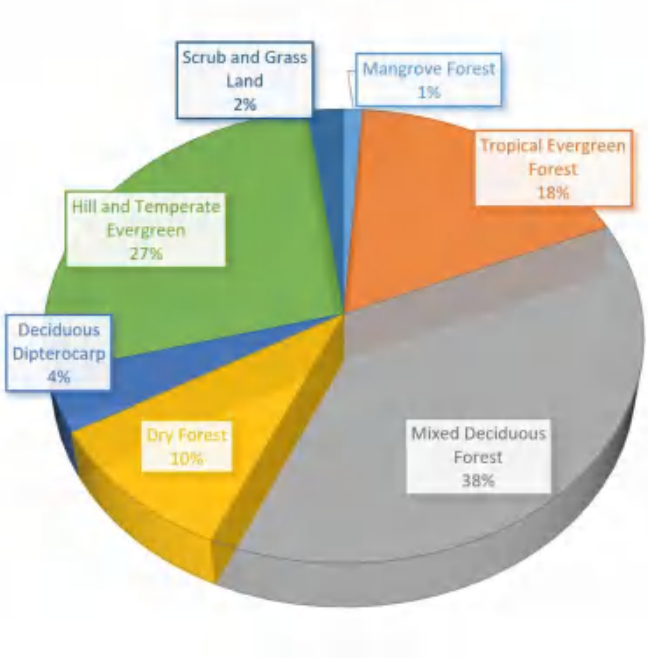

Figure 2: Extent of major forest types in Myanmar

2.2 Deforestation and Forest Degradation

Deforestation is "the conversion of forest land use into to non–forest land use" (i.e., 100% loss of Above Ground Biomass). **Forest degradation** is "the process of losing carbon stock from forest land, i.e. the land use remains forest, but the amount of carbon stock in the forest is reduced". *(Source: Myanmar REDD+ Programme* – Forest Reference Emission Level (FREL) of Myanmar*)*

Deforestation and forest degradation are serious issues being tackled by most developing economies. Myanmar is the seventh-most deforested economy in the world according to FRA-2020. The area of forest cover had decreased from 57.9 % of the economy area in 1990 to 42.19% in 2020. The net annual forest area loss was 1.17% in 1990-2000, 1.03% in 2000-2010, and 0.96% in 2010-2020(FAO, 2020). The extent of forest cover changes in 10-years intervals from 1990 to 2020 is shown in Figure 3.

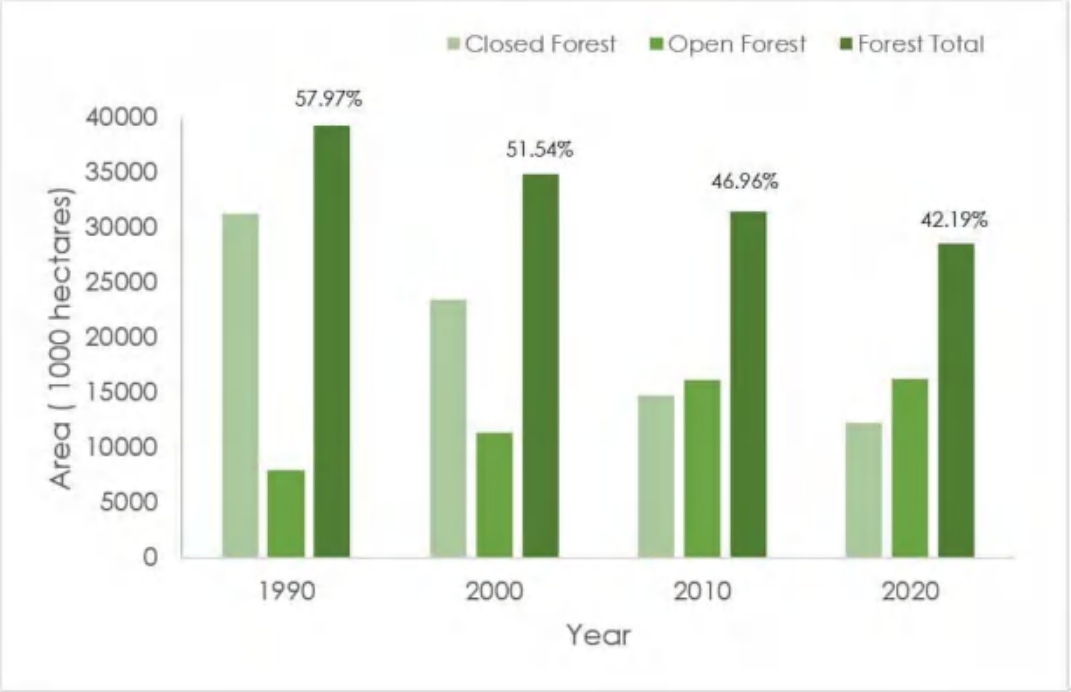

Figure 3: The extent of forest cover changes in 10-years intervals from 1990 to 2020

2.3 Major Drivers of Deforestation and Forest Degradation

Within the forestry sector, the main causes of deforestation and forest degradation include the overexploitation of timber (legal and illegal), over-extraction of fuelwood and charcoal, unstable shifting cultivation, forest fires, overgrazing, pests and diseases, and storms and landslides. Beyond the forestry sector, deforestation and forest degradation are mainly attributed to the expansion of agriculture (for subsistence and commercial uses), mining, infrastructure development, hydropower development, urbanization and resettlement, as well as aquaculture development.

The most important driver of deforestation has been clearing for farming. Conversion for agricultural use has occurred in and outside of the Permanent Forest Estate (PFE), although

there are differences of opinion as to the relative losses in the different forest categories. According to one estimate, agricultural expansion was responsible for approximately 1 million hectares of forest conversion between 2002 and 2014, with rubber and oil palm plantation establishment being the major drivers.(*Treue, T., Springate-Baginski, O., and Htun, K. 2016. Legally and Illegally Logged out: Extent and Drivers of Deforestation & Forest Degradation in Myanmar. EcoDev/ALARM. alarmmyanmar.org/pdf/).* The area allocated for agricultural development is more than twice the size, but many areas have not been planted and/or converted.

The goal of the Master Plan for the Agriculture Sector (2000-2001 to 2030-2031) is to convert about 4 million hectares of **wasteland** for private industrial crop production, with rubber, oil palm, paddy, pulses, and sugarcane for export particularly encouraged. Based on the new Economic Policy that seeks *to establish an economic model that balances agriculture and industry and supports the holistic development of agriculture, livestock and industrial sectors so as to enable rounded development, food security and increased exports,* the general trajectory of increases in exports of major agricultural commodities and the development of transportation networks, forest conversion for agricultural production (especially corn and rubber) is expected to increase. In terms of area affected, direct drivers like mining and hydropower development will play a minor role. The shifting cultivation area has decreased since 2000 and is expected to decrease further. A recent spatial assessment found that only 1.6% of mangrove deforestation between 2000 and 2012 could be attributed to aquaculture. But interest in developing Myanmar's coastal aquaculture industry has emerged, particularly cultured shrimp for export, and supported by infrastructure development negative impacts on mangroves should not be discarded.

The Government of Myanmar, research and CSO/NGO sources concur that forest degradation has occurred for decades due to harvesting volumes for teak exceeding the annual allowable cut (AAC). The recorded harvest of other hardwoods, mostly dipterocarps, stayed well below the AAC until 2003. Since then, harvests of this category started to exceed the downwardly regulated AAC. There is no indication in the literature that legal logging is causing less damage to the remaining forests in some states and/or regions than in others. Overgrazing of forests by domestic livestock is likely to be an issue in the future, especially in the Dry Zone. The increased purchasing power of Myanmar's population is increasing demand for animal products, including dairy products.

3. Overview of the important Policies, Laws and Institutional Arrangement to approach the Forest Rehabilitation and Degraded Forest Rehabilitation

The policies, legislations, instructions, and strategic action plans have entered into force in Myanmar for the sustainable management of forest resources, the protection, and conservation of natural biodiversity, and responding to climate change by mitigation and adaptation measures.

3.1 Policies, Laws and Regulations related to Degraded Forest Rehabilitation and Sustainable Forest Management

Related to degraded forest rehabilitation and sustainable forest management, Myanmar has the following policies, laws and regulation;

Forest Policy (1995)

Environmental Policy (1994)

National Environmental Policy (2019)

National Land-Use Policy (2016)

Myanmar Climate Change Policy (2018)

National Wetland Policy and Action Plan (2014)

Environmental Conservation Law (2012) and Rules (2014)

Conservation of Biodiversity and Protected Areas Law(2018) and Rules(2019)

Forest Law (2018) and Rules (to be enacted)

3.2 Overview of Policies, Laws and Regulations to approach the Forest Rehabilitation and Degraded Forest Rehabilitation

Achieving the national goals and aims of ensuring socio-economic development and stabilizing the environment and ecosystem, Myanmar Forest Policy (1995) was developed in an integrated and balanced manner, and its main six policy imperatives were set up as follows:

1) Protection of soil, water, wildlife, biodiversity, and the entire environment;

2) Sustainability of forest resources to ensure a perpetual supply of both tangible and intangible benefits accrued from forests for present and future generations;

3) Basic needs of the people for fuel, shelter, food, and recreation;

4) Efficiency to harness, in a socio-environmentally friendly manner, the full economic potential of forest resources;

5) Participation of the people in the conservation and utilization of forests; and

6) Public awareness about the vital role of forests in the well-being and socio-economic development of the nation.

National Land Use Policy (2016) is to be systematic and harmonized in all land and tenure rights at the National level, Myanmar developed a National Land Use Policy in 2016. It will be the guiding document for the enactment of the National Land Law, which will harmonize existing land-related laws and solve issues related to land use and tenure rights among all relevant institutions.

Political and economic transitions can have substantial impacts on forests. Myanmar is transitioning from an authoritarian, centralized state with a highly regulated economy to a more decentralized and economically liberal democracy, which will affect the landscape.

Overlapping and conflicting priorities and agendas by the forestry and agriculture sectors are a major concern. The significant shift from forest to non-forest uses, particularly agriculture, has been the largest driver of deforestation. With higher agricultural production goals, increased foreign investment, and increased exports, these historical patterns will only increase. The Ministry of Agriculture, Livestock and Irrigation (MoALI) and Forest Department are targeting the same lands to achieve their future goals and mandates. This creates an inherent and untenable conflict. There is still no process for tackling this conflict, which include the targets of the 30-year Master Plan for the Agriculture Sector (2000-01 to 2030-31). They clash with the planned increase of Reserved Forest (RF) and Protected Public Forest (PPF) by roughly 4 million hectares. In addition, land administration is fraught with overlaps in jurisdictional authority and bureaucratic inefficiency.

The lack of a typical land-use policy and related land-use law was a major driver of deforestation and forest degradation in the past. It led to many land-use conflicts and lack of systematic governance on land tenure, aquatic resources and forests. It did not support integration of all relevant community, inclusive public participation and consultation in decision-making processes related to land use and land resource management. The 2016 Land Use Policy (LUP) addresses these issues, especially by decentralizing some decision which can be implemented by its respective district levels. There is still lack in the consideration of environmental and social issues in carrying out the development and also the inclusive participation for decision making process is still deficient Moreover, the human resource capacity in permitting license is also weak, need to be provided capacity building programme/ training, which has been recognized in the draft of the National Environmental Policy.

Myanmar's Forest Law, revised in 2018 based on the former Forest Law of 1992, is the main legal framework to achieve the effective implementation of the government's forest policy and environmental conservation policy. It is also consistent with the international agreement. The new Forest Law covers the principles of sustainable forest management, while partly liberalizing property rights for timber, particularly teak, subject to ministerial instructions. It also aims to promote people's participation in forest management while contributing to their basic needs. Currently, the government is drafting new Forest Rules, which currently undergoing revision.

The Conservation of Biodiversity and Protected Areas Law was enacted in 2018, replacing the former law entitled Protection of Wildlife and Protected Areas Law (1994). The new law brings more opportunities for recognizing the rights and potential roles of local communities while creating the new category of "Community Protected Areas." It favors not only promoting co-management but also supporting international obligations such as the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES). Penalties for legal infringement are more intense in the new law. The new Rules of Conservation of Biodiversity and Protected Areas are currently under revision, after being drafted in August 2018 for the second time.

Community Forestry Instructions (2019) Recognizing the important role of people's participation in forest management, in line with the policy imperative "Participation of the

people in the conservation and utilization of forests," Myanmar launched Community Forestry Instructions (CFIs) in 1995 and amended them in 2016 and 2019. The new CF instructions (2019) pave the way not only for the provisions of local people's basic needs but also for the commercialization of forest products while encouraging nature-based tourism for improving incomes and social welfare. These instructions are part of Myanmar's Forest Law because the establishment of community forest is described in section 7, sub-section (d), section 9, sub-section (h) and section 12, sub-section (d) of Myanmar's Forest Law. Their degree of legal powers is described in section 40 of CFIs 2019; *Violation of the Community Forestry Instructions, prescriptions of the Management Plan, and directives and instructions periodically issued by the Forest Department can lead to legal actions which could include the termination of the Community Forestry*.

3.3 Planning Framework related to Degraded Forest Rehabilitation and Sustainable Forest Management

Related to degraded forest rehabilitation and sustainable forest management, Myanmar has the following plans;

National Biodiversity Strategy and Action Plan (NBSAP) (revised in 2016)

National REDD^{+} Strategy Plan (2020)

National Master Plan (2001-2002 to 2030-2031)

Forest Management Plan (2016-2017 to 2025-2026) (69 Districts)

Myanmar Reforestation and Rehabilitation Plan(MRRP) (2017-18 to 2026-27)

The National Forestry Master Plan (2001-02 to 2030-31) is the guiding element for forest management in Myanmar on a sustainable basis, as well as for meeting the sectoral target of the Forest Department, Myanmar. It provides strategic direction covering a wide range of forestry issues, including protection and conservation, reforestation and rehabilitation, production, and law enforcement. It also provides guideline for the fundamental framework for the ten-year forest management plan at the district level.

4. Myanmar Reforestation and Rehabilitation Programme (MRRP)

4.1 Goals

1) To regain the ecosystem rich in biodiversity through reforestation and rehabilitation of forests.

2) To mitigate the impacts of climate change

3) To support the socio-economic development of the nation

4) To support the sustainable forest management

4.2 Objectives

1) To restore and rehabilitate the forest with the appropriate methods

2) To strengthen the investment of large- and small scale private plantation

To support the community forestry and agro-forestry practices

3) To formulate the plantation policy through consultation with relevant stakeholders

4) To encourage the participation of all relevant stakeholders in restoration and rehabilitation programme

4.3 Project Period of this Programme

Myanmar Reforestation and Rehabilitation Programme(MRRP) is being conducted 10 years, based on two project phases taken by five years of each. Phase I is 2017-2018 Fiscal Year to 2021-2022 Fiscal Year, and Phase II 2022-2023 Fiscal Year to 2026-2027 Fiscal Year.

4.4 Project Area

It is being implemented in 69 Forest Districts of 15 States and Regions.

4.5 Implementing Agencies

It is implemented by Forest Department (FD) and Dry Zone Greening Department (DZGD) under the Ministry of Natural Resources and Environmental Conservation.

4.6 Budget

Within the fiscal years from 2017-2018 to 2026-2027, the budget which is consumed for forest operations, infrastructure, vehicles, fuel, other necessitates & staff salary are 589 Billion MMK (~ 280.8822 million USD by 27-7-2024 CBM Exchange Rate). The whole budget is funding by Myanmar Government Capital.

4.7 Plantation Zone

Plantation zones are classified in order to successfully accomplish objectives of the rehabilitation and reforestation program based on the management and accessibility. The plantation zones are classified as follows:

No	Zone no	Region/State
1.	Zone-1	Tanintharyi State/ Mon State / Kayin State
2.	Zone-2	Ayeyarwady Region/ Rakhine State
3.	Zone-3	Bago Region/ Yangon Region/ Naypyitaw council
4.	Zone-4	Sagaing Region/ Kachin State/ Chin State
5.	Zone-5	Mandalay Region/ Magway Region
6.	Zone-6	Shan State/ Kayar State

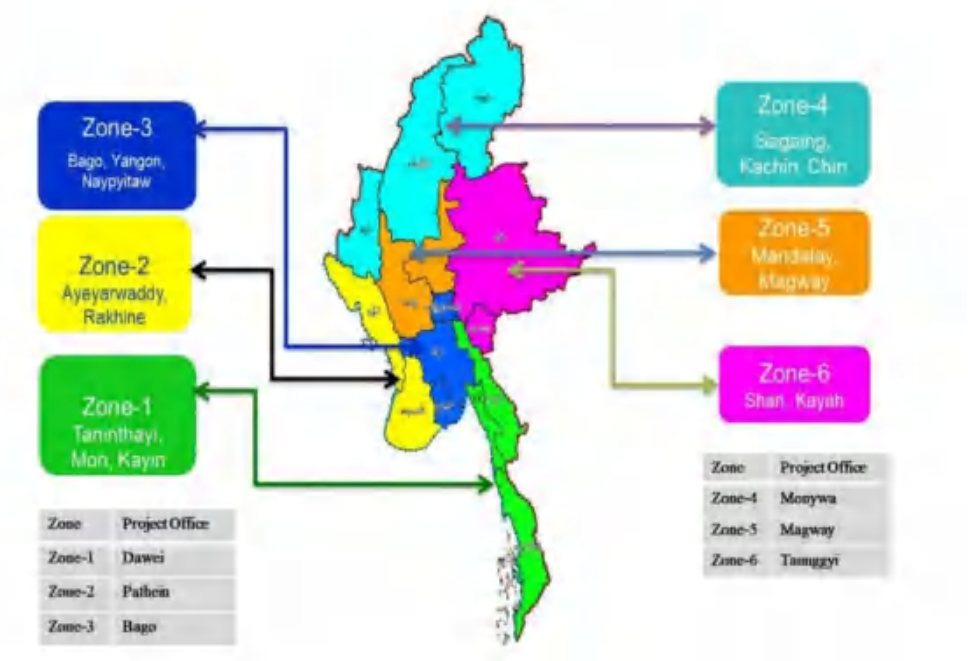

Figure 4: Classification of zone and locations of zone office

4.8 Expected outputs

1) Adoption of Forest Plantation Strategy.

2) (142,626) Hectares of forest plantations owned by the State established.

3) (115,378) Hectares of private plantations established.

4) (331,250) Hectares of Assisted Natural Regeneration area in the Production Forests.

5) (202,342) Hectares of remaining natural forests in Central Dry Zone conserved.

6) (311,742) Hectares of Community Forests established.

7) Reservation of (41,854) square kilometer (6.195% of economy area) constituted as Permanent Forest Estate to meet the national target of 30% of PFE in accordance with Myanmar Forest Policy 1995.

8) Contribution of job opportunities for (0.25) million people annually in order to develop the socio-economic condition of local communities.

9) Capacity of the local people and staff members (about 38,120 people) built up.

10) Impacts of climate change mitigated through the establishment of plantations, restoration of forests, reservation and protection of biodiversity with the active participation of people.

4.9 Implementation activities by Forest Department (FD) and Dry Zone Greening Department (DZGD)

No		Activities	Unit	Imple-menting Agencies	10 year Target	Accomplish-ment after 6 years 2022-2023	%
1		Forest plantation Strategy			Processing		
2		Assisted Natural Regeneration	Hectares	FD	331,250	91,375	27.58
3		Protection of remaining natural forests	Hectares	DZGD	202,342	95101	47
4		Enrichment Planting	Hectares	FD	59,598	28,180	47.28
5		Establishment of State-owned Forest Plantations	Hectares	FD	115,558	59,480	51.47
				DZGD	27,068	9,516	35.16
	(a)	Establishment of Commercial Plantations	Hectares	FD	65,923		
	(b)	Establishment of Watershed Plantations	Hectares	FD	9,362		
				DZGD	4,633	2,084	44.98
	(c)	Establishment of Mangrove Plantations	Hectares	FD	12,015		
	(d)	Establishment of Village Supply Firewood Plantations	Hectares	FD	28,257		
				DZGD	14,058	4,257	30.28
	(e)	Establishment of Greening Plantations	Hectares	DZGD	3,237	878	27.13
	(f)	Establishment of Hill Plantations	Hectares	DZGD	5,139	2,296	44.69
6		Establishment of Private Forest Plantations	Hectares	FD	115,378	34,092	29.55
	(a)	Establishment of Teak Plantations	Hectares	FD	34,417		
	(b)	Establishment of Hardwood Plantations	Hectares	FD	80,960		
7		Establishment of Community Forest	Hectares	FD	311,742	181,969	58.37
8		Establishment of Agro-forestry	Hectares	FD	6,764	4,062	60.05
9		Special treatment to old forest plantations of inferior quality	Hectares	FD	45,064	12,774	28.35
10		Seedling Distribution	No. of trees (Million)	FD	97.09	58.13	59.86
11		Tending operations on 5 years Old Plantations					
	(a)	Cleaning and Pruning	Hectares	FD	34,964	6,504	18.61
	(b)	Thinning	Hectares	FD	70,621	51,384	72.76
12		Establishment of Seed Production Area		FD			
	(a)	Selection of Plus Trees	No. of tree	FD	6,050	2,250	37.19
	(b)	Establishment of Teak Hedge Gardens	Hectares	FD	30	18	60
	(c)	Establishment of Clonal Seed Orchard	Hectares	FD	30	8	26.67

No		Activities	Unit	Imple-menting Agencies	10 year Target	Accomplish-ment after 6 years 2022-2023	%
	(d)	Establishment of Seed Production Area	Hectares	FD	1,731	1,038	59.96
13		Upgrading Seed and seedling Center	No.	FD	8	8	100
14		Reservation	Sq-km	FD	41,854	2,307	5.5
15		Water Resource Development		DZGD			
	(a)	Construction of small ponds	pcs	DZGD	210	115	54.76
	(b)	Construction of Check Dams	pcs	DZGD	1208	808	66.89
	(c)	Construction of Tube Wells	pcs	DZGD	26	18	69.23
	(d)	Construction of tank to collect rain-water	pcs	DZGD	66	74	112
16		Establishment of Special Greening	No. of trees (million)	DZGD	2.452	1.187	48.41
17		People-oriented planting for rural development	No. of trees (million)	DZGD	2.623	1.495	57
18		Promoting the use of fuel-wood substitutes		DZGD			
	(a)	Efficient stoves distribution	stove	DZGD	195,140	196,714	101
	(b)	Utilization of briquettes	brick	DZGD	25,170,444	18,448,656	73.29
	(c)	Utilization of agricultural residues	ton	DZGD	591,280	785,088	132
	(d)	Establishment of Model villages	village	DZGD	530	238	44.91
	(e)	Environmental Education Extension	time	DZGD	15796	8,039	50.89
	(f)	Opening of extension centers	time	DZGD	1440	525	36.46
19		Training(Public/Gov Staff)	person	FD	35,600	122,76	34.48
				DZGD	2520	756	30

(Source; Forest Department and Dry Zone Greening Department)

According to the 6 year experience of MRRP by implementing the above mentioned activities, objective (1), (2), (3) and (5) are in progress. Therefore, overall accomplishment of this programme after 6 year is 54.27 % and we are performing our best to achieve 100% fulfillment of this programme.

4.10 Recorded Photos

Assisted Natural Regeneration

Kalawpa Reserved Forest, Pinlebu Township, Sagaing Region

Enrichment Planting

Gap Planting

Line Planting

Pinlebu(2) Protected Public Forest, Pinlebu Township, Sagaing Region

Establishment of Community Forest and Agroforestry

Community Forestry

Agroforestry, Shan State

Seedling Distribution/ Nationwide Tree Planting Campaign

Myanmar

Teak Plantation(2020), Mankaw(3) Protected Public Forest, Pinlebu Township, Sagaing Region

Surveying

Felling and Cutting

Fire Protection before Burning

Burning

Reburning

Staking

Planting

Weeding

Survival Counting

Fire Protection After Planting

First Year Teak

Second Year Teak

Mankaw(3) Protected Public Forest, Pinlebu Township, Sagaing Region

5. Finding and Discussion of MRRP and Lesson Learned From this Programme

For adoption of Forest Plantation Strategy, it is weak to involve stakeholders through cross-sectoral cooperation.

For Assisted Natural Regeneration, it is different from economic point of view to ecological point of view. So, the operation processes are different and it is weak to check because these operations are carried out in large scale.

For Enrichment Planting, it is recommended to select suitable native species. It is also weak to maintain after one year operation because there is no budget plan for the second year.

For Establishment of Plantation, classification of plantations based on different types brings better achievement with different purposes. Although watershed plantations aid catchment forest and village supply firewood plantations aid local people for fuel-wood needs without depending remaining natural forest, it is need to consider establishment of commercial plantations in large scale with monoculture. However, establishment of large amount of plantations create job opportunities for local people and it is affective to conserve the plantation with local people interest. But, for the degraded forest, rehabilitation can achieve by plantation establishment because it covers land-use conflicts.

For Special treatment to old forest plantations of inferior quality, the budget investment is lower than establishment of new plantation although the operations are the same to the new plantation establishment.

For seedling distribution, it is need to make strong seedling at the time of distribution. So, it is need to begin seedling one year ahead of distribution.

Other activities like Community Forestry and Agroforestry have been successfully implemented because these activities have been carried out with people participation.

In this Programme, Seedling Distribution, Community Forestry and Agroforestry activities are the best way for the local people to participate in the rehabilitation of degraded forest. With Seedling Distribution, Myanmar government is strongly and actively participate and encouraging by holding Nationwide Tree Planting Campaign throughout the whole economy. The objective is to encourage and persuade people to plant trees and to understand the important and usefulness of forests for human being in non-forested areas. This Tree Planting Campaign involves individuals, civil societies, students, and governmental and non-governmental organizations.

According to the 6 year experience of MRRP, when a programme which cover wide areas or throughout the whole economy is take out, adoption of forest operations should not be equal in different localities. The budget norms for the operation should not be the same from the beginning to the end if the program is long term duration. It should be separate in 3 to 5 year each because commodity prices are not stable and the labor charges are different in different localities.

According to the current political situation in Myanmar, some area of States and Regions are insecure and cannot be accessed. Some activities like Assisted Natural Regeneration (ANR) and Forest Reservation have to be carried out in remote areas of these States and Regions. Therefore, due to the lack of assessment of these activities, we cannot achieve our intended target. To achieve the successful MRRP, the political and financial support play the major factor in the implementation according to the 6 year experience of because there are a lot of skillful person in Myanmar.

6. Conclusion and the Way Forward

This programme covers the reforestation and rehabilitation of Myanmar forests into national level by setting up targets for each region and state of the economy, in cooperation with people participation power. The experiences from this programme can be applied and the following positive change can be replicated and scaled up to other forest related agencies for the Sustainable Forest Management and Degraded Forest Rehabilitation.

Should To-

- To pay more attention in the participation of local community in the establishment of plantations, restoration of forests, reservation and protection of biodiversity
- To effectively promote community-based forest management and sustainable agricultural practices such as agroforestry, community forestry, Nationwide Tree planting Campaign, etc.;
- To involve stakeholders in all levels and in all forms through cross-sectoral cooperation for a successful plantation strategy adoption;
- To select suitable native species for the achievement of Enrichment Planting;
- To bring better achievement of plantation in different plantation types with different purpose instead of establishment of large scale of commercial plantation in a monoculture way;
- To begin seedling one year ahead in order to make strong seedling at the time of distribution;
- To make an amendment and repair the laws, rules and regulations which are overlapping and conflicting with other department and institutions.

Should Not To-

- Not to focus Assisted Natural Regeneration only in economic point of view for a better restoration;
- Not to be equal adoption of forest operations in different localities if a programme which cover wide areas or throughout the whole economy is take out;
- Not to be the same the budget norms for the operations of a program if the program is long term duration because commodity prices are not stable and the labor charges are different in different localities

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Degraded Forest Rehabilitation and Management in Myanmar

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Abstract: This report is related to forest rehabilitation and sustainable forest management and how to overcome the challenges and to achieve the opportunities in Myanmar. Firstly, yield regulation for natural forests is presented for sustainable forest management. Under Myanmar Selection System, annual allowable cut (AAC) is applied. However, this system favors only teak. And also this system does not considered residual growing stock after harvesting. The system cannot provide optimal growing stock and coupled with optimization techniques cannot be possible. So, the global optimum cannot achieve. On the other hand, matrix model is very flexible and can be used with linear programming. Therefore, it is recommended the matrix model should be applied in natural forest management in Myanmar because it simple and powerful to obtain sustained in the long-term. For the plantation management, there is no any steady state forest or regulated forest in Myanmar. In order to reach this target, growth and yield information is urgently needed. After that, dynamic model can be applied coupled with linear programming. This will lead to sustainable forest management in term of plantations. In the natural forest and planed forest, in both cases, permanent sample plots should be established throughout the nation. Finally, this report supports the way how to go the sustainable forest management in Myanmar.

1. Introduction

The Republic of the Union of Myanmar is located in Southeast Asia between latitudes 9°32' and 28°31‟N and longitudes 92°10‟E and 101°11‟E. Myanmar is bordered by China, Laos, Thailand, Bangladesh and India. The total area of Myanmar is 676,577 km2, stretching for 936 km from east to west and 2,051 km from north to south. The topography of Myanmar can roughly be divided into four parts: namely the Western Hills Region, the Central Valley Region,the Eastern Hills Region and Tanintharyi Coastal Strip.

Myanmar has three distinct seasons; hot season, rainy season and cold season. The Central Myanmar has an annual rainfall of less than 1,000 mm while the Rakhine coast receives more than 5,000 mm. Besides, the average highest temperature in the Central Myanmar is about 43.3 ° C while in Northern Myanmar, it is about 36.1 ° C and on the Shan Plateau, between 29.4 ° C and 35 ° C. Due to these ecological diversity, Myanmar is endowed with a rich diversity of habitat types. Myanmar has been protecting and conserving its diverse biological resources on a sustainable basis.

According to FAO FRA 2015, about 42.92% of the economy‟s total land area is still covered with forests. Myanmar‟s forests are socially and economically significant to the economy. Over 70% of the economy‟s total population are rural and dependent on forest resources for basic needs such as food, fodder, fuel, and shelter. Despite high dependency on forests, considerable extent of natural forests in the economy is an indication of the consistent exercise of sound forest management practices for years.

2. Forest cover changes over time

The status of forest cover changes in Myanmar is shown in the Table-4 and Figure-2 below. Due to the various factors, forest cover is gradually decreasing and other land cover areas are gradually increasing between 1990 and 2015 according to FRA (2015).

Deforestation was at an alarming rate in the past three decades due to various reasons. The forest cover changes between 1990 and 2015 indicate accelerating rates of deforestation–0.9 to nearly 2% annually. The extent of forest area is changing by different rate on a different period. The annual forest change rate during 1990-2000 is -435 thousand hectare (,000 ha) or –1.2% per year. During the year 2010 -2015, forests are changing from very highest rate of annual change at –1.8% per year in the last period of 5 years. The overall forest loss calculated for the 25-year period of 1990-2015 is -407.1 thousand hectare (,000 ha) per year and the annual change rate is –1.2% annually. Therefore, Myanmar was among the tropical economies with the highest rates of deforestation, after Brazil and Indonesia (FRA, 2015).

3. Land Use

Myanmar's forests vary in species composition and stand structure, and constitute a valuable ecosystem due to their wide extent, varied topography and different climatic conditions. The Forest Resource Assessment (FRA, 2015) has indicated that Myanmar is endowed with a forest covered area of 42.92% of the economy's total land area. This positions Myanmar as one of the highest in the Asia Pacific Region.

Possessing a great variation of forest ecoregions, there are six major forest types in Myanmar. Areas of respective forest types are shown in Table 2. The majority of the forest area is covered by mixed deciduous forest, and hill and temperate evergreen forests, accounting for 38.20 and 26.92 percent, respectively.

Table 1: Forest Type in Myanmar

No.	Major Forest Type	Ha	% of Forest Area
1	Mangrove Forest	325,259.20	1.12
2	Tropical Evergreen Forest	5024,093.00	17.30
3	Mixed Deciduous Forest	11,093,662.00	38.20
4	Dry Forest	2,904,100.00	10.00
5	Deciduous Dipterocarp	1,237,146.60	4.26
6	Hill and Temperate Evergreen	7817,837.20	26.92
7	Scrub and Grass Land	638,902.00	2.20
	Total Forest Area	29,041,000.00	100.00

4. Myanmar Forest Policy

Myanmar Forest Policy (1995) has been formulated in a holistic and balanced manner with the overall context of the environment and sustainable development taking full cognizance of the forestry principles. It formalizes the commitment and intent of the Government to ensure the sustainable development of forest resources for social, environmental and economic purposes. The policy paves the way for prudent use and enhanced benefit from the forest while maintaining ecosystem integrity and environmental balance. Six imperatives identified in the policy are:

(1) Protection of soil, water, wildlife, biodiversity and the entire environment;

(2) Sustainability of forest resources to ensure perpetual supply of both tangible and intangible benefits accrued from the forests for the present and future generations;

(3) Basic needs of the people for fuel, shelter, food and recreation;

(4) Efficiency to harness, in the socio-environmentally friendly manner, the full economic potential of the forest resources;

(5) Participation of the people in the conservation and utilization of forests; and

(6) Public awareness about the vital role of forests in the well-being and socioeconomic development of the nation.

5. Forest Law

The old Forest Law (1992) was repealed by the new Forest Law enacted in 2018. The basic principle, management of forest land, conservation and protection, administrative actions, and offences and penalties were revised and updated in the new Forest Law (2018). The new Forest Law comprises nine basic principles and 58 sections under 13 Chapters, highlighting the constitution of reserved forest and declaration of protected public forest, management of forest land, establishment of forest plantation, extraction and removal of forest produce, disposal of drift, stranded and waif timber, establishment of wood-based industry, administrative action (search, arrest and administrative action) in respect of offences and penalties. The new Law recognizes local and indigenous peoples‟ rights, encourages people's participation in forest management, private sector involvement in forestry sector development, human resource development and extension to local people.

6. Rehabilitation of Dry Zone

The dry zone of Myanmar lies in the central portion of the economy and covers about 12% of the total land area. It has very harsh climatic conditions with extreme temperature, prolonged drought period and erratic rainfall. Thus, the "Agricultural and Rural Development Corporation" (ARDC) implemented afforestation projects in Dry Zone since 1953-54 and ended on 30th September 1963. In 1994, the Government launched a project entitled "Nine District Special Greening Project" in the Dry Zone of Central Myanmar for rehabilitation as well as greening of the Dry Zone. Based on the experiences and success of the Project, Dry Zone Greening

Department (DZGD) was constituted under Ministry of Forestry in July 1997. The working area of Dry Zone Greening Department consists of 53 Townships from 13 Districts of 3 Regions, covering 19.54 million acres of the central dry zone of Myanmar.

Dry Zone Greening Department has formulated a comprehensive master plan for a 30-year period from 2001-2002 to 2030-2031 with a view to implement the following four main tasks;

(i) Establishment of Forest Plantations

(ii) Protection and Conservation of Remaining Natural Forests

(iii) Promotion on Utilization of Fuel wood Substitutes

(iv) Water Resources Development

7. Sustainable Forest Management

7.1. Natural Forest Management

The Myanmar Selection System (MSS), originally known as the Brandis System, was developed during the period 1880-1920 as a combination of yield regulation by the Brandis method and periodical improvement fellings to favour teak. Dr. Dietrich Brandis, a German botanist, became Superintendent of Bago Yoma Forests in January 1856. MSS has been the principal forest management system applied in managing the natural forests of Myanmar since 1856. It involves formation of felling series, each of which is divided into 30 annual coupes based on equal productivity and more or less the same size and worked over a period of 30-year felling cycle. On the other hand, MSS is practiced within the bound of area limit (Felling series-30 Blocks), size/girth limit (63 cm or 73 cm DBH) and time limit (a felling cycle of 30 years). Fixing of Annual Allowable Cut for teak and hardwood, conducting pre- and post-harvest inventory and cultural treatments such as improvement felling, enrichment planting, climber cutting etc, are the characteristics of MSS. MSS has been being applied in Myanmar practically to all types of natural forests with virtually blanket silvicultural prescriptions, although it is well aware that silvicultural techniques are sometimes highly site-specific.

Furthermore, Forest Management Units (FMUs) are formed for each District (totaling 68 Districts across the economy). Each and every FMU also has 10 years forest management plan which is also called District Forest Management Plan. District Forest Management Plan includes seven working circles namely Production Working Circle (PWC), Planted Forests Working Circle, Local Supply / Community Forestry Working Circle (LS/CFWC), Watershed Forests Working Circle (WFWC), Nonwood Forest Products Working Circle (NFPWC), Protected Areas Working Circle and Special Working Circle (such as mangrove working circle, pine working circle, resin production working circle, bamboo working circle etc). Among these WCs, PWC covers an area of 30 million acres in which sustainable timber production is conducted in accordance with the AAC of the District Forest Management Plan. Forest Management Plans are revised every 10 years to cope with the changing situation of forest resource status of the Districts.

Development of Myanmar‟s criteria and indicators (C&I) for SFM at both national and FMU levels was completed in October 1999, and formally approved by the MONREC (formerly Ministry of Forestry). Myanmar‟s C&I, which is based on ITTO‟s C&I of 1998, contains 7 criteria each at both national and FMU levels. There are 78 indicators and 257 required activities at the national level, and 73 indicators and 217 activities at the FMU level.

7.2. Annual Allowable Cut

Under MSS, only mature trees are selected and harvested. Harvesting of trees is regulated based on annual growth and controlled by girth limits prescribed by species or species groups. Felling of exploitable trees is within the bounds of Annual Allowable Cut (AAC). Fixing AACs, therefore, accords the increment of individual tree species, which has taken place over the course of 30-year felling cycle. AAC is thus a tool that ensures the harvest of timber yield on a sustained basis. AACs for teak and for non-teak other hardwoods are periodically revised and fixed based on the forest inventory data.

7.3. Plantation Forestry

Myanmar initiated the establishment of Teak plantation as early as 1856 on a small scale using Taungya method. In 1941, the extent of forest plantations reached 47,167 ha. Large scale plantation forestry began in 1980 and about 30,000 ha of forest plantations have annually been established since 1984. In 1998, the Government initiated special teak plantation program to increase timber production. At present, annual planting rate amounts to 6,000 ha as well as annual distributions of about 17 millions of seedlings to the public for tree planting campaign. The Forest Policy (1995) stipulated that plantation forestry has always been the supplementary and the existing natural forests will not be substituted with forest plantations. Table -7 and show forest plantations by types and by species, respectively.

7.3.1. Government-owned plantations

Myanmar initiated the establishment of Teak plantation as early as 1856 on a small scale using Taungya method. In 1941, the extent of forest plantations reached 47,167 ha. Large scale plantation forestry began in 1980 and about 30,000 ha of forest plantations have annually been established since 1984. In 1998, the Government initiated special teak plantation program to increase timber production. At present, annual planting rate amounts to 6,000 ha as well as annual distributions of about 17 millions of seedlings to the public for tree planting campaign. The Forest Policy (1995) stipulated that plantation forestry has always been the supplementary and the existing natural forests will not be substituted with forest plantations. Table -2 shows forest plantations by types.

Table 2: Forest plantations by types (from 1981-1982 to 2018)

No.	Plantation Type	Area (ha)	Percent of Total Area (%)
1	Commercial	491,403	54.11
2	Village supply	187,022	20.59
3	Industrial	72,519	7.98
4	Others	14,269	1.57
5	Watershed	139,160	15.32

6	Mangrove	3,828	0.42
	Total	908,200	100

7.3.2. Myanmar Reforestation and Rehabilitation Programme (2017-18 to 2026-27)

The forest cover in Myanmar is about 42.92%, whereas closed forest and opened forest account for 21.56% and 21.36% of the economy‟s total area respectively (FAO 2015). Average annual deforestation rate is about 1.72% (1,348,620 acres) of the economy‟s total area between 2010 and 2015. As a result, degraded forests amounted to 22.29% (3,725,0000 acres) of the economy‟s total area.

In order to restore the degraded forests, Forest Department launched Myanmar Reforestation and Rehabilitation Programme (MRRP) (2017-18 to 2026-27) in 2017. MRRP is being implemented in all 15 States and Regions (i.e., 68 Districts) of the economy. Dry Zone Greening Department is also cooperating with Forest Department in implementing MRRP. It is a milestone and significant initiative of the Government with various objectives as follows:

- To restore and rehabilitate the degraded forests for climate change mitigation and adaptation as well as to enhance ecosystem services
- To fulfill the demands on teak and other commercial timber species
- To strengthen the investment of private sector in forest plantations
- To improve the livelihood and socioeconomic conditions of the rural people through increasing job opportunities and the community forestry
- Formulation of Forest Plantation Policy In order to achieve the objectives, the following targets are set, and being implemented with great efforts:
- establishment of 148,627 ha (352,438 Acres) of state-owned forest plantations establishment of 115,427 ha (285,104 Acres) of private plantations
- encouraging and improving Assisted Natural Regeneration covering 331,392 ha (818,538 Acres) in the Production Forests
- conservation of 202,429 ha (500,000 Acres) of remaining natural forests in Central Dry Zone
- establishment of 311,875 ha (770,332 Acres) of Community Forests
- reservation of 1,610 square miles (6.195% of economy area) to fulfill the national target of 30% of PFE in accordance with Myanmar Forest Policy 1995.
- formulation of forest plantation policies and strategies

7.3.3. Private Forest Plantations

With the decreasing availability of logs from natural forests, plantations become the important source of timber. Historically, forest plantations were established and managed by the Government for various purposes. With the changes of political and socioeconomic conditions, the Government allowed private sector to invest in establishment of teak plantations and hardwood plantations in 2006 in order to accelerate plantation forestry, meet the timber demands, increase forest cover and enhance job opportunities.

Up to date, 13,127 ha of private teak plantations and 16,220 ha of non-teak forest plantations have been established. Table - 9 shows the area of private teak plantations and non-teak forest plantations.

Table 3: Private teak and non-teak forest plantations

	Plantation Type	Area (Acre)
1	Teak	148,551
2	Hardwood (Non-teak)*	112,086
3	Industrial	410055
	Total	670,692

Note: **Xylia xylocarpa, Pterocarpus macrocarpus, Acacia mangium*

8. Challenges and Opportunities

Despite a substantial contributions and great efforts to achieve sustainable forest management, there are many challenges Forestry Sector is facing. The most significant challenges are:

- High rate of deforestation and forest degradation (i.e. annual deforestation rate of 1.7 percent during 2010-2015)
- Expanding area of reserved forest and protected public forest up to 30 percent of the total economy‟s area as well as protected area coverage up to 10 percent of the total economy‟s area.
- Conflict of interests; powerful (political and economic) interests may favor deforestation and forest degradation
- Conflict of sectoral policies and plans as well as legislation which may accelerate deforestation and forest degradation
- Some of the main drivers of deforestation and forest degradation often lying outside of forest sector (eg. related with agriculture, mining, infrastructure development etc.)
- Weak law enforcement and poor coordination mechanism among line ministries in fighting against illegal logging
- Integration of criteria and indicators into national forest programmes

While many changings being faced, there are many opportunities to achieve the goals of Forest Policy and sustainable forest management. The major opportunities include:

- Political will and supports to the sustainable forest management and environmental conservation
- Moratorium of timber harvesting in Bago Yoma Region, Home of Teak Tectona grandis (area of 1.5 million ha) for 10 years starting from 2016-17 fiscal year
- Export ban for the confiscated timber
- Export ban for any log or timber extracted incompliant with sustainable manner, (e,g., conversion timber is no longer allowed to export)
- Export ban of round log since 1st April 2014 not only to promote exporting the value-added products but also to fulfill the demand of raw materials for domestic wood-based industrial sector.

- Logging below Annual Allowable Cut (AAC) (for teak, under 55% of the AAC and for other hardwoods, under 33%) to reduce deforestation and forest degradation
- Increasing number of capable human resources in forestry sector
- Implementation of the Myanmar Restoration and Rehabilitation Programme (MRRP) for 10- year period (2017-2018 to 2025-2026) with government‟s budget.

9. The Way Forward

Forest Department under MONREC is committed to achieving the targets of not only Forest Policy (1995), Myanmar Sustainable Development Plan (MSDP) and sustainable forest management but also the international commitments including Nationally Determined Contributions (NDC), Sustainable Development Goals (SDGs) etc. Accordingly, Forest Department will continue to implement the following measures and activities in support of SFM in accordance with the criteria and indicators formulated in the context of Myanmar.

- To reduce/stop the rate of deforestation and forest degradation while increasing forest cover through all appropriate means and ways;
- To systematically conserve and manage existing natural forests and restore degraded ones in accordance with the principles of Myanmar Selection System (MSS) while carrying out reservation to achieve the forest policy target of reserved forest and protected public forest up to 30% of the economy‟s total land area;
- To expand and enhance protected areas (PA) to fulfill the forest policy target of 5% and 10 % target of the 30-year Forestry Master Plan for biodiversity conservation and climate change mitigation benefits through increasing carbon stocks in addition to ecosystem services and social benefits;
- To pay more attention in achieving Myanmar Reforestation and Rehabilitation Programme
- To effectively promote community-based forest management and sustainable agricultural practices such as agroforestry, community forestry, nation-wide tree planting programme, etc.
- To efficiently harvest and utilize forest resources including non-timber forest products to ensure sustainability;
- To strengthen and effectively implement the forest law enforcement, governance and trade (FLEG-T) and Myanmar timber legality assurance system (MTLAS)
- To implement REDD+ to reduce deforestation and forest degradation and enhancement of forest carbon stock and non-carbon benefits To promote forestry research, education and extension leading to better understanding of the complex relationship between ecosystems and human well-being;
- To enhance capacity for the implementation of criteria and indicators for sustainable forest management and biodiversity conservation
- To actively cooperate with international communities, private sector, local communities, ethnic groups and relevant stakeholders in addressing issues such as sustainable forest management, climate change, loss of biodiversity and desertification and land degradation, etc.

- To strengthen organizational capacity and institutional framework of the forestry sector for dealing with the dynamic situations of the forestry-related issues and matters in the national as well as global perspectives.
- To strengthen synergies for sustainable forest management through cross-sectoral cooperation and national forest programmes, and
- To promote the incorporation of the economic viability of sustainable forest management in rural development policies and strategies.

10. Recommendations

In Myanmar, natural forests have been managed by annual allowable cut (AAC) in order to get sustained yield. But AAC do not consider the residual stand structure. In AAC felling cycle is 30 years and before and after cutting, pre-harvest and post-harvest inventories are carried out. This is very expensive. Therefore, it is recommended that matrix model should be developed to manage natural forest efficiently. In this case, permanent sample plots should be established. Moreover, matrix model can be optimized by linear programing. Timber volume and net present value will be able to optimized. In matrix model, felling cycle can be changed by forest manager as desired, for example, 5 year felling cycle, 10 year felling cycle, and so on. Nowadays, carbon dioxide sequestration is important and by applying matrix model the net income from timber production and from CO_2 sequestration can be optimized simultaneously. AAC has the following formula.

$$AAC = ARR + [\frac{OWS - \frac{1}{2}FC * ARR}{LP}]$$

$$ARR = \frac{CII}{TP}$$

Where,

AAC= annual allowable cut

ARR= annual rate of recruitment

OWS= orginal woking stock(the largest girth class trees)

FC= felling cycle (30 years)

LP-= Liquidation period(60 years)

CII= the second largest girth class calss trees

TP= time of passage

Table3: Girth classes and time of passage for the calculation of AAC

Girth Class	No. of trees	TP	Causalty(%)	Available Trees
>=7'(CI)	31523		95	
6' – 7'(CII)	18114	26	85	
4' 6" – 6'(C3)	42768	37	70	

3’-4’ 6”(CIV)	101737	33	50	
1’ 6”- 3’(CV)	150910	29	25	

Matrix model has the following nature.

$$R_t = 100 - 10B_t + 0.2N_t$$

$$y_{1,t+1} = a_1 y_{1t} + R_t$$

$$y_{2,t+1} = b_1 y_{1t} + a_2 y_{2t}$$

$$y_{3,t+1} = \quad b_2 y_{2t} + a_3 y_{3t}$$

Where,

a = Fraction staying in the same class

b = Fraction growing into the next class

Rt = ingrowth during specific interval

Bt = basal area per hectare for average trees

Nt = number of trees per hectare

To construct growth matrix (*G*) and calculate column vector (*c*) for 5 year cutting cycle can be used the following notations.

$$y_{t+m} = Ky_t + u$$

Where

$$K = G^m$$

and

$$u = \sum_{i=0}^{m-1} G^i c$$

m is time unit and 1,2,3,…..,n .

Here, if growth period is 5years, for 5 year cutting cycle, m = 1 and for 30 year cutting cycle, m = 6.

For LEV maximization, the following objective function can be used.

$$P_H = vh\frac{(1+r)^T}{(1+r)^T - 1}$$

Where,

P_H = the net income from timber production discounted from infinity

v = timber value per cubic meter

h = trees harvested per hectare

r = discount rate

T = felling cycle length

$$Z_{PV} = vh\frac{(1+r)^T}{(1+r)^T - 1} - vy$$

Where,

Z_{PV} = objective function to maximize LEV.

y = growing stock per hectare

Steady state constrain must be as follow.

$$y = G\ (y - h) + c \quad \text{or} \quad y - G\ (y - h) = c$$

For the planation management, there are only the two old yield tables for teak. They are not suitable for the current conditions due to different stand density (for example different spacings). Other commercial species, yield tables have not been constructed yet. Therefore, permanent sample plots in each plantation to study growth and yield should be established. From permanent sample plots, not only growth and yield but also polymorphic site index can be studied. In Myanmar, only two site indices are available. One covers the whole economy and another one covered Bago Township, Bago Region of Myanmar. Another aspect to support growth and yield studies is to develop two variable volume equations and taper models for all commercial species. And then, volume – age yield models should be analyzed.

In Myanmar, there is no steady state or special steady forest (regulated forest) to manage sustainably. Therefore, it is very important to satisfy this situation. Without this, it is possible to support sustainable forest management for sustained yield. So, dynamic models for plantation management should be applied coupled with linear programming. After that, the volume or land expectation value can be optimized with different rotations to provide sustained yield for periodic income. Nowadays, carbon storage of trees plays an important role in forest management. Therefore, simulation is necessary. And then, The net income from timber production and carbon storage can be adjusted for different rotations.

It is also needed to conduct research for different species by applying experimental designs. For example, spacing trials, basal area trials and biomass (carbon storage) trials, etc. should be carried out. Randomized complete block design and split-plot design are highly recommended.

In order to apply dynamic model, Forest growth equations can be write down as follow.

m is age class. The length of the period is *u*. A_{ij} is state variable and the area in age class *i* at the j^{th} period.

The forest is managed for *p* periods, each *u* years long. At the end of this conversion period the forest will reach a sustainable forest structure and harvest. The decision variables X_{ij} is the area cut and reforested from age class *i* in period *j*.

$$A_{11} = A_{11}^0$$

$$A_{21} = A_{21}^0$$

……..

$$A_{m1} = A_{m1}^0$$

$$A_{1j} = \sum_{i=1}^{m} X_{i,j-1} \qquad j = 2, \dots, p+1$$

$$A_{ij} = A_{i-1,j-1} - X_{i-1,j-1} \qquad i = 2, \dots, m-1; j = 2, \dots, p+1$$

$$A_{mj} = \left(A_{m-1,j-1} - X_{m-1,j-1}\right) + \left(A_{m,j-1} - X_{m,j-1}\right) \qquad j = 2, \dots, p+1$$

Where A_{i1}^0 is initial area in age class i . To be feasible, the state variables and decision variables much be such that the area harvested and reforested from each age class in each period is nonnegative and less than the corresponding stock:

$$X_{ij} \geq 0 \qquad i = 1, \dots, m; j = 1, \dots, p$$

$$X_{ij} \leq A_{ij} \qquad i = 1, \dots, m; j = 1, \dots, p$$

For objective function formulation, use the following notations.

$$\text{FV} = \text{PV}_c + \text{PV}_\infty$$

Where FV is forest value, PV_c is present value of the income up to the steady state and PV_∞ is the present value after the steady state. u is the length of period and p is number of period.

$$PV_c = \sum_{j=1}^{p} \frac{N_j}{(1+r)^{ju}}$$

$$PV_\infty = \sum_{i=1}^{m} \frac{N_{ip}}{[((1+r)^u - 1)](1+r)^{pu}}$$

$$N_j = R_j - C_j$$

Where N_j is the net income, R_j is the gross revenue and C_j is reforestation cost during period j.

$$R_j = wQ_j = w \sum_{i=1}^{m} v_i X_{ij}$$

Where m is age classes, w is the unit of price of timber, Q_j is the timber harvest in period j and v_i is the volume per unit area in age class i.

$$C_j = c \sum_{i=1}^{m} X_{ij}$$

11. Conclusion

This report focuses on how to overcome from desertification and forest degradation to forest rehabilitation and how to go sustainable forest management for sustained yield. In Myanmar, for the yield regulation of natural forest, AAC is applied. However, this yield regulation does not consider the residual stand structure. The matrix model is very flexible and it allows forest managers to be able to change desirable felling cycle. And also, the model can be used coupled with linear programming to obtain global optimum. So, to develop matrix growth models are needed urgently. This will be a big challenge for Myanmar forestry sector. For forest rehabilitation, MRRP is special program. This is one opportunity. For plantation, there is no updated growth and yield in formation and also steady state or regulated forest. In this case, to sustained yield, growth and yield studies should be carried. Dynamic growth model should be applied. Finally, this report intends to satisfy sustainable forest management in Myanmar.

Degraded Forest Rehabilitation and Management in Nepal

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Chapter 1: Economy Background

Nepal is a landlocked economy bordering China on the north and India on the south, east, and west. It has an area of 147,516 sq. km. Situated between latitudes 26º22' and 30º27'N and longitudes 80º04' and 88º12'E within 885 km (east to west) and 193 km (north to south), Nepal has a diverse climate, spectacular landscape, and a considerable number of ecosystem types. Nepal has six vegetation divisions and thirty-five forest types (Stainton, 1972) within five physiographic regions: High Himal, High Mountains, Middle Mountains, Siwalik, and Tarai (CBS, 2019).

Figure 1: Administrative map of Nepal

The Constitution of Nepal has declared the economy the Federal Democratic Republic with three tiers of Government. It has seven Provinces, seventy-seven districts, and 753 local Governments. Local Governments are commonly known as Local levels (CBS, 2022).

Nepal is rich in culture, religion, ethnicity, language, and tradition with more than 126 caste/ethnic groups, 123 native languages, and ten religious groups (CBS, 2011). The economy's economy is agriculture and remittance-based. The share of agriculture, forestry, and fishery in Gross Domestic Product is 23.95%, and per capita income is 1,381 United States

Dollar (USD) (MoF, 2022). Despite the significant role that the forestry sector plays in the national economy, there is no system of separate accounting to assess the precise contribution of the forestry sector. Forest ecosystem goods and services are vital components of the rural economy and act as buffers during natural disasters. Investing in the conservation and management of forest ecosystems is a cost-effective nature-based solution to mitigate climate change.

Preliminary data of the population census 2021 shows a 0.88% annual growth rate which is the lowest since Nepal started its population census in 1961. Topographic variation and changes in altitude have given rise to different climatic zones in Nepal. Below 1000 meters above sea level (masl), the tropical to sub-tropical climatic zone prevails. Middle mountains are characterized by a cool to warm temperate climate, high mountains (3000-5000 meters) have a sub-alpine to alpine climate, and Himal have permanent snow with tundra and arctic climate. Hills and mountains constitute more than $2/3^{rds}$ of the area of the economy.

Fragile topography and the people's limited adaptive capacity make Nepal vulnerable to the adverse impact of climate change (Government of Nepal, 2020). A climate risk profile for Nepal (USAID, 2017) shows an increasing trend in average annual temperature from 1960-2015; more frequent droughts, rapid rate of glacier melt, and increased incidences of glacier lake outburst flood. The report further projected an increase in average annual temperature between 1.6 and 2.2^{o} C, up to a 5% increase in average annual rainfall, and an increase in glacier melt by 2050.

As a result of changes in temperature and rainfall, there has been a shift in vegetation range, phenological change, increased incidences of forest fires, the spread of aligned and invasive plant species, and watershed degradation (MoFE, 2021b). Furthermore, the agriculture sector has experienced a loss in crop production and increased incidences of insects and disease pests (MoFE, 2021a).

Chapter 2: Status of Deforestation and Forest Degradation in Nepal

In Nepal, significant land cover changes have occurred over the past few decades because of natural and anthropogenic causes. Studies have acknowledged land cover change as a critical driver affecting ecosystem goods and services of the forest. For example, studies conducted in the Kailash sacred landscape area of Nepal found that between 1990 and 2009, there was a 9% decrease in forest cover and 12% increase in cropland (Uddin et al., 2015). The study further noticed a rise in forest fragmentation and patch forest, suggesting that agriculture expansion and high dependency on forests for fuelwood and timber are significant drivers of deforestation and forest degradation. Other studies have also found that decreased forests and water bodies, and expanded agricultural lands are related to landscape health and the decrease in ecosystem goods and services (Shrestha, Ye, and Khadka, 2019; Pokhrel & Sherpa, 2019; Sharma et al., 2019).

The National Land Cover Monitoring Report has also estimated the land cover change between 2000 and 2019, identifying a shift in forest, cropland, and grassland. The report shows that between 2000 and 2019, cropland decreased by 2%, and the forest increased almost by the same proportion (FRTC, 2022). This is also supported by research findings which suggest that

community forestry, out-migration, and less dependence on forest resources have increased forest cover in the middle mountains (Chhetri et al., 2021; Yale E360, 2019).

Over the course of 30 years, between 1964 and 1994, Nepal lost 2.134 million hectares of forest, which were either converted into shrub land or into other land uses. However, this trend reversed in 2010/11. From 1964 to 1994, there was a continuous decrease in forest area and increase in shrub land. The trend improved after 1994, with less forest loss, and between 1994 and 2010/11, the forest area increased from 29% to 40.36%. During this same time period, shrub land decreased from 10.6% to 4.38%, and total forest area (including shrub land and other wooded land as defined by the survey) increased from 39.6% to 44.74%.

The latest National Forest Resource Assessment in Nepal found that the economy has 44.74% (6.61 million hectare (ha) of the land area under forest cover (DFRS, 2015). It is also reported that forest and other wooded land covered 45.31% (6.70 million ha.) area of the economy in 2019, while it was 43.56% (6.44 million ha.) in 2000 (FRTC, 2022). Between 1994 and 2010, the forest area increased from 29% to 40.36% and shrub area decreased from 10.6% to 4.38%, showing a significant reduction in the rate of deforestation. Research has found a noticeable improvement in forest cover throughout the economy except in Tarai, which has a higher population density (Chaudhary, Uprety, and Rimal, 2016). The Terai contains the lowest percentage of forest cover compared to other regions, and the deforestation rate has been consistently higher in recent decades. From 1978/79 to 1985/86, the annual deforestation rate was the highest, with an annual loss of 2.11%, which is eleven times higher than the national average for that period. The FRA (2010-2014) also showed an increasing trend of deforestation in the Terai and Chure. Between 1991 and 2010, the forest area in the Terai decreased at an annual rate of 0.40%. This increased to 0.44% between 2001 and 2010.

While data of Nepal's change in forest cover has been available since 1964, it is difficult to get data on forest degradation due to the lack of a commonly agreed definition and the complexity of the nature of degradation (Acharya & Dangi, 2009; Acharya, Dangi, and Acharya, 2011; Khanal & Khadka, 2016). Thus, making a quantitative assessment of the extent of degradation at the national level challenging. However, on a small scale, a study conducted in the Tarai region of Nepal between 2010 and 2020 showed that the forest area affected by disturbance (105,650 ha.) was much larger than the deforested area (2753 ha.) (Aryal et al., 2021).

Deforestation and forest degradation disrupt the sustained flow of ecosystem goods and services from a forest, set back other ecosystem functions, and undermine the well-being of forest-dependent communities. In a landscape, a healthy forest ecosystem helps enhance the services of other ecosystems and plays a significant role in ecosystem resilience on a larger scale. Therefore, finding and addressing the drivers of deforestation and forest degradation is a vital prerequisite to forest and landscape restoration.

Drivers of deforestation and forest degradation (D&D) across the economy have been documented in Nepal's first stages of REDD+ preparation. These drivers are further synthesized in the national REDD+ Strategy of Nepal (MoFE, 2018). The REDD+ Strategy has presented the drivers of D&D, its potential level of effect on forests, affected physiographic regions, and

the underlying causes. It is interesting to note that the same driver has different level of effect depending on the physiographic area.

Table 1 Drivers of deforestation and forest degradation in Nepal

Driver	Affected physiographic region and level of effect #	Result
Unsustainable harvesting and illegal harvesting	1-S, T; 2-HM; 3-MM	Degradation
Forest fire	1-S, HM; 2-T; 3-MM	Degradation
Poorly planned infrastructure development	1-MM; 2-S, HM; 4-T	Deforestation
Over/uncontrolled grazing	1-S, T, HM; 4-MM	Degradation
Weak forest management practices (unmanaged/undermanaged)	1-S, T, HM; 3-MM	Degradation
Urbanisation and resettlement	1-T, S; 5-MM, HM	Deforestation
Encroachment	1-T, S; 5-MM, HM	Deforestation
Mining/excavation (Sand, boulders, and stones)	1-S, T; 3-MM; 5-HM	Deforestation and degradation
Expansion of invasive species of plants	1-S, T; 4-MM; 5-HM	Degradation

Adapted from National REDD+ Strategy, 2018.

Physiographic region: HM-high mountain, MM-middle mountain, S-Chure/Siwaliks, T-Tarai/Inner Tarai

Level of effect: 1- Very high; 2- High; 3- Medium; 4- Low; 5-Very low

These drivers of D&D are the result of several predominant underlying causes: skewed population distribution and migration; limited livelihood opportunities; growing demand-supply gap of forest products; inadequate human resources; and several political and institutional factors such as ineffective land use policy; weak political support; a low priority of research and development; and a poor national strategy for managing natural disasters and climate change (MoFE, 2018b).

The prominent causes and drivers of D&D are interlinked, which causes undesirable land use changes which affect overall landscape vitality. Therefore, restoring forests and other ecosystems requires site-specific measures to address the prominent underlying causes as well as the drivers of forest ecosystem degradation in an integrated manner.

Chapter 3: Overview of the Approaches to Forest Rehabilitation

Government of Nepal has been adopting the approach of restoring forest ecosystem functions through rehabilitation, reconstruction, and reclamation of forest systems since 1960s and has made budgetary provisions to restore the forests through carrying out several restoration activities like nursery establishment, seedlings development, and plantation programs annually in public and private lands. Furthermore, large-scale planation such as *Dalbergia sissoo*, *Eucalyptus spp*. were promoted. The establishment of PAs like, national parks, wildlife reserves also contributed directly to restoration outcomes. The government investments are also made

through deployment of security forces (Nepal army and armed forest guards) in forests and protected areas. It is estimated that over 370,000 hectare of plantation forests have been established in the degraded mid-hills of Nepal. As the forest management paradigm shifted to community management approach in the 1970s, local communities protected these plantations and thus the plantation forests have successfully been established. Community forestry is believed to be instrumental in restoring forests and natural ecosystems. So far, over 2.4 million hectares (about 38 percent) of forests have been managed as community forests in the economy (CFSC, 2024).

The forest policy reform of 1976 was a key initiative for promoting the community-based forest management program in Nepal. Nepal's successful community-based approach to managing forests, biodiversity, and watersheds is an example of how appropriate policies, an institutional enabling environment and local people-led efforts can halt or reverse deforestation and forest degradation, particularly in the hills and mountains. So far, approximately 40% of the economy's total forest area is managed under different community-based modalities, and 23.39% land area of the economy is under national parks and protected area systems (MoFE, 2022).

Nepal has gone through different evolutionary phases of policy development that have at times resulted in both negative and positive consequences. The institutional structures and their functions have also significant impact on forest restoration over the years in the economy.

- 1950s: The Private Forest Nationalization Act 1957 has always been regarded as a major policy instrument for fueling deforestation in many parts of Nepal (Laudari et al., 2020). The act transformed the forest management under customary practices into open access resources. As a consequence, rapid deterioration of forest resulted through conversion of forested areas into farmlands through the random felling of trees across the economy (Pandit et al., 2011). In addition, the government-initiated resettlement program in Terai by inviting hilly migrants to convert forest land into agriculture and settlement (Ghimire, 2017).
- 1960s: During this decade, the D and FD continued and even speeded up due to the resettlement program and because of forest area controlled by the government. The government introduced Forest Act 1961 and Forest Protection Act 1967 to curb deforestation, but emphasized the felling of Sal timber, mainly to export to India (Stewart, 1986). The government initiated some plantation projects in some areas mostly to supply raw materials (Guthman, 1997).
- 1970s: Paradigm shift in forest management approach from state-centric to local government-centric as Panchayat Forest (PF) and Panchayat Protected Forest (PPF) was observed during this decade but it was limited only to mid-hill region. The Terai received more hill migrants as a result of malaria eradication, which fueled deforestation and forest degradation. The establishment of protected area (PA) started during this decade. Large-scale plantation of tree species such as Dalbergia sissoo and Eucalyptus spps started in communal and private lands to meet fuelwood and timber demand.
- 1980s: Policies devised during this decade primarily focused to conserve forests of mid-hill totally ignoring the deforestation in Terai (Guthman, 1997) and initiatives were more

focused to increase state control over the Terai forests. This resulted in loss of trust among the indigenous people who were guarding the Terai forest, therefore triggered deforestation (Adhikari et al., 2010; Malla, 2001). Migration from the hills continued during this decade as well. Political movements too resulted in rapid destruction of forest and encroachment of forest area continued during this decade as well.

- 1990s: The expansion of CF was prevalent during this decade but in hills only and very few CFs were handed over in Terai as compared to Hills (Bampton et al., 2007). With the aim to replicate CF model of the hill, Community Forestry Project and Churia Hills Community forestry project were initiated in Terai and Chure region. But the replication of the CF model from the hills did not get successful in Terai due to the issue of distant users and benefit-sharing accrued from high value timber (Rai et al., 2017, Rai et al., 2007). Production oriented forest management was piloted in 19 districts in central Terai through the development of the Operational Forest Management Plan (OFMP) (Laudari et al., 2020). This decade showed exponential growth of population thus experienced encroachment and forest degradation to meet shelter and food requirement for growing population. Political movements such as Maoist insurgency and beginning of a multi-party system intensified encroachment in forest land and exploitation of natural resources of Terai.
- 2000s: Collaborative Forest Management modality was introduced in Terai which mainstreamed distant users who were largely ignored by the CF program (Bampton, 2007). Public land forestry was also introduced during this period with the formation of multi-stakeholder district level platform known as District Forest Sector Coordination Committee (DFSCC). At the same time, corridor approach initiated to connect PAs in the Terai region. These initiatives, to some extent, helped restore landscape of Nepal's Terai.
- 2010s to till date: Nepal's new constitution of 2015 fundamentally transforms the economy from a unitary political structure to a federal system. It establishes three spheres of government, i.e., at the federal, provincial, and local levels. Each level enjoys certain exclusive powers, which are enumerated in Schedules 5, 6, and 8 of the constitution. Exclusive powers can be exercised by the respective level by enacting laws that are consistent with constitutional provisions. Concurrent powers shared by the Federation and Provinces are listed in Schedule 7 and that shared by the Federation, Province and Local Levels are listed in Schedule 9. While using the powers provisioned by Schedule 7 and 9, new provincial and local laws should be consistent with the Constitution and Federal laws. Constitution of Nepal that outline the distribution of powers related to the forest and environment sector among the federal, provincial, and local levels.

  Schedule 5: Federal Powers

  National and international environment management, national parks, wildlife reserves and wetlands, national forest policies, carbon services

  Schedule 6: Provincial Powers

  Use of forests and waters and management of environment within the province

  Schedule 7: Concurrent Powers of Federal and Province

Utilization of forests, mountains, forest conservation areas and waters stretching in inter-provincial form

Schedule 8: Local Powers

Protection of watersheds, wildlife, mines and minerals

Schedule 9: Concurrent Powers of Federation, Province, and Local Level

Forests, wildlife, birds, water uses, environment, ecology and biodiversity

With endorsement of new constitution Nepal is still on transition phase in implementing federalism and endorsing new policies and legislation. Some major policies and laws related to forest and landscape restoration are listed below:

National Agroforestry Policy, 2019

The objectives of this policy are to reduce pressure on forests, develop a climate resilience ecosystem, create employment and income opportunities, and strengthen the well-being of the communities. These objectives are in line with the principles of forest and landscape restoration (MoAD, 2019)

Climate Change Policy, 2019

One of the objectives of this policy is to build the resilience of ecosystems at risk of climate change's adverse impacts. This policy reiterates the need to integrate agriculture, water, forest, biodiversity and watershed, natural and cultural heritage, and disaster management-related activities to build climate-resilient ecosystems and ensure the sustained flow of ecosystem goods and services. This policy contributes to the planning and implementation of forest and landscape restoration in Nepal (MoFE, 2019a).

National Forest Policy, 2019

National Forest Policy promotes the protection of forests, protected areas, watersheds, biodiversity, and wildlife to produce ecosystem goods and services through sustainable and participatory management of these resources. This policy builds on the success/best practices of community-based forest management. It follows the principle of integrated natural resources management and human well-being (MoFE, 2019b).

Forest Act, 2019

Salient features of the Forest Act are the identification of forest carbon, biodiversity conservation, watershed, hydrological cycle, and eco-tourism as ecosystem services; declaration of wildlife corridors and biodiversity conservation area; community-based forest management; private and agro-forestry; and declaration and demarcation of the forest protection area and the associated landscape. In addition, the establishment and operation of the Forest development fund may prove to be a financial window of opportunity for innovative projects on FLR (Forest Act, 2019).

National Parks and Wildlife Conservation Act, 1973

This act enables the declaration of several types of protected areas and their buffer zone, regulates the entry to national parks and the use of natural resources. This act has played an essential role in conserving the economy's ecosystems, species, and genetic diversity (National Parks and Wildlife Conservation Act, 1973).

Soil and Watershed Conservation Act, 1982

This act empowers the Government to declare any watershed of the economy as a conserved watershed area and regulate the land use through an integrated watershed management plan. Activities of conserved watersheds are supportive of landscape restoration (Soil and Watershed Conservation Act, 1982).

Environment Protection Act, 2019

This act has provisions to formulate a climate change adaptation plan, declare natural heritage, and environmental protection areas, and set up an environmental protection fund and its operation. These provisions help the establishment of landscapes for restoration. The Environment Protection Fund also enables the allocation of dedicated funding for restoration (Environment Protection Act, 2019).

Likewise Provincial Governments have also enacted forest and environment-related laws with relevant ecosystem and landscape restoration provisions.

- Koshi Pradesh has enacted its Environment Protection Act 2019, and Forest Act, 2020 which has provision to declare forest protection areas, national heritage sites, biodiversity, and environmental conservation areas.
- Madhesh Pradesh has enacted its Forest Act 2021 with specific provisions such as declaring forest protection areas, promoting plantation and agro-forestry, conserving chure landscape, and its sustainable management. This provision provides a firm legal base for ecosystem restoration in the province.
- Bagmati, Gandaki and Lumbini Pradesh enacted the Forest Act 2019 with provision of declaring forest protection areas, environment protection areas, and management.
- Through the specific provisions of the Pradesh Forest Act 2021, Karnali Province can declare important biodiversity areas, wildlife corridors, and forest/botanical gardens.
- Similarly, the Sudur Paschim Pradesh Forest Act 2020 has a provision for declaring forest protection areas and protected watersheds.

Above mentioned provisions contained in the provincial forest and environment acts have set the ground for furthering forest and landscape restoration through programmatic intervention.

Local Government (rural municipalities and municipalities) perform their function as per the constitutional mandate and business allocation rules. The role includes land use planning, watershed protection, river training, promoting greenery, water source protection, climate change adaptation, disaster management, biodiversity conservation, enterprise development, and invasive species management. Local Governments can also set up dedicated units such as

forest, environment, and watershed sections to ease the implementation of relevant plans and programs.

Institutions

Ministry of Finance (MoF) formulates a development cooperation policy, monitors its implementation, distributes financial resources, and conducts bilateral and multilateral agreements to receive foreign grants/loans.

Ministry of Home Affairs (MoHA) formulates disaster management policies and laws. It regulates its implementation sets up and runs a disaster relief fund and provides support to the local disaster relief fund.

Ministry of Forests and Environment (MoFE) is mandated to work for the protection and management of forests, biodiversity, watersheds, and protected area in an effective, efficient manner for the sustainable management of these resources. As the focal institution, MoFE is responsible for implementing Rio Conventions (biodiversity, climate change, and land degradation) in Nepal. Departments and agencies under MoFE, through their specific role and responsibilities, help in translating the mandates of MoFE into action on the ground.

Ministry of Agriculture and Livestock Development (MoALD) include policy formulation; regulation of agriculture, livestock, fisheries, and horticulture sector; promotion of agro-biodiversity and biotechnology. This Ministry is also responsible for managing rangeland, agriculture research, and agri-statistics.

Ministry of Land Management, Cooperatives and Poverty Alleviation (MoLMCPA) formulate policy, legal instruments, and standards and regulate land use, land use and capability classification, and the national land information system.

Ministry of Federal Affairs and General Administration (MoFAGA) is primarily responsible for coordinating and communicating between the Federal, Province, and local levels, formulating policy, standards, and guidelines for local infrastructure, and supporting area and local level in human resources and institutional capacity development.

Ministry of Energy, Water Resources, and Irrigation (MoEWRI) is responsible for energy, water resources, and irrigation-related policy, standard, and regulations. In addition, MoEWRI conducts climate change-related research and studies. This Ministry also prepares river basin and water use master plans and coordinates for hydro-meteorological data collection.

Provincial ministries related to Forests, Watersheds, and Environments have a specific mandate to manage the forest, biodiversity, and watershed resources and address the drivers of forest and ecosystem degradation and landscape restoration within the provinces. Divisional Forest Offices also undertake afforestation, reforestation, and restoration of degraded forests and watersheds.

Provincial Ministry of Law and Internal Affairs (MoLIA) is responsible for disaster risk management and relief operation, operation and management of disaster relief fund,

coordination with the Local level disaster management committee, and establishment and management of hydro-meteorological stations.

Provincial Ministry of Economic Affairs and Planning (MoEAP) is responsible for allocating financial resources within the Province, receiving foreign aid with the Federal's consent, formulation of province-level development policy, systematic planning, and utilising conditional grants from the Federal.

Provincial Ministry of Drinking Water, Irrigation and Energy (MoDIE) is responsible for water-induced disasters (river and landslides), river training, and watershed protection.

Provincial Ministry of Agriculture (MoA) is responsible for managing food security and food sovereignty. Besides this, the Ministry also promotes the overall agriculture, horticulture, livestock, and fisheries sector.

Chapter 4: A Case Study of Forest Rehabilitation

Historical observation shows that unless people are given user rights and ownership to control and make decisions, people lose interest in effective practices of forest management (Gilmour and Fisher, 1998). Reminiscing at the global history of advancement of community-based forest management, a demand for a paradigm shift in forest management tenure including the devolution of power of forest management was crucial in order to challenge the extensive deforestation and forest degradation (White and Martin, 2002). Likewise, community-based forest management (CBFM) practice originated in Nepal due to the progressive degradation and deforestation of hill forests caused by institutional failure (K.C., 2016). CBFM practices, in the form of different indigenous or traditional practices, have a long history in Nepal. Before 1950s, forest resources were managed in traditional indigenous ways such as Talukdari, Kipat, and religious forest management systems particularly by local elites of a feudal autocratic Rana regime in Nepal. It was privatized forest management regime, as all the resources of the economy were administrated as private properties of Rana's. After abolition of Rana regime from the economy in 1950, government of Nepal promulgated Private Forest Nationalization Act 1957 to protect, manage and utilize the forest of Nepal as state property. All the private and communal properties had come under the control of State. People's traditional rights of access and use to forest resources were diminished. It was nationalized approach for forest management. After that, nationalized approach remained dominant in the forest management regime in Nepal, and the Private Forest Nationalization Act 1957 was followed by Forest Act 1961. Ironically, the Private Forest Nationalization Act 1957 and Forest Act 1961 were not able to prevent people from unregulated extraction of forest resources by creating conflicts between local people and administration. Local people were represented as destroyer of forest resources rather than manager, causing further deforestation. Thus, by the mid-1970s the government realized the importance of people's participation in management of forest resources. It was difficult to protect and manage forests by the government alone.

In the mid-1970s, government of Nepal and a number of donor agencies began showing concern about the accelerating degradation of Nepal's forests and the negative effects it was having on the environment (Acharya, 2003). This led to the local communities being given the rights to

manage and use their local forests as the main strategy to reverse the trend. In the wake of nationalization, the government of Nepal formulated the National Forest Plan in1976 which for the first time recognized the role of local communities and explicitly emphasized people's participation in forest management. This change in policy was the result of the government's realization that forest resources cannot be managed without cooperation of local communities. To implement the concept laid down by the National Forest Plan 1976, the Forest Act 1961 was amended in 1977 and 1978 to define new categories of forests to be managed by local communities, religious institutions and individuals through Panchayat Forest (PF) and Panchayat Protected Forest (PPF) regulations under Panchayat Political System.

The major thrust to the community forestry program came through the Master Plan for Forestry Sector of 1989 which fully recognized community and private forestry as the largest among the six identified primary forestry programs and encouraged transfer of forests to local communities for active management and utilization. Subsequently, Forest Act 1993 and Forest Regulation 1995 provided detailed guidelines and policy framework for community forestry program. This legislation opened the door to implement community forestry programme nationwide and became the milestone in the history of forest management governance in Nepal.

Community forest (CF) in Nepal is defined as national forests handed over to the local user group pursuant to section 18 of Forest Act, 2019 to develop, conserve use, and the forest and sell and distribute the forest products independently by fixing their prices as according to approved Operational Plan. The forests are managed according to the Operational Plan (OP) prepared by Community Forest Users Groups (CFUGs), approved by the Divisional Forest Office (DFO). According to the Act, CFUGs have to be established and registered at the Divisional Forest Office before handing over of the forests and they are self-sustained institutions. The CFUGs can act as self-governing entities to generate, utilize and sell the forest products as mentioned in the Operational Plan.

Community forestry promotes the management of forests as Common Pool Resources (CPRs) (Ostrom, 1992; Acharya, 2003). The CFUGs mange the community forests based on local situation and their interests. Furthermore, almost all the benefits that come from the community forest belongs to the users, the benefit sharing mechanism inside group can be determined by the users themselves. However, there are some mandatory provisions determined by the Forest Act such as the allocation of 25% of the community forest income for forest development activities and 50% of the remaining income must be allocated to poverty alleviation and women empowerment programs inside their user group (MoFE, 2019). These provisions are laid to ensure equitable benefit sharing amongst the users and ensure the sustainable management of forest.

Nepal's community forest (CF) management program is one of the most prominent and long-standing examples of forest management decentralization (Gilmour, 2016; Paudel et al., 2021). The goal of this program is to conserve and expand forest cover, promote sustainable forest management, and improve local livelihoods (MFSC, 2013). Today, CFs occupy around 2.4 million ha and are managed by over 23,000 CF user groups comprising 3.2 million households and nearly 47% of Nepal's population (CFSC, 2024).

Community forests have created natural capital in the form of new forests, and improved existing forest conditions and biodiversity. According to Smith et al. (2023) report, forest conditions have improved in between 1988 and 2016, with an average of 47% showing improvements in forest cover within the study area. K.C. (2016) concluded that community forestry management in Nepal significantly improved biodiversity. It led to increased forest biomass and carbon stocks, a shift towards more productive tree species, and a rise in wildlife populations. Additionally, forests became denser, providing better habitats for animals, though this also resulted in some wildlife causing damage to nearby crops.

Chapter 5: Lesson Learned

Decentralization of Forest Management empowered local communities to halt deforestation and forest degradation

The decentralization of forest management in Nepal through Community Forestry, initiated under the Forest Act of 1993 and updated in 2019, has significantly bolstered forest cover and sustainability efforts nationwide. By empowering local Community Forest User Groups (CFUGs) with the authority to manage nearby forest resources, this approach fosters a sense of ownership and responsibility among community members. CFUGs, comprised of individuals intimately familiar with local ecosystems, actively monitor and protect forests, effectively curbing illegal activities like logging and encroachment. This localized stewardship has been crucial in reducing deforestation rates and promoting sustainable resource utilization practices.

Furthermore, community forestry initiatives in Nepal prioritize reforestation and afforestation programs. CFUGs engage in comprehensive tree planting campaigns and adopt sustainable harvesting practices, contributing to the restoration of degraded lands and the expansion of forested areas. These efforts not only enhance biodiversity conservation and mitigate climate change impacts but also improve soil quality and maintain critical watershed functions. Economic incentives derived from sustainable forest management, including income from timber and non-timber forest products (NTFPs), as well as ecotourism ventures, further incentivize community commitment to conservation practices while supporting local livelihoods. Through capacity building and knowledge sharing initiatives, community forestry empowers local residents with the skills needed to adaptively manage forests in response to environmental changes, ensuring resilience and sustainability for future generations.

Strong legal support is utmost

The Forest Act of 1993 and Forest Regulation of 1995 laid the foundation by empowering Community Forest User Groups (CFUGs) with clear rights and responsibilities. For example, Section 16 of the 1993 Act enabled CFUGs to draft constitutions, elect leaders democratically, and formulate operational plans, thus legitimizing their role and fostering a sense of ownership. The Forest Act of 2019 further strengthened these provisions with specific measures detailed in Chapter 5, Section 18. Additionally, the Forest Act of 2019 includes mechanisms for accountability and enforcement. These comprehensive legal provisions have not only empowered local communities but also ensured effective protection and sustainable use of forest resources, leading to increased forest cover and reduced degradation in Nepal.

Inclusiveness is crucial

Inclusiveness is crucial for successful forest management interventions in Nepal as it ensures that diverse perspectives and knowledge systems are incorporated into decision-making processes. The active involvement of women, Dalits, indigenous people, and other marginalized groups fosters a sense of ownership and responsibility towards forest conservation. When these groups are included, they bring unique insights and practices that contribute to more effective and sustainable management of forest resources. Furthermore, inclusiveness ensures equitable benefit distribution, improving livelihoods and reducing the socioeconomic pressures that often lead to deforestation and forest degradation. By empowering all community members, particularly those who have traditionally been underrepresented, forest management becomes a collective effort, enhancing its effectiveness and sustainability.

Chapter 6: Take Home Message

Nepal's Community Forestry program has brought about significant positive changes by empowering local communities to manage forest resources effectively. This initiative has fostered a strong sense of ownership and stewardship among community members, promoted inclusive governance by involving diverse stakeholders, implemented sustainable resource management practices that enhance forest health and resilience, generated economic benefits through responsible harvesting and ecotourism, and facilitated capacity building through education and training programs. These changes have not only contributed to increased forest cover and biodiversity conservation but also improved local livelihoods and strengthened community resilience against environmental challenges.

Recommendations for the Way Forward:

- Policy Support: Ensure continuous policy support and legal frameworks that uphold community rights and responsibilities in forest management. Regular updates and revisions of forest laws should reflect evolving community needs and environmental priorities.
- Monitoring and Evaluation: Implement robust monitoring and evaluation mechanisms to assess the impact of community forestry initiatives on forest cover, biodiversity, and community livelihoods. Use data-driven insights to refine strategies and improve outcomes over time.
- Partnerships and Collaboration: Foster partnerships with government agencies, NGOs, academia, and private sectors to leverage resources and expertise for sustainable forest management. Collaborate on research, funding opportunities, and technical support to enhance program effectiveness.
- Community Empowerment: Continue to prioritize inclusive governance and community empowerment in all aspects of forest management. Support capacity building efforts that strengthen local leadership, decision-making, and sustainability practices within community forest user groups.

By building on these positive changes and recommendations, Nepal's Community Forestry program can serve as a beacon for other regions seeking to enhance forest conservation,

promote sustainable livelihoods, and empower local communities in managing natural resources effectively.

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Degraded Forest Rehabilitation and Sustainable Forest Management in Sri Lanka

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1. Introduction

Sri Lanka is an island with an area of 65,610 km2 including inland water bodies. It lies between 5 °55′ and 9 °55′ northern lattitudes and between the eastern longitudes of 79 °42′ and 81 °52′. Despite its relatively small size, the island exhibits an exceptional array of terrestrial and freshwater ecosystems that support a remarkable diversity of species. Being an island, Sri Lanka's forests are rich in endemic species of flora and fauna. Sri Lanka has the highest species density (number of species present per unit area) for flowering plants, amphibians, reptiles, and mammals in the Asian region (NARESA, 1991). [7]

Sri Lanka and Western Ghats of southwestern India have been grouped together as one of the 34 global hotspots of biodiversity, implying that biologically they are among the richest and at the same time the most endangered terrestrial biogeographic region in earth. Sri Lanka has some 751 known species of amphibians, birds, mammals and reptiles according to figures from the World Conservation Monitoring Centre. Of these, 21.7% are endemic, meaning they exist in no other economy, and 11.9% are threatened. Sri Lanka is home to at least 3314 species of vascular plants, of which 26.9% are endemic. 9.6% of Sri Lanka is protected under IUCN categories I-V . [14]

Sri Lanka is divided into three main climatic zones (wet, dry and intermediate) based on the average annual rainfall. Diversified topographic features, varying climatic conditions and edaphic factors have led to the development of different forest types in Sri Lanka. By the dawn of nineteenth century, Sri Lanka's forest cover was estimated at 70% of the total land area. Since then, the forest cover has decreased progressively over time (Forestry Planning Unit 1995; FAO 2010).

According to the latest forest cover assessment conducted in 2015, Sri Lanka has a total natural forest area of approximately 1.92 million ha covering 29.7% of the total land area of the economy. During this recent forest cover survey , the Forest Department identified the extents of the specified forest types grouping them as follows; montane forests (44,758 ha), sub-montane forests (28,514 ha), lowland rain forests (123,301ha), moist monsoon forests (117,886 ha), dry monsoon forests (1,121,392ha) riverine forests (2,425 ha), mangroves (15,670 ha) and open and sparse forests (429,484 ha).Of these forest types moist monsoon forests and dry monsoon forests are found in the Dry Zone. The Intermediate Zone accommodates dry monsoon as well as moist monsoon forests. With the sparse and open forests found across the two zones.

The Wet Zone is characterized by species rich lowland rain forests as well as lower montane and montane forests. In all climatic zones, riverine forests are along streams and rivers. Each of these forest types has inherent characteristics based on their local environment and species composition, playing an important role in biodiversity conservation, hydrology (especially in head waters protection), soil conservation, amelioration of the environment and as a source of raw material for livelihood development. Different forest types thriving in different climatic zones provide a high level of species diversity. In particular the economy's floral biodiversity and number of endemic species is extremely high relative to its size. [11]

In order to conserve biodiversity, the Government of Sri Lanka (GoSL), through the two major agencies concerned, the Forest Department (FD) and the Department of Wildlife Conservation (DWC), has undertaken significant efforts by creating a large network of protected areas. The present protected area network of the FD includes 125 Conservation Forests (176,691 ha), 4 International Biosphere Reserves (143,106 ha) and 722 Reserved Forests (1,157,023ha). Due to the presence of unique biodiversity, the United Nations Educational, Scientific and Cultural Organization (UNESCO) has designated 2 World Heritage Sites (Sinharaja - 11,127 ha) and the Central Highlands of Sri Lanka, which is a serial property comprising three component parts: Knuckles Conservation Forest (31,305 ha), Horton Plains National Park (3,109 ha) and the Peak Wilderness Protected Area (20,596 ha)). The DWC is also responsible for a significant number of protected areas targeted towards faunal and floral biodiversity conservation. These include 3 Strict Nature Reserves (31,571 ha), 16 National Parks (738,547 ha), 7 Nature Reserves (101,645 ha), 1 Jungle Corridor (8,777 ha) and 61 Sanctuaries (277,122 ha). [11]

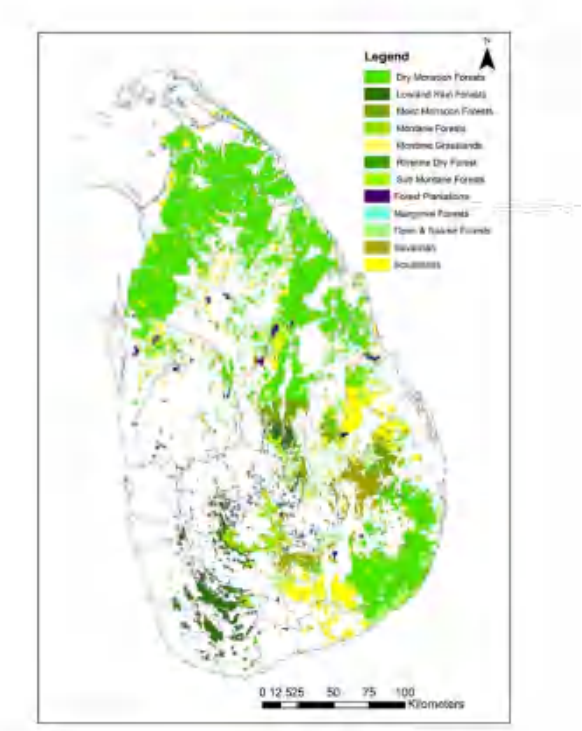

Figure 1: Natural forest types of Sri Lanka

According to four forest cover assessments since 1956 to 2010, the rate of deforestation shows a slightly decreasing trend over time.

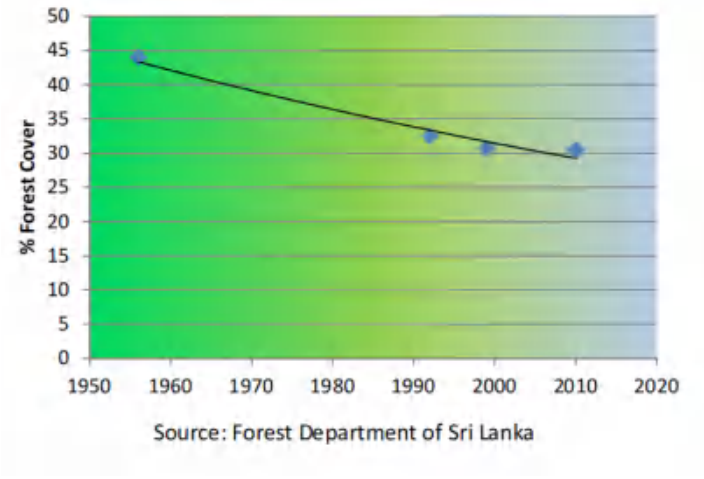

Figure 2: Change in Sri Lanka's Forest Cover (%)

2. Recent and Current Drivers of Deforestation and Forest Degradation

Deforestation and forest degradation that occurred during the past two decades are examined in this section.The key underlying drivers has given rise to the following scenario of deforestation and forest degradation, which is currently in operation.

Local demand for timber still acts as an underlying driver that give rise to felling of timber. However, there is no state involvement in logging from natural forests anymore. Therefore, felling takes place entirely as an illicit activity depending on the level of monitoring and enforcement in local areas.

Global demand for export crops still act as a valid underlying driver for deforestation especially in low-grown tea areas. However, as in the case of logging, the state patronage has been lifted and it takes place entirely as small-scale encroachments.

Especially in dry zone areas where large-scale land settlements and irrigation development were undertaken. Their activities have given rise to significant deforestation in the form of encroachments for commercial highland crops. The key underlying driver that mobilizes these encroachments is growing local demand for crops such as maize, vegetables and other field crops such as chillies and onions.

2.1 Encroachments

Encroachments of forests occur mainly due to the following major reasons.

Agriculture is the dominant cause of encroachments of forest lands in many areas. Chena cultivation is dominates include Anuradhapura, Monergala and Hambantota districts. Encroachment of forest lands in wet zone districts of Kalutara and Ratnapura are connected mainly to tea, rubber and cinnamon cultivation and cardamom to a limited degree.

People encroach forest lands for residential settlements in all parts of the economy. Sometimes agriculture and residential purposes are connected and encroachers occupy forest lands and

cultivate perennial trees (fruit trees, coconut) and dig wells to claim the ownership of such lands. Often they claim such lands without any legal ownership.

Some people have encroached lands for gem mining in Ratnapura, Kandy and Matale districts. Another common encroachment in Kalpitiya, Chillaw and Puttalam areas was for shrimp farms that led to widespread destruction of mangrove habitats.

2.2 Infrastructure Development Projects

The FD has released around 40,000ha of forests for various development projects during the past few years.

- Irrigation development projects;
- Major hydro-power generation projects;
- Mini hydro power projects;
- Road development projects including highways;
- Agricultural and livelihood projects;
- Resettlement projects;
- Tourism projects;
- Airports and harbours.

2.3 Private agriculture ventures

Large private agriculture ventures are responsible for significant deforestation. Among the major crops involved in such ventures are sugar cane, cashew and banana. The recent takeover of underperforming private sugar ventures by the government and subsequent plans to expand the sugar cultivation to around 130,000 ha in eight districts with private sector participation could lead to significant deforestation.

In addition to the above major proximate drivers of deforestation, other proximate drivers of forest degradation with more localized impacts. Major ones include the following:

Illicit felling: Even though large-scale felling operations are rare, incidents of illegal timber extraction take place in some areas. Reported numbers are usually lower than actual numbers.

Illegal extraction of NTFPs: Incidents of illegal extraction of NTFPs (e.g. wallapatta (Agarwood), medicinal plants, sandal wood, rattan) take place in. People sometimes use harmful methods of extraction.

Firewood collection: Harmful practices are done by some users. For instance, trees are peeled and barks are heavily damaged to suppress the growth. The trees will gradually die and will be then used for fuel wood.

Grazing lands: This refers to creation new grazing areas by converting forests. On occasion large herds of cattle move from one area to other, damaging vegetation.

Regular forest fires: Increased incidence of forest fires has become a major concern. Marginal lands are mostly affected by fires.

Spread of invasive species: Spread of invasive species is a cause of degradation especially when forests are located adjacent to agricultural lands. It affects the places like even protected areas such as Sinharaja in the wet zone. Among significant invasive species are Lantana, Myroxylon, Miconia, and Alstonia.

Occurrence of natural disasters: The high risk of earth slips and damage by high winds is reported from Kandy, Nuwara Eliya and Ratnapura districts.

Pest and disease attacks on forest trees: Incidents of diseases and pest attacks area also reported as causing degradation.

Extraction of gravel, soil, metals and others products: Quarrying for gravel, sand and metal from marginal areas of forests leads to degradation.

Forces involved in ongoing deforestation and degradation process are many and complex. Among others, the following factors appear to act as major catalyst and inhibitors of the ongoing process of deforestation and degradation.

Permissive and weak land use policies, regularization of encroachments. unclear ownership of forest lands, long delays in legal proceedings, weak implementation and planning, political patronage and interference, poor coordination among agencies, population growth, commercialization of rural economies and improved agricultural technology are concider as major catalysts.

Forest policy and protected area management, environmental laws and regulations, home gardens, community dependence and customary rights, public pressure and awareness about environment and forests and off-farm employment opportunities are considered as major factors that helped to reduce the rate of deforestation and degradation to some degree by acting as inhibitors. [12]

3. Approaches of Forest Rehabilitation

Management of the economy's forest cover falls mainly within the purview of two government entities, the Forest Department (FD) and the Department of Wildlife Conservation (DWC). FD and the DWC are responsible for the management of approximately 19.2% and 17.6% surface area of the island respectively (including both forest and non-forest lands). Some fragmented areas of forests are within lands administered by the Coast Conversation and Coastal Resources Management Department, the Land Reform Commission (LRC) and the Mahaweli Authority of Sri Lanka (MASL), in estates leased to Regional Plantation Companies (RPCs) and in Vihara & Dewala (temple) lands. Some forests are also under private ownership. The extent and condition of forests in these ownership categories is not available. [11]

Several steps have been taken to control and minimize the degradation of natural forest vegetation in Sri Lanka. They are:

• Introduction of a national forestry policy; and

• Development of a forestry master plan

Based on recommendations made in the Forestry Master Plan a National Forestry Programme has been developed and implemented with donor assistance.

Sri Lanka's National Forestry Policy (1995) has been drawn up to provide clear directions in planning and implementation of forestry programmes on the island. It reflects consultations lasting for almost a year involving a wide range of stakeholders including the general public and NGOs.

The National Forestry Policy objectives are as follows:

i. To conserve forests for posterity, with particular regard to biodiversity, soils, water, and historical cultural, religious and aesthetic values;

ii. To increase tree-cover and productivity of the forests to meet the needs of present and future generations for forest products and services; and

iii. To enhance the contribution of forestry to the welfare of the rural population, and strengthen the national economy, with special attention paid to equity in economic development.

The protected areas under the jurisdiction of the Department of Wildlife Conservation and the Forest Department are administered under the following legislation.

• The Forest Ordinance

Administered by the Forest Department and deals with the establishment and protection of Coservation forests, Forest reserves, village forests and other state forests and forest products. Regulates the timber transport.

• The Flora and Fauna Protection Ordinance

Makes provisions for National Reserves (National Parks, Nature Reserves, Strict Nature Reserves and Jungle Corridors) and Sanctuaries and their administration by the Department of Wildlife Conservation.

• National Heritage and Wilderness Area Act

Makes provisions for the preservation of genetic resources, unique ecosystems, and habitats of endangered and threatened species. Administered by the Forest Department.

Under the Forest Department The Silviculture and Forest Management (S&FM) Division has the responsibly for management of natural forests and forest plantations in sustainable manner to ensure provisioning of forest products and services.

The main activities of the component on reforestation include the following

- Establishment of block plantations to produce timber for timber production
- Establishment of plantations for protection
- Reforestation of clear - felled plantation sites for timber production
- Conversion of pine monoculture plantations into, mixed broad-leaved species

- Establishment and management of forest nurseries
- Forest Fire Management
- Management of young plantations
- Implementation of Private Sector Reforestation Program
- Conservation of Hilltops in the Central Highlands

In order to increase percentage of forest cover of Sri Lanka up to 32% of the land area from 29.7 %Forest Department started forest enhancement programme in 2014. Silviculture and forest management division has the responsibility to achieve the above aim by implementing various activities. Three main strategies have been recognized to enhance the forest cover. They are protection and conservation of existing forests, expansion of forests in to new areas and improvement of tree cover on private lands.

Following are the main implementing arrangements/mechanisms being practiced in Sri Lanka for the rehabilitation of degraded forests [13]

Block reforestation

Block reforestation is defined as the reforestation of medium to large size tracks of state land by the forest department, either directly (employing labourers directly) or through contracting the task to established contractors. This is often considered as "classical forestry", i.e. the normal work of forest departments.

Block planting by local level organizations

This is a form of forestry in which land remains in the hands of the state, but reforestation/ afforestation is done by a local organization in cooperation with the Forest Department.

Social forestry approaches

Several different approaches – more than fifteen - have been pursued by the Forest Department in implementing social forestry. They range from those purely focused on conservation (protection of soil and water resources) to those aimed at employment generation and income enhancement, and those geared to purely production (economic growth) objectives.

- Co-operative Reforestation/Village Reforestation/Taungya
- Farmers' Woodlots

Private Sector Leasehold Reforestation

The program "private sector participation in reforestation" as launched by the Forest Department in 1995 to mobilise private sector involvement in tree growing in the dry zone lands. Applications were invited from the private sector for the leasing of 10,800 hectares of abandoned state lands in five districts.

Forest plantations as an investment scheme

Establishment of commercial forest plantations by private sector mobilizing investment from the general public is a recent development in Sri Lanka. There are more than five private companies operating in the dry zone and intermediate zone using Teak and Mahogany respectively as their main tree species. The program is implemented in medium to large scale private lands which are degraded and abandoned.

Non- Governmental Organizations

The role of NGOs in forest rehabilitation has been mainly indirect. They have helped to strengthen rural organizations and to build up the confidence of the rural people in finding independent solutions to their problems. However, most NGOs involved in forestry conduct their activities in an ad hoc manner. [13]

4. Selected Restoration project

A small scale restoration project is selected as case study and it was started in 2017 in my former working area located in Neluwa, Galle, Southern province of Srilanka. The project was funded by private agencies called MAS Capital (Privet limited and Linea Aqua (private) limited . and restoration work has been done under the supervision of forest department. The summary of the project work as follows.

4.1 Introduction

Pidurukanda degraded forest patch is located in Neluwa range, Neluwa Beat, it is in the vicinity of the Sinharaja Natural Heritage Wilderness Area and Thibbotuwathota Forest. One can reach the forest by travelling 3 km from Neluwa towards Sinharaja Forest road. The area of the Pidurukanda degraded forest patch is 5 ha and Forest Department demarcated the forest in 2014 but the forest has not been declared as reserved forest when the period of restoration work has been done. This land was added to the Sinharaja rain forest reserve in 2021.

The Pidurukanda degraded land is located in the edge of the Thibbotuwathota Forest which categorized as a Lowland rain forest. Elevation varies from 1200m to 1400m , average annual temperature is approximately 23.5 ^{0} C and it annually receive more than 2500mm of rainfall lies within 3600-4500mm. The rainfall is well distributed with peak periods, during the two monsoon, May- September and October – December. There is no dry spell throughout the year.The tree density is high so the canopy cover of the forest is more than 80%.The degraded Horakanthaeliya forest was low land Rain forest originally. People who lived in adjoining villages had cleared forest for cultivation after some time they have abandoned the land and *Dicranpteris linearis* is densely occupied at present, natural regeneration has been suppressed and no other species can occupy the land. The land is subjected to fires periodically so natural regeneration is further interrupted. However, *Aistonia macrophylla* and *penniseturn polystrachyon* are present sparsely on some part of this land. In order to restore this land up to the original state we had to carry out series of interventions.

MAS Capital (Privet limited and Linea Aqua (private) limited had in principally agreed to support Forest Department to restore the degraded forest land its original state after the joint

field inspection. The brief report was presented the activities to be carried out, activity plan and the budget to implement the restoration work on the degraded forest lands.

4.2 Objectives

The objective of the project was to improve the species composition and forest biomass five hectare of degraded forest within the Horakantheliya forest by 2021.

4.3 Time Duration

The project have been started in June 2017 and continued till end of December 2021

4.4 Intervention to Be Carried Out in Horakanthaliya Degraded Forest

Forest restoration have been done with enrichment planting as well as applied assisted natural regeneration practices in the degraded forest main activities conducted are described below

a)Surveying and mapping

The proposed area forest restoration have been surveyed and mapped using GPS.

b)Establishment of baseline

Four sampling plots of 12.6 m radius have been established in the degraded site and data and vegetation were collated in each sample to establish the baseline. These Samples were revisited annually assess the interventions.

c) Fire Protection

Fire is one of the causes of degradation of this land Therefore, Intensive fire protection programmer has been be implemented to protect the forest form fires, Fires Line of 3 km was established around the degraded land where fires are originated The wide of the fire line was 10 m and all the vegetation have been removed completely. The fire line is cleared once year during the dry season. The villagers who are living vicinity of the area were informed to be vigilant over the fire occurrence.

d) Strip Planting

Three meter wide strips were cleared at three meter interval along the contour planting was done along the strip at two meter interval. In between two planted strips 3m wide strips were low slashed. Around 830 seeding were planted in each hectare. Species early succession spices and nitrogen fixing species *Puerazia phascoloides, Gliricidia sepium* are the most suitable legumes for the land. Once the micro environment is favorable, late succession species were planed to be established in fourth and fifth years But finaly plan was changed, late succession species have been introduced in the bigining. Early succession spices and nitrogen fixing species were not stablished.

e) Promotion of the growth of young seeding

There were young seeding on the degraded land but they cannot grow and establish well due to fire damages and disturbances of *Dicranpteris linearis* it suppresses the growth of young seeding of other species by limiting availability of light space moisture and nutrients,

therefore , *Dicranpteris linearis* have been completely removed in planting strips and other strips were low slashed. Low slashed was done atleast twice a year. .

g) Monitoring

The performance of the programme have bean monitored continuously, forest officers have visited the land at frequents intervals to observe the growth of the seeding and growth of the ferns, in addition, data collection using the same samples have been done annually. Data series were taken after 3 years of the stablishment of the plantation. Data were summarised as follows.

3m x 50m sample plots were stablished on the planting strips and low slashed strips separately. Consider about the data were taken in planting strips, average no of plants given in Figure 3. *Depterocarpus zeylanicus* and *Syzigium operculatum* species have highest seedling survival percentage and *Bhesa ceylanica* and *Garcinia cambogia* have moderatly survival percentage in the planting site.

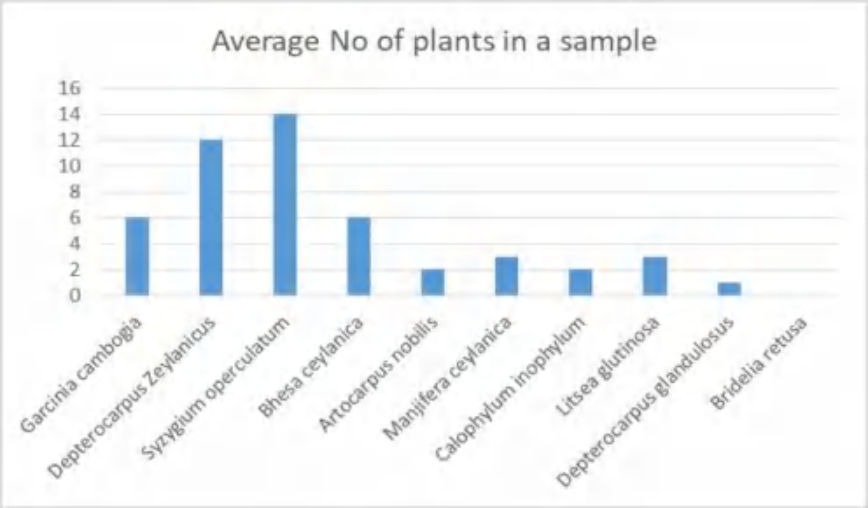

Figure 3: Average no of plants in planting strips.

Sampels in Low slashed stips, plant count was taken according to two height class. Results were shown in figure 4 and 5 as follows.

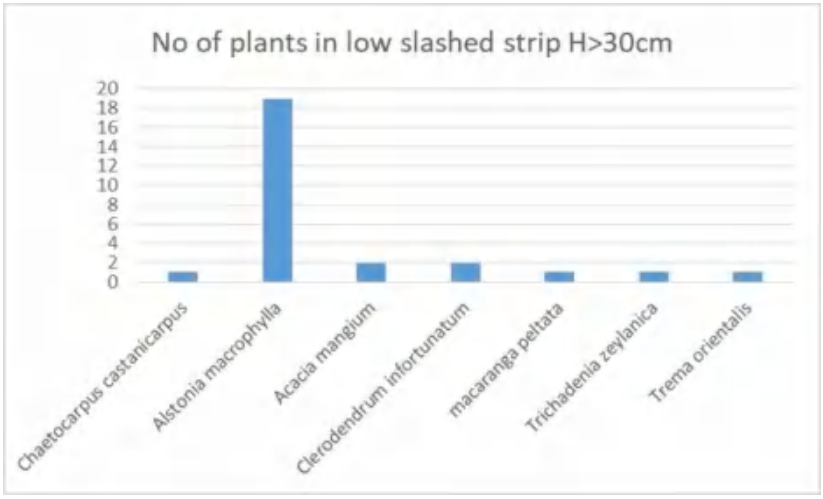

Figure 4: No of plants in low slashed strip (height >30cm)

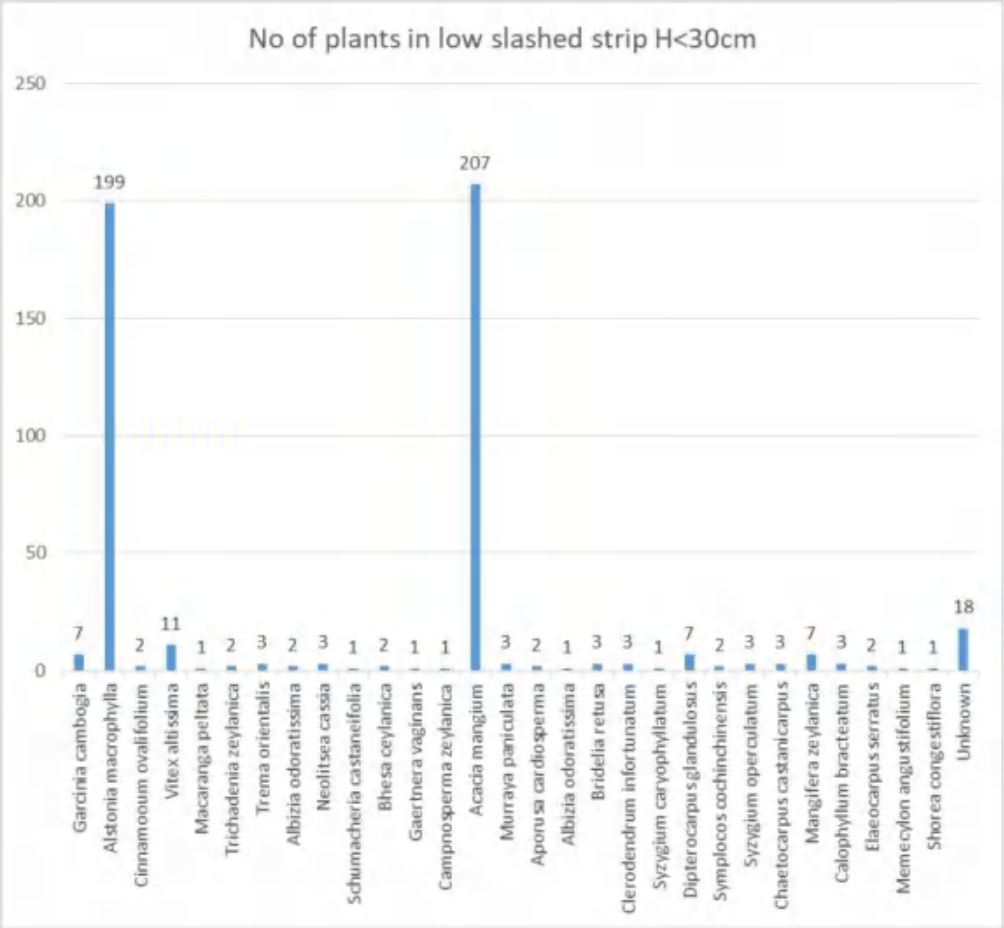

Figure 5: No of plants in low slashed strip (height <30cm)

In low slashed strips, *Alostonia macrophylla* and *Accacia mangium* species were found to be a dominant naturally regenerated species. Most of them are pionior species and rare in late succession species.

Sample plots in the planting strip were stablished as first one was plotted near the thick forest boundary, second one was located 50m away from the forest bounday and third one was located in 100m away from the forest boundary, mid of the fernland.

Results were shown in figure 6 and 7 more abundant species were identified. When we concider average DBH and average height in individual species, plants were more dominant in the forest boundary then it was decreasing along from the forst boundary towads the mid of the fern land.

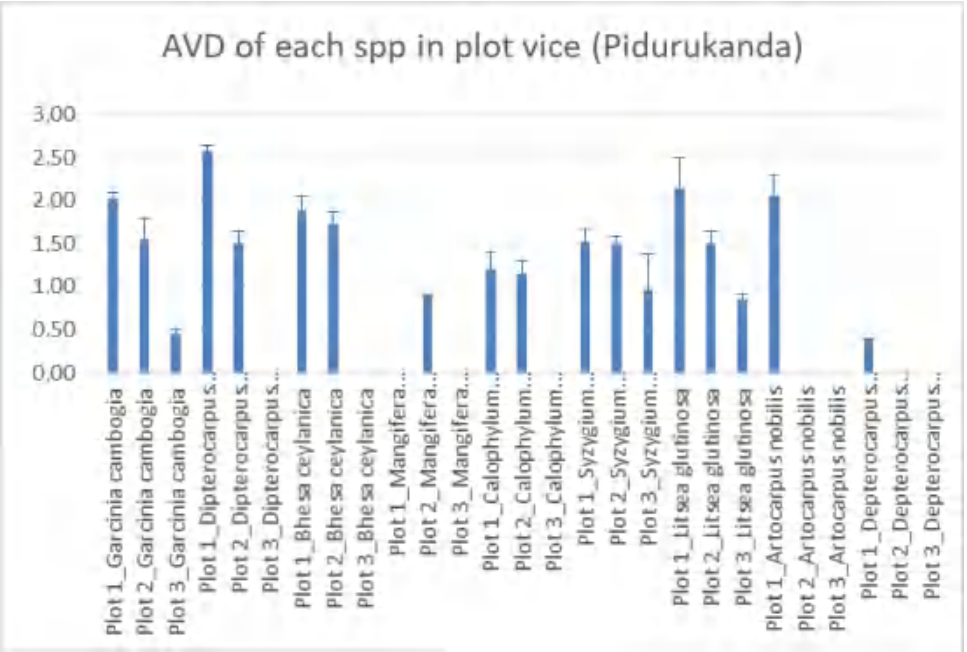

Figure 6: Average diameter of each species in plot vice

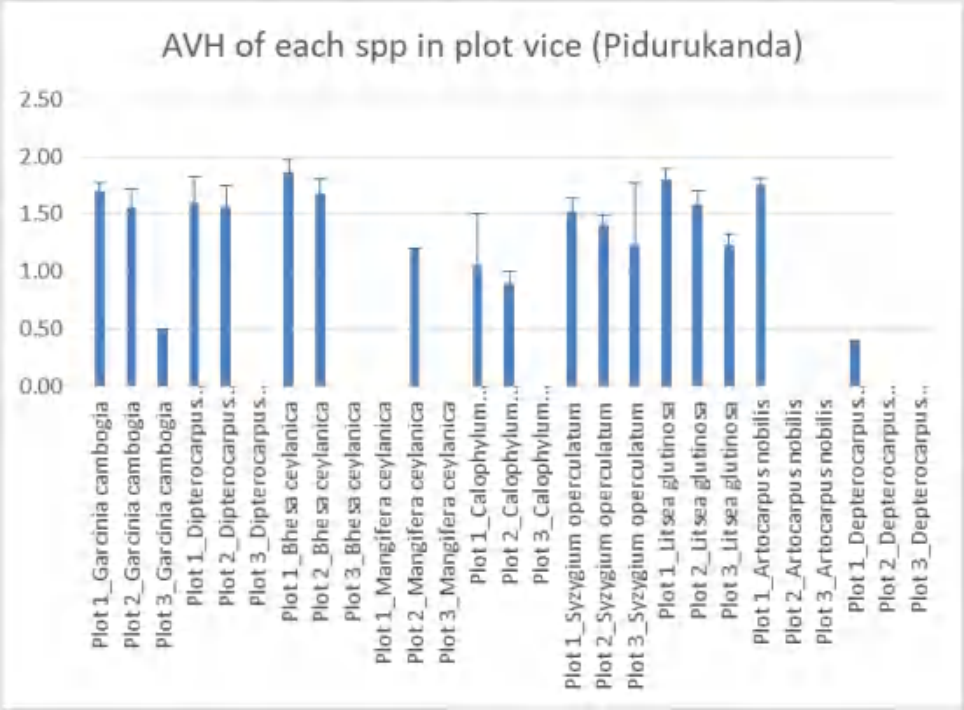

Figure 7: Average height of each species in plot vice

5. The Lessons That Can Be Learned from This Project

Permanent conversion to agriculture and subsequent domination by fern and grasslands posses a different set of problems for forest conservation

In this context, succession on post-agricultural lands may be arrested by a variety of site-specific biotic and abiotic factors. Here we have identified on the effects of five biotic factors (seed dispersal, development of a soil seed bank, seedling emergence, herbivory, competition) and five abiotic factors (fire, microclimatic conditions, soil nutrients, water availability,

disturbance) as constraints to forest succession on degraded anthropogenic fernland in a Pidurukanda restoration site.

Experiments have proven that in such cases the sequential amelioration of the site by way of relay floristic patterns of vegetation establishment can be an approach that can work. But in this small restoration work such kind of approach was not followed. As a example in the biging of the establishment of plant nitrogen fixing species like Puerazia phascoloides, Gliricidia sepium were not introduced.

Planting fast-growing species (often non-native) can facilitate understory establishment of second growth that comes in naturally or the purposeful promotion of late-successional canopy tree species by under-planting. In this context late- successional species were introuduced in the bigining, it was badly effected to the plant growth and their survival of the planting site.

Colonisation of fernlands by trees is constrained by limited seed dispersal from adjacent remnant forest patches and their incorporation into fernland soil seed banks. For the few tree seeds that are dispersed into fernlands, a combination of vertebrate herbivory and annual dry season fires reduces the likelihood that they emerge as seedlings.

Inhibition of tree seedlings by grasses or fernes may arise because grasses typically have a much greater root length to mass ratio than tree seedlings, and established grasslands possess a high fine root density in surface soils nutrient and water availability suggest that either factor might have been limiting. In the fernlands rhizometous fern spread via clonning spreading along the ground and climbing on other vegetation. When the fern grows on to a new site it produces layers of stems and leaves repeatedly grow a network of vegetation. Since conversion from the natural forest, the soils at these sites have been affected by removal of top soil, erosion, multiple phases of cultivation, compaction by grazing herbivores and increased direct exposure to solar radiation, rainfall and high winds. These processes have led to significant reductions in soil organic matter and in concentrations of most major nutrient elements, and a loss of soil structure. We observed that many tree seedlings planted into the fernlands showed symptoms of chlorosis, possibly arising from the low soil nutrient status of the soils, and wilting of the tree seedlings during the dry seasons.

Clipping and tilling of the dominant grasses increased woody plant seedling emergence at the edge, where densities of seeds in the soil seed bank, seed inputs through dispersal, and the height and density of the vegetation, were greater than in the fernland at greater distances from the forest (Gunaratne 2007). The positive effect of tilling (removal of all grass biomass) was much greater than that of clipping. It was effected fernlands also same. In this restoration site 3m wide planting strips were completely removed from ferns with their rhizomes (root-removal treatment). Finaly results showed growth diference in planting strip and low slashed strip and also average DBH and height of the plants much higher in forest edge than the mid of fernland.

6. **Positive changes and recommendation**

Dicranopteris linearis fernlands can develop as a result of rain forest clearance followed by frequent burning. In Sri Lanka, D. linearis fern-lands are capable of suppressing the

regeneration of rain forest. The most severe soil disturbance, like root-removal treatment was more productive than low slashed strips. By comparison, Emergence of planted seedlings, no of plants survive and their height and DBH values are more significant.

Forest succession on above mentioned fernland was limited by dispersal limitation and the low rate of woody plant seedling emergence. We emphasize the importance of the edge habitat and early successional species more productive of forest ecosystem expansion into fernland. Trema orientalis, macaranga peltata, Clerodendrum infortunatum specises which were fast-growing light-demanding species were identified as more suitable early successional plants.

Some experiments have demonstrated that Pinus caribaea can be used as a nurse for facilitating the establishment of site-sensitive tree species. After 5 years Pinus can significantly shade out grasses and ferns, and provided the plantation is protected from fire, the higher levels of humidity and partial shade provide conditions suitable for seedling establishment. Consider about above restoration site, Alstonia macrophyla and Acacia mangium were identified as nurse trees.

Further researches are required to determine the relative importance of low nutrient on tree seedling establishment and strategy for forest restoration in south west part of low economy wet zone in Sri Lanka, including trials of additional species from the native tree flora.

Once the micro environment is favorable, late succession species were planed to be established in fourth and fifth years. Depterocarpus zeylanicus, Syzigium operculatum, Bhesa ceylanica and Garcinia cambogia were identified as more suitable late successional species for the selected above restoration site among the planted specises.

Fire occurances were adversely effected for regenerating plant seedling. Adequate fire belts should be opened around the restoration site.

Some drawbacks were observed in the agrement which were signed in between the forest department and private sector. Some restoration project implemented with adequate funds but after one or two years funds were not release according to time frame, some funds are stopped. Finally it adversely effected for restoration work.

Above mentioned positive changes should be implemented for scaled up to as above mentioned restoration sites which were situated in same climatic and geograpical areas in Sri Lanka.

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Degraded Forest Rehabilitation and Sustainable Forest Management: A Case Study of Highland Reforestation Program in Northern Thailand

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Abstract: Thailand, located in the tropics near the equator, hosts a wide range of plant, animal, and microorganism species. Currently, the economy has a forest area of 162,909.05 square kilometers, constituting 31.47% of its total land mass. The forests in Thailand are primarily characterized as either evergreen or deciduous forests. Evergreen forests are spread across all the regions of Thailand, while deciduous forests are mainly found at elevations of up to 1,000 meters above sea level, barring regions in the South and some eastern provinces.

Thailand has prioritized the conservation and restoration of forests through national policies that have set a goal of achieving 40% forest cover. This effort is supported by funding from the private sector and involvement from various stakeholders, including local communities. In this context, the reforestation initiatives at the Angkhang Royal Agricultural Station can serve as a successful model for highland forest restoration.

1. Introduction

Thailand is home to diverse flora and fauna, which is mostly attributed to its location in the tropics near the equator. The economy's forests are classified into two major types: deciduous and evergreen. It is reported that the forested area has been steadily decreasing from 170,110.70 square kilometers in 2000 to 162,909.05 square kilometers in 2023, which constitutes 31.47% of Thailand's total land area.

Although the rate of forest decline has slowed down, it still remains a cause for concern. This ongoing loss of area has prompted collaboration among government agencies, the private sector, and general public to protect and restore degraded forests. The private sector plays a crucial role in funding these restoration efforts. Additionally, the Thailand Greenhouse Gas Management Organization (Public Organization) has developed several mechanisms to support voluntary greenhouse gas reduction, realizing that reducing emissions by focusing on the forestry sector can be an effective strategy for mitigating greenhouse gases. This can be accomplished through reduced deforestation, forest degradation, reforestation, and the establishment of forest plantations with economic value.

Thailand's national and agency-level strategies aim to conserve and restore forested areas, with a target of 40% forest cover, with 25% for conservation and 15% for economic forestry.

This document compiles information related to the current state of forests in Thailand, highlighting the decline and degradation in forest areas. It outlines the actions taken by relevant agencies to combat these issues and provides an overview of key policies for forest protection and restoration. A good practice of highland forest restoration program at the Angkhang Royal Agricultural Station, northern Thailand, is also presented.

2. Current status of deforestation and forest degradation in Thailand

2.1 Forest Status

The land use types in Thailand can be categorized into three main types:

- Forested Areas that include national parks, wildlife sanctuaries, national forest reserves, mangrove forests, and other legally designated forest areas.
- Agricultural Areas that include rice paddies, field crops, fruit orchards, perennial crops, vegetable gardens, and flower gardens.
- Non-Agricultural Areas that include community areas, buildings, water bodies, and other non-agricultural lands.

Figure 1 illustrates the change in the use of these three land use types from 2005 to 2022. It shows that area under both the forested and agricultural cover has been decreasing since 2008, while that under non-agricultural areas has been increasing.

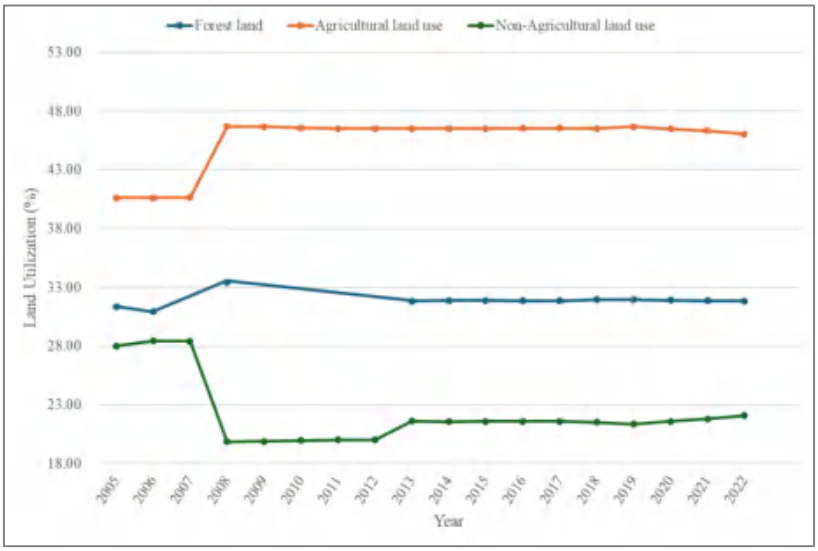

Figure 1: Land utilization of Thailand, 2005-2022

Source: Royal Forest Department, Office of Agricultural Economics

Forested area in Thailand can be primarily categorized into evergreen and deciduous forests, with each type being further classified as follows:

Evergreen Forests: It can be found throughout Thailand, including: 1) Moist Evergreen Forest: Found mainly in the southern and eastern coastal regions at elevations below 600 meters, 2) Dry Evergreen Forest: Frequent in the northern and northeastern regions at elevations between 300-600 meters, 3) Hill Evergreen Forest: Predominantly found in high mountain ranges of the north, at elevations between 1,000-1,200 meters, 4) Pine Forest: Located on high mountains in

the northern region and at moderate elevations between 200-1,800 meters, 5) Mangrove Forest: Found primarily in the southern and eastern coastal areas, in mudflats or estuaries regularly flooded by seawater 6) Swamp Forest: Situated in areas where the land is regularly flooded by freshwater, typically characterized by poor soil drainage and 7) Beach Forest: Found along coastal beaches not regularly flooded by seawater.

Deciduous Forests: Primarily located in the northern, northeastern, and central regions at elevations below 1,000 meters and include: 1) Mixed Deciduous Forest: Commonly found in the northern region in areas with sandy loam soil, mainly consisting of teak trees, 2) Deciduous Dipterocarp Forest: Found in dry areas with sandy or gravelly soil, especially in the northeastern region and 3) Savannah Forest: That grow on degraded lands where deforestation has previously occurred, leaving grass as the dominant vegetation.

2.2 Deforestation and Forest Degradation Status

Figure 2 illustrates the distribution of forested areas in Thailand, indicating that the northern and western regions possess the highest forest cover, accounting for 63.24% and 58.86% of each region's total area, respectively. These forests are predominantly located along mountain ranges, which are critical for watershed conservation and wildlife habitats. Despite existing policies and regulations aimed at preventing forest encroachment, illegal activities have persisted over time. Consequently, Thailand's forest area has decreased from 170,110.70 square kilometers (33.15% of the economy’s total area) in 2000 to 162,909.05 square kilometers (31.47%) in 2023.

Figure 2 Forest area in Thailand (2023)

Source: Forest Management Bureau (2023)

The current developments in recent years have seen an increase in public awareness related to the problems caused by deforestation. It is now widely recognized as one of the most serious threats to the loss of biodiversity in developing economies. Deforestation can lead to floods, soil erosion, disease outbreaks, watershed degradation, and the destruction of wildlife habitats, which can result in the extinction of species and reduction in genetic diversity. However, a complete protection of the remaining forest cover is challenging due to economic and legal constraints. Therefore, maintaining or increasing the current forest cover requires balancing deforestation with effective reforestation efforts. The decline in forest areas is driven by both direct and indirect factors. Direct causes include forest encroachment for agriculture, tourism, and infrastructure development. Indirect causes are related to issues arising out of unclear forest boundaries and land use classifications, insufficient public awareness and education, inadequate inter-agency coordination, poverty, and conflicts between conservation policies and economic development strategies. Additionally, unsustainable land conflict resolution policies, population growth, and non-compliance with state regulations contribute to the problem. Forest degradation can be further exacerbated by direct factors like illegal logging and uncontrolled forest fires, as well as indirect factors such as weak law enforcement, high market value of certain timber species incentivizing illegal activities, and the ongoing demand for forest products for commercial purposes (UN-REDD, 2013).

3. Land Management Policy and Planning

The Ministry of Natural Resources and Environment, which was established in 2002, is responsible for the conservation, protection, and restoration of natural resources and the environment, as well as sustainable management of these resources. The ministry oversees several key agencies tasked with managing Thailand's forest areas:

- Royal Forest Department: This department is charged with conserving, protecting, restoring, maintaining, and promoting the forest areas. It manages forestry operations, logging, collection of forest products, land use within forest zones, and other forestry-related activities, all in accordance with the relevant laws and regulations. The department's strategic focus is on public cooperation to enhance the economic value of the economy and improve the quality of life of the citizens. It also carries out several other duties as mandated by law. The Royal Forest Department is responsible for approximately 103,919 square kilometers of land, including national forest reserves and forested areas governed by the Forest Act of 1941.
- Department of National Parks, Wildlife, and Plant Conservation: This department is responsible for the conservation, promotion, and restoration of forest resources, wildlife, and plant species within designated conservation areas. Its duties include protection of the existing conservation forests and rehabilitating/restoration of degraded forest areas to their natural state. The department uses strategies that foster a sense of ownership and participation among local communities in managing local resources. This approach helps to maintain ecosystem balance, environmental stability, and biodiversity, ensuring that these areas can continue to serve as watersheds, wildlife habitats, food sources, recreation areas, and natural tourism sites. The department

oversees approximately 109,892.72 square kilometers, encompassing national parks, forest parks, wildlife sanctuaries, non-hunting zones, botanical gardens, and arboretums.

- Department of Marine and Coastal Resources: This department is tasked with the conservation, restoration, and management of marine and coastal resources, with specific focus on coastal lands, mangrove forests, coral reefs, seagrass beds, and marine animals. Its mission is to maintain the ecological balance and enhance the social and economic stability of the economy in a sustainable manner. The department oversees approximately 141,210.69 square kilometers, which includes mangrove forests, beach forests, swamp forests, beaches, islands, coastlines, coral reefs, and seagrass beds.

4. Strategies and Forest Laws

A steady decline in forest areas and ongoing forest degradation, both of which can significantly contribute to climate change, has prompted Thailand to develop comprehensive strategies for the sustainable conservation, protection, promotion, and development of its natural resources and biodiversity. These strategies aim to preserve the forested areas, preventing deforestation, and monitoring and controlling wildfires. The key master plans and strategies include:

- The 20-Year National Strategy (2018-2038): This strategy emphasizes sustainable growth, with a target of maintaining forest and green cover at no less than 55% of Thailand's total land area. This is further divided into 35% for natural forests, with 15% for green areas designated for utilization and 5% for urban forests and green spaces for recreation and education.
- The 13th National Economic and Social Development Plan (2023-2027): Serving as a crucial mechanism for implementing the directives of the National Strategy, this plan sets goals to increase the forest areas to cover 33% of the economy’s land for natural forests and 12% for forests designated for utilization.
- The 20-Year Strategic Plan of the Ministry of Natural Resources and Environment (2017-2036): This plan outlines specific targets for forest conservation and management, including the protection and preservation of 142,208 square kilometers (25% of the economy’s area) designated as conservation forests and 63,792 square kilometers as national forest reserves. It also includes the restoration and expansion of degraded forest areas, with a focus on restoring 5,072 square kilometers under conservation forests and 26,000 square kilometers in national forest reserves, along with the development of economic forests.
- The National Forest Policy: This policy provides a unified framework for the development of the economy’s forests, balancing conservation with a sustainable utilization and development of natural resources, economy, and the society. The policy targets 40% forest cover across the economy’s land area, allocating at least 25% for conservation forests and at least 15% for economic and community forests.

In addition to these national policies, each agency responsible for forest management has developed strategies and action plans to implement these policies within their respective jurisdictions, while also enforcing laws for forest protection and conservation. Key laws include: 1) Forest Act B.E. 2484 (1941) and subsequent amendment in B.E. 2532 (1989), 2) National Park Act B.E. 2504 (1961), 3) National Reserved Forest Act B.E. 2507 (1964) and subsequent amendments in B.E. 2522 (1979) and B.E. 2528 (1985), 4) Wildlife Preservation and Protection Act B.E. 2535 (1992), 5) Forest Plantation Act B.E. 2535 (1992) and 6) Chainsaw Act B.E. 2545 (2002).

5. Drivers of deforestation and forest degradation

The drivers of deforestation and forest degradation in Thailand can be categorized into two groups:

- **Direct Drivers**

Agricultural Expansion: This encompasses the conversion of forests into farmland for commodities such as rubber, palm oil, and other cash crops. Deforestation is a result of the demand for these commodities.

Illegal Logging: Illegal Logging: Thailand is currently facing a substantial obstacle in its efforts to combat illegal logging, which continues to degrade its forests despite the widespread acknowledgement of its detrimental consequences. In 1989, Thailand implemented a comprehensive moratorium on logging in an effort to address this issue. Nevertheless, the timber market's lucrative nature has prevented this measure from effectively reducing unauthorized operations. The consequences of such illegal activities are not limited to mere deforestation; they disrupt entire ecosystems and have the potential to have long-term financial and ecological consequences. A coordinated effort involving law enforcement enhancement and community engagement is essential for the preservation of our forests.

Infrastructure Development: The clearance of forests is frequently necessary for the construction of roads, highways, and urban expansion. The pressure on forested areas is expected to increase as Thailand's population and cities continue to expand.

Mining and Quarrying: When forests are removed to access mineral resources, extractive industries, such as mining and quarrying, can result in deforestation.

Charcoal Production: The traditional method of charcoal production entails the destruction of trees, thereby causing forest degradation.

- **Indirect Drivers**

Population Growth: As Thailand’s population increases, there is a heightened demand for forest resources. This demand arises from the need for housing, agriculture, and infrastructure. Consequently, deforestation occurs to accommodate agricultural expansion, residential areas, and transportation networks. The correlation between population growth and the conversion of forest lands into rice paddies and sugar cane fields exemplifies the significant impact of human expansion on natural environments.

Economic Policies and Land Use Planning: Deforestation can be indirectly facilitated by policies that prioritize economic growth over environmental conservation. Particularly agricultural policies in Thailand, there has been a significant emphasis on the cultivation of cash crops, which include plants with global market demand such as rubber and palm oil. The expansion of these crops necessitates extensive land use. This space is predominantly sourced from forested areas. While such policies have contributed to economic growth in Thailand, they come at a considerable cost to the environment, resulting in diminished biodiversity and reduced forest cover.

Land Tenure and Ownership Issues: Illegal forestry and land conversion can occur as a result of unclear land rights and inadequate enforcement. The issue of land ownership regulations in Thailand has significantly contributed to the depletion of forested areas. The failure to address ambiguities surrounding land claims and the authorization for their use has allowed certain individuals to exploit these oversights. Consequently, they acquire more land than likely anticipated for financial gain. This exploitation of legal gaps has led to the destruction of verdant spaces as they are cleared for commercial and private developments, thereby increasing the deforestation crisis.

Global Market Demand: Land-use decisions in Thailand are influenced by the international demand for products such as rubber, palm oil, and wood. The demand for these products is on the rise as economies expand and consumer preferences evolve. Consequently, forests are frequently removed to satisfy this demand, resulting in deforestation.

6. **Reforestation and Forest Restoration in Thailand**

6.1 Key Elements of Reforestation and Forest Restoration

Thailand is setting out on a critical mission to fundamentally transform its approach to forest conservation. The strategy includes the implementation of advanced land management practices and ensuring of the involvement of local communities. The primary goal is to safeguard the nation's diverse flora and fauna while concurrently enhancing the quality of life for its citizens without jeopardizing the integrity of natural ecosystems. The objective of this initiative is to achieve a delicate equilibrium between environmental sustainability and economic development. Through meticulous planning and a steadfast commitment to preserving nature, Thailand aims to become a leading figure in forest conservation efforts. This effort is dedicated to the long-term well-being of future generations, in addition to addressing current challenges.

Thailand prioritizes forest restoration as a crucial strategy to mitigate the impacts of climate change. The economy has set an ambitious target to reduce greenhouse gas emissions by 30% from projected business-as-usual (BAU) levels by 2030, with a potential for further reduction to 40% through enhanced access to technology, finance, and capacity building. In line with these efforts, Thailand is also committed to achieving long-term goals of carbon neutrality by 2050 and net-zero greenhouse gas emissions by 2065 (UNFCCC, 2022). The forest sector can play a pivotal role in achieving these objectives, serving both as a carbon sink and a source of emissions due to deforestation and degradation. The key elements of forest restoration in Thailand include:

- Government Initiatives and Policies

National Forest Policy: The first comprehensive National Forest Policy was developed in 1985, setting a forest cover target of 40%, comprising of 25% conservation forests and 15% forests with economical value. In 2019, the current National Forest Policy was endorsed by the Cabinet, with objectives that include:

a) Fair and sustainable conservation and use of forest resources, wildlife, and biodiversity. Additionally, effective prevention strategies to mitigate the destruction of national forests and wildlife.
b) Ensuring that forest resource governance is effective, knowledge-based, and inclusive of the needs of all stakeholders.

Role of Government Organizations: Key government agencies, including the Royal Forest Department, the Department of National Parks, Wildlife, and Plant Conservation, and the Department of Marine and Coastal Resources, are instrumental in an effective implementation of these policies. Their focus should be on conserving existing forest lands and promoting tree plantations to enhance overall forest cover.

- Community Involvement and Rights

Establishment of Community Forest: Promoting community-based forestry management and the establishment of community forests is essential as such initiatives can empower local communities to actively participate in restoration efforts.

Addressing Land Disputes: Resolving land disputes in designated forest areas is crucial. Ensuring secure land rights for local communities is key to successful restoration.

- Biodiversity Conservation and Climate Change Mitigation

Protected Areas: Establishing and maintaining protected areas is critical for conserving biodiversity as these areas serve as refuge for various plant and animal species.

Reforestation Programs: Targeted reforestation programs are implemented to restore degraded ecosystems, enhance biodiversity, and increase carbon sequestration.

Wildlife Conservation: Efforts to protect and restore habitats would benefit not only forests but also the diverse wildlife that are dependent on them.

- Sustainable Practices and Monitoring

Agroforestry and Sustainable Plantations: Promoting agroforestry practices and sustainable tree plantation can contribute to both conservation as well as aid local livelihoods.

Monitoring and Adaptive Management: Regular monitoring of restoration sites ensures that interventions are effective, with adaptive management allowing for adjustments based on real-world outcomes.

- Environmental Education and Awareness

Public Awareness Campaigns: Educating the public about the importance of forests, their role in climate regulation, and the need for restoration fosters a sense of stewardship.

Involving Schools and Communities: Engaging schools and local communities in tree-planting activities and environmental education helps create a sense of ownership and responsibility for forest conservation.

Successful forest restoration in Thailand is a collaborative effort involving government organizations, non-governmental organizations (NGOs), local communities, and individuals. By addressing these key elements, Thailand can work toward a sustainable forest restoration and safeguard its natural heritage for future generations.

Forest restoration in Thailand requires cooperation between government agencies, that own the land, such as the Royal Forest Department and the Department of National Parks, Wildlife, and Plant Conservation, and private entities that request to use the land for reforestation projects. These private entities bear the cost of planting and maintaining the reforested areas in accordance with regulations set by the land-owning agencies. Educational institutions serve as advisors, offering scientific guidance based on research in species selection, planting methods, and maintenance to ensure a successful forest restoration. Additionally, the Royal Project Foundation is a key organization focused on restoring forests in highland areas in the northern region, beginning with the first reforestation effort at the Angkhang Royal Agricultural Station in Chiang Mai.

7. A Good Practice of Highland Reforestation at Royal Agricultural Station Angkhang, Northern Thailand

The Angkhang Royal Agricultural Station, situated in Doi Angkhang within Moo 5, Mae Ngon Sub-district, Fang District, Chiang Mai Province, is geographically located at coordinates E504901, N2201313 on map sheet 4848 IV. The station lies approximately between latitudes 19 °15' to 19 °57' North and longitudes 99 °01' to 99 °03' East. Established in 1969, this station holds the distinction of being the first research station of the Royal Project Foundation. The primary purpose of the Angkhang Royal Agricultural Station was to address two critical issues: the widespread cultivation of opium and degradation of forest resources, which are essential watersheds for the region's ecosystems. This initiative was aligned with the royal vision of King Bhumibol Adulyadej, who emphasized the importance of allowing natural systems to regenerate and sustain themselves, encapsulated in the principle of "let the mountains help themselves." The project sought to convert opium fields into productive highland agricultural plots, thereby providing sustainable sources of income for the local residents. Today, the Angkhang Royal Agricultural Station functions both as a research center and an experimental field station. It focuses on the cultivation of highland crops, including a variety of flowers, aromatic plants from both Thailand and abroad, fruit trees, and vegetables. The station's broader goal is to enhance the livelihoods of the local population by developing agricultural practices that generate income, while preserving the natural environment.

The highland reforestation project at the Angkhang Royal Agricultural Station follows the royal initiative of King Bhumibol Adulyadej, known as the "Three Forests, Four Benefits" approach. This involves:

Edible Forests: Providing food resources.

Fuel Forests: Producing firewood.

Utilization Forests: For construction and other uses.

Conservation Forests: For ecosystem restoration and conservation.

The fourth benefit, conservation forests, aims to restore and rehabilitate ecosystems degraded from past deforestation. Prior to the beginning of the project, the area was heavily deforested, characterized by barren hills and grasslands, with only a few large trees remaining. Some areas had been used for opium cultivation and agriculture for a long time, while others were abandoned agricultural lands (Figure 3)

Figure 3: Royal Agricultural Station Angkhang, before and after reforestation

The highland reforestation project is a semi-demonstration research collaboration between the Royal Project Foundation, the Faculty of Forestry at Kasetsart University, and is supported academically and financially by Taiwan, including the National Taiwan University (NTU), the Taiwan Forestry Research Institute (TFRI), and the Forest Development Administration (FDA) of the Vocational Assistance Commission for Retired Servicemen (VACRS). Its objectives are to 1) to investigate the silviculture of exotic-man-made forests at Angkang highland; 2) to provide wood for basic consumption for the local communities; 3) to study the effects of tree species on soil and water conservation; and 4) to transfer gained knowledge and experience to

other highlands restoration efforts that have similar environments to Angkhang for a sustainable development of the forest-based community. Therefore, the project focuses on four activities, i.e., seedling production for forest plantation and extension program, establishment and management of plantation, income generation from man-made forests, and research and training related to forest plantation.

The reforestation efforts began with a survey to select potential planting areas at the end of year 1981. Seeds from Taiwan were brought in to produce seedlings, focusing on fast-growing exotic species for research and area restoration. Planting started between 1982 and 1993, covering a span of 12 years with approximately 9.6 hectares planted per year (Thiutsa, 1996). Currently, the total area under planted forest is 131.2 hectares. The Royal Project Foundation has expanded these efforts to other highland areas through the Royal Project for Community Forests, with funding from the Royal Project Foundation.

The growth performance of exotic tree species at Doi Angkhang resulted in mixed results, with some species and bamboo struggling to thrive, while others exhibiting robust growth and high survival rates. Certain exotic species outperformed native species in terms of growth, indicating their potential importance in reforestation efforts at the Royal Agricultural Station Angkhang. Notable species that demonstrated superior performance included *Acacia confusa Merr., Fraxinus griffithii C.B. Clarke, Liquidambar formosana Hance, Cunninghamia lanceolata (Lamb.) Hook.*, and *Cinnamomum camphora (L.) J.S. Presl*.

The reforestation process at the station involved several critical steps:

- **Seedling Preparation:** Selecting and cultivating healthy seedlings to ensure strong initial growth.
- **Site Preparation:** Proper site preparation, including soil assessment and modification, to provide a optimum growing environment.
- **Weeding:** Regular weeding to reduce competition for nutrients and water between the young trees and other vegetation.
- **Survival Rate Survey and Replanting:** Continuous monitoring of tree survival rates and necessary replanting to maintain the desired forest density.
- **Fire Prevention and Control Measures:** To prevent and control fires, which pose a significant threat to young forests.
- **Pest Control:** Regular pest control to protect the trees from insects and disease.
- **Pruning and Thinning:** Pruning and thinning to improve tree structure, promote healthy growth, and manage forest density.
- **Utilization of Planted Trees:** Assessment of potential use at tree maturity, ensuring that the reforested areas provided both ecological and economic benefits.

The Faculty of Forestry at Kasetsart University conducted a study in 2020 (Diloksumpun, 2020) to evaluate the combined economic, social, and environmental benefits of highland reforestation for carbon sequestration at the Angkhang Royal Agricultural Station. The study indicated that the total economic and social value derived from highland reforestation for the local community amounted to 12,032,603 Baht per year. Of this, 2,925,895 Baht is attributed

to the benefits of forest utilization and preservation of local culture, while 9,106,708 Baht is tied to the broader economic and social gains, representing 24% and 76% of the total value, respectively. Additionally, the value of carbon sequestration through biomass was estimated at 262,595 Baht per year, with an additional 129,609 Baht per year attributed to carbon sequestration in soil. The value of standing timber in the area amounted to another 2,997,575 Baht per year. In total, the combined economic and social benefits of highland reforestation at the Angkhang Royal Agricultural Station was estimated at 15,422,382 Baht annually.

The assessment also considered the combined benefits of soil and water conservation, including water retention, soil preservation, temperature regulation, and nutrient conservation. The study concluded that the total value of these benefits varied depending on the reforestation model and was correlated with the cross-sectional area of the trees. The highest value for soil and water conservation was observed in reforestation efforts involving mixed exotic species, followed by those combining exotic and native species, and finally, naturally regenerating forests. These models yielded conservation values of 943,931.25, 669,893.75, and 526,218.75 Baht per hectare, respectively.

In evaluating plant biodiversity, the study found that the biodiversity in planted forest areas was comparable to that of natural forests, such as hill evergreen forests and dry evergreen forests at higher elevations. The lessons learned from the highland reforestation project at the Angkhang Royal Agricultural Station, conducted under the Royal Project Foundation, offer a model for the best possible practices to ensure sustainable forest restoration and carbon sequestration. The project underscores the principle of landscape forest restoration, aligning with King Bhumibol Adulyadej's royal initiative of the "three types of forests, four types of benefits" concept. This approach involved the planting of forests that provide food, fuel, and utility resources, with the fourth benefit being the conservation of forests to protect natural resources. This strategy would also support the primary objective of the Royal Project Foundation, which is to enhance the quality of life for highland communities.

The Angkhang Royal Agricultural Station's reforestation program has identified several critical factors that have contributed to the success of sustainable reforestation efforts in the context of forest landscape restoration (Diloksumpun et al., 2017):

- Land Use Zoning: Land use zoning is crucial for the successful implementation of forest landscape restoration. Each zone should be carefully planned to determine the most suitable reforestation patterns and plant species based on the area's specific characteristics and needs of the community. This approach ensures that restoration efforts are ecologically appropriate and beneficial to the local population (Figure 4).

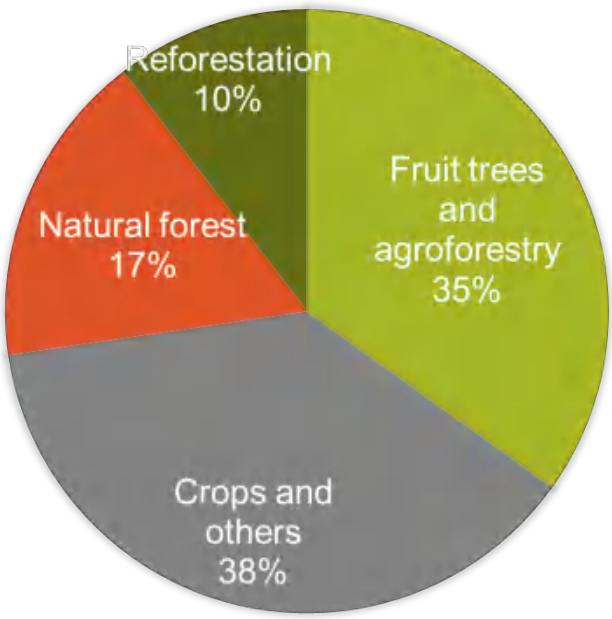

Figure 4: Land Use Zoning at Royal Agricultural Station, Angkhang

- Defining the Objectives of Restoration

Carbon Sequestration Potential: In zones requiring rapid restoration, planting a mix of fast-growing trees may be necessary, as this can enhance carbon sequestration in both biomass and soil more effectively than other methods.

Biodiversity Conservation: In areas focused on restoring forest resources and watersheds with an emphasis on biodiversity, it is advisable to plant fast-growing exotic species alongside native species. Over time, natural succession would occur, and these fast-growing species can be harvested if they reach a stage maturity, allowing the natural succession to continue.

Silviculture Practices: The use of silviculture principles in operations is essential. This includes matching tree species to the site, as well as meticulously managing reforestation plots. Practices such as branch pruning and tree thinning are crucial to ensure optimal tree growth.

Community Participation: To ensure successful forest restoration, the participation of all stakeholders is important, especially that of the local community. In particular, the station is surrounded by a variety of hilltribe communities. The reforestation efforts at Angkhang Royal Agricultural Station began with the collaboration between various agencies for research purposes and later expanded through community cooperation via the community forest project. The villagers were able to plant, maintain, and utilize forest resources under the agreed-upon regulations.

Overall, the success and sustainability of reforestation programs relies heavily on the involvement of the local community. Therefore, fostering community awareness and engagement in planting and maintaining the forest is of utmost importance.

8. Conclusion

The success of forest restoration at the Angkhang Royal Agricultural Station can be attributed to four key factors: effective land use zoning, clear restoration objectives, silviculture principles, and strong community involvement. The careful zoning of land into distinct agricultural and forest areas ensured that each region was utilized optimally, allowing for a focused and efficient restoration. Clear restoration objectives further guided the selection of appropriate tree species, which were chosen based on specific needs of the area and local community. This strategic approach ensured that the reforestation efforts were both ecologically sustainable and beneficial to the local economy. Additionally, an active participation of the local community was integral to the restoration efforts. Community members were involved in various activities and provided with employment opportunities related to the restoration projects, fostering a sense of ownership and commitment to the initiative's success. In extending these efforts to other areas, Thailand emphasizes the importance of these factors by developing strategies and policies at both the national and agency level, accompanied by detailed action plans. The private sector also played a crucial role in supporting forest restoration, particularly through financial contributions linked to voluntary greenhouse gas reduction projects that comply with Thailand’s standards for forestry and green areas.

Acknowledgement

This document was based on a compilation of information from the activities of faculty and researchers at the Faculty of Forestry, Kasetsart University. The Faculty of Forestry, Kasetsart University has been involved in the highland reforestation project since its inception and has continued to collaborate with the Royal Project Foundation to this day. This collaboration includes financial support and provision of research facilities from the Royal Project Foundation.

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Rehabilitation and Management of a Thailand Community Forest

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Abstract: Deforestation and degradation of forests are significant problems in Thailand, as they are worldwide. These problems adversely impact forest health and the economic, social and environmental development of rural communities, particularly in Asian-Pacific economies where dependence on forests for livelihoods is commonplace. In Thailand, illegal logging, conversion to agricultural uses, forest fires, and unchecked and unregulated harvesting of forest products are significant causes. The Royal Forest Department of Thailand is primarily responsible for managing and protecting forest resources in national forest reserve areas. It has established myriad programs to address and rehabilitate deforested and degraded forests including forest management programs. Community forest management serves as an effective approach to restore deforestation and degradation forests in Thailand. Community forest management programs involve a wide array of actions, such as plantation, establishing forest patrols, preventing and controlling forest fires, building check dams, conducting forest surveys and alignment, and engaging in traditional and cultural forest related activities. In spite of these efforts, problems exist. Land management and a lack of a unified nationwide system to address forest land problems is a consequential contributor to deforestation and degradation. A comprehensive vision, plan, direction funding, knowledge, expertise, technology, and training should be provided to communities. Moreover, collaboration and cooperation among stakeholders in all sectors, including the citizenry, private and governmental organizations, and other economies is crucial. Working together, sustainable forest management through corrective measures to balance the interests of conservation and the utilization of resources can be achieved.

Keywords: Deforestation, degraded forest, forest rehabilitation, community forest management, Thailand

1. Deforestation and Forest Degradation

Forests provide provisioning, regulating, supporting and cultural ecosystem services (Millennium, 2005) which are vital to supporting and enhancing the quality of life of those who reside in close proximity to natural forest reserve areas. Thailand is one of the most bio-diverse economies in Southeast Asia and one of the 20 most bio-diverse economies in the world (The Swiftest, 2022). Forests cover 31.57% of the economy (Table 1) with 63.53% of the northern, 59 % of the western, 24.32% of the southern, 21.86% of the eastern, 21.53% of the central and

14.97% of the northeastern Thailand regions covered by forest (Royal Forest Department, 2022). Deciduous (mixed deciduous and dry dipterocarp forests) forests comprise 18.26% of the economy's forests and are the primary types. Others include dry evergreen (4.30%), moist evergreen (3.68%), and montane forests (3.38%) (Royal Forest Department 2019). Over 15,000 species, approximately 8% of all global plant species, can be found in Thailand (Office of Natural Resource and Environment Policy and Planning, 2009).

Table 1: Changes in Thailand's forest area from 1973 to 2021

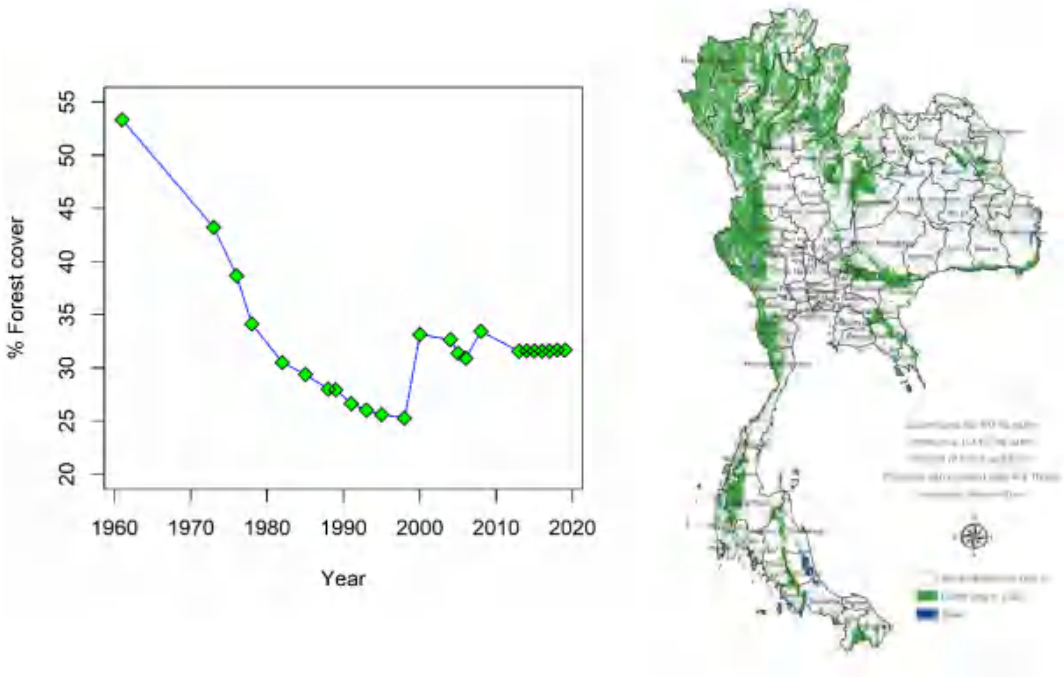
Years	Total forest area (ha)	% of forest cover
1973	22,170,700.00	43.21
1976	19,841,700.00	38.67
1978	17,522,400.00	34.15
1982	15,660,000.00	30.52
1985	15,086,600.00	29.40
1988	14,380,300.00	28.03
1989	14,341,700.00	27.95
1991	13,669,800.00	26.64
1993	13,355,400.00	26.03
1995	13,148,500.00	25.62
1998	12,972,200.00	25.28
2000	17,011,078.32	33.15
2004	16,759,097.60	32.66
2005	16,100,130.00	31.38
2006	15,865,259.00	30.92
2008	17,158,565.00	33.44
2013	16,339,126.00	31.57
2014	16,365,664.00	31.62
2015	16,358,557.10	31.60
2016	16,347,968.81	31.58
2017	16,345,016.08	31.58
2018	16,398,128.35	31.68
2019	16,397,451.63	31.68

2020	16,376,557.56	31.64
2021	16,353,989.50	31.59
2022	16,341,755.99	31.57

Source: Royal Forest Department (2022)

For decades, illegal logging and an ever-increasing demand for agricultural land have had a significant and detrimental impact on Thailand's forests (Thai Forestry Sector Master Plan, 1993) and on the economy, the environment, and the local residents. In 1961, forests covered 53.33% of the economy's total land area (Food and Agriculture Organization of the United Nations, 2009). Forest area was 43.21% in 1973, and 25.28% in 1998, less than half of what it was in 1961 (Royal Forest Department, 2022). The Thai government's nationwide logging ban in natural forests in 1989 elevated the focus of forest management on local participation, promoted ecotourism and provided a greater understanding of non-timber forest products (NTFPs) utilization behaviors and impacts. Yet, Thailand is still facing challenges and threats to its forest resources and livelihoods.

Based on the data in Table 1, the annual rate of deforestation was 367,940 ha per year between 1973 and 1998. Deforestation was 30,423.74 ha, per year between 2000 and 2022. Forest area decreased from 2000 to 2022 by approximately 1.58%. Forest area changes from 1961 to 2022 are shown in Figure 1.



(a) (b)

Figure 1: (a) Changes in forest area from 1961 to 2019 and (b) distribution of forest cover in each region

Source: Forest Land Management Office, Royal Forest Department (2022)

Commercial logging and the elevated demand for agricultural use of land to satisfy the needs of a burgeoning population have been the primary drivers of deforestation in Thailand (Thai Forestry Sector Master Plan, 1993). Encroachment onto forest land and illegal logging continue to threaten the forests and those who rely on them. This is particularly true in northern Thailand where the most illegal activities and the highest forest conversion rates were reported (Lakanavichian, 2001). Illegal logging has a far-reaching and multi-faceted impact on the economy, the environment, and the local residents (Rosander, 2008).

In the 1960s and 1970s, illegal logging brought about a rapid decline in forest resources (International Centre for Environmental, 2003). This trend continued into the 1980s resulting in significant deforestation and degradation (Food and Agriculture Organization of the United Nations, 2016). In 1989, severe floods in the South of Thailand caused more than 370 deaths and property damage exceeding US $240 million. Deforestation, particularly upland, was a principal contributing factor. This flooding was a seminal moment in the process of altering the economy's forest policies (Sadoff, 1992). Wide-reaching resolutions were passed in response to the damage suffered by the economy; a nationwide logging ban was promulgated via emergency decree in January 1989, and all licenses to log in natural forest areas were revoked, effectively banning commercial logging, particularly in the upland (Lakanavichian, 2001).

Subsequent thereto, policies, laws, and institutional frameworks were directed to address what had become and was then recognized to be a growing and significant problem. Involving local communities in the protection of forests became a mainstay of the government's approach to combatting deforestation and degradation (International Centre for Environmental Management, 2003).

However, the Royal Forest Department found that illegal forest encroachment in national forest reserve areas of Thailand continued to be widespread. In the past ten years, 21,484 cases involving 4,902 alleged offenders and over 83,700 ha, of encroached upon land were reported. During the same period, there were 20,348 cases of illegal logging, 9,015 alleged offenders and 44,893.08 m^3 of timber taken contrary to law (Table 2).

Table 2: Thailand national forest reserve area encroachment and illegal logging, 2015-present

Year	Encroachment			Illegal logging		
	# of cases	# of offenders	Area impacted (ha)	# of cases	# of offenders	Volume (m^3)
2015	3,637	893	23,661.55	4,055	1,656	6,808.78
2016	3,298	721	17,336.52	3,527	1,344	6,581.76
2017	2,303	516	8,417.78	2,880	1,217	5,000.17
2018	1,855	391	7,869.27	2,844	1,158	5,737.69

2019	1,762	357	7,898.24	1,589	662	3,485.37
2020	2,236	493	7,27922	1,205	590	2,998.78
2021	1,906	408	3,030.99	1,320	803	4,269.21
2022	1,523	358	3,266.30	1,089	596	3,136.86
2023	1,659	457	2,339.02	1,062	606	4,089.95
2024	1,305	308	2,621.26	777	383	2,784.51
Total	21,484	4,902	83,720.14	20,348	9,015	44,893.08

m^3 = cubic meter

Source: Forest Protection and Forest Fire Control Office, Royal Forest Department (2024)

Encroachment remains a consequential contributor to forest degradation and deforestation. Thus, it is crucial that all concerned agencies in Thailand collaborate to address these problems that are existential to the economy's forests.

Forest fires, especially in national forest reserve areas located near communities, are also a notable cause of deforestation and degradation. In Thailand, roughly 23 million people live near national forest reserve areas which supply forest products that help to satisfy basic needs of rural communities (Witchawutipong, 2005). In these remote areas of Thailand, fires are part of the fabric of daily living. They are employed for legitimate and legal reasons such as site preparation, disease and pest control, and to harvest NTFPs. They are also used illicitly for logging, hunting, and shifting cultivation. Regardless of their intended use, their ubiquitousness creates a considerable forest management problem as each has the potential to cause large-scale damage. In 2022, The Royal Forest Department reported 1,473 cases of forest fires which damaged 2,990 ha; 80% of these occurred in the northern region of the economy (Royal Forest Department, 2022). They are frequent during the dry season in deciduous forests, including mixed deciduous and dry dipterocarp forests (Sukwong and Dhamanittakul, 1977; Bunyavejchewin, 1983) which are the most prominent forest types in Thailand. They cover 18.26% of the nation's forest area (Royal Forest Department, 2019), and they provide the most valuable timber and NTFPs for remote rural communities to access to supplement their livelihoods.

2. Related Strategies and Policies

Thailand's 20-Year National Strategic Plan (2018-2037) reflects its commitment to increase its green area cover to 55%, allocated as 35% natural forests, 15% forest areas for utilization, and 5% for green areas or stands of trees outside of forests. Thailand's 1985 National Forest Policy as modified in 2019 reiterated its goal of maintaining at least 40% of the economy's total area as conservation forests (25%) and economic forests (15%). Efforts in pursuit of these objectives focused on forest management, forest product utilization and forest services and industry (Royal Forest Department, 2021). This reflects a commitment to myriad policies and strategies aimed at ensuring that economic benefits through conservation can be balanced and realized.

Expanding forest areas and realizing these objectives involves governmental agencies, the private sector, and a high level of participation by community residents and, thus, is inherently difficult. Under the Ministry of Natural Resource and Environment (MONRE) there are three organizations primarily responsible for managing the economy's forest resources. The Royal Forest Department (RFD) manages forest reserves that are outside protected areas, the Department of National Park, Wildlife and Plant Conservation (DNP) manages protected areas such as national parks, wildlife sanctuaries, arboretums, and forest parks, while the Department of Marine and Coastal Resources (DMC) has authority over the mangrove resources.

Several acts of legislation addressing forest resource management have been promulgated, such as the Forest Act B.E. 2484 (1941), the National Reserved Forest Act B.E. 2507 (1964), the Forest Plantation Act B.E. 2535 (1992), the Chainsaw Act B.E. 2545 (2002), the National Park Act B.E. 2562 (2019) and the Wild Animal Conservation and Protection Act, B.E. 2562 (2019). The Thai government most recently approved the Community Forest Act B.E. 2562 (2019) which authorized forest management decision-making at the local level (Royal Thai Government, 2019). This reflects the present underlying forest management policy philosophy that emphasizes participation in all phases of management efforts. In addition, emphasis is placed on the environmental, social, and economic benefits to the people and their surroundings that are provided by forest resources and forest ecosystem equilibrium.

There are challenges ahead as the present forest coverage is approximately 32% of the economy's area, which is far from the goal of 55% green area cover of the 20-Year National Strategic Plan. Policies seem to be having a muted positive impact as forest area decline and destruction of forest resources is not increasing year-over-year, and there is optimism that this trend will continue. Adopted policies promote the establishment of 15,000 community forests encompassing 1.6 million hectare, manage forest land in a systematic and fair manner, promote the restoration of degraded forests, increase economic forest areas, and promote and develop green spaces in cities and rural areas. There have also been advancements in the management of forest resources, such as improved technology, cooperation with foreign administrations, permission policies, and wood and wood product certification (Royal Forest Department, 2021).

3. A Project/Programme of Forest Rehabilitation

The Royal Forest Department is responsible for 1,221 national forest reserve areas that cover approximately 23,438,870 ha. The Department represents the primary sector spearheading the economy's commitment to the 20-year National Strategic Plan (2018-2037) and the National Forest Policy (2019) in its efforts to rehabilitate the economy's forests and expand the forest areas. The economy's forest area is decreasing every year. The main causes are encroachment and transformation of forest areas into agricultural and/or residential lands. There is a conflict between the government and the people which contributes to the problem. The Thai government is aware that forest resources benefit the entire economy and wishes this to continue, however, it cannot and does not ignore the existing problems of which the people need to be made aware. Thus, the role of community forest management in forest rehabilitation and management in Thailand is discussed herein.

The ideas and philosophy of community forest management (CFM) have been widely accepted and adopted in Thailand and many developing economies. Improved forest conditions that yield more abundant and beneficial forests can result from involvement in forest management activities. It is an effective approach to restoring degraded forests, helping to fulfill the needs of local residents, increasing income and benefiting the poor. Community forest management is also generally recognized as an effective sustainable forest management tool. In Thailand, the Royal Forest Department has promoted CFM since 1987 (Royal Forest Department, 2014), and it has expanded and been widely accepted, as evidenced by the widespread level of participation throughout the economy.

Implementing CFM to rehabilitate degraded forests comprises various activities which are vital to improving conditions and enhancing the ecosystem services and the benefits they provide. In Thailand, those measures include plantation, protection and weed control efforts, patrols, forest fire control, surveys and alignment, building check dams (to inhibit water flow, retard erosion, and increase soil hydration), and engaging in cultural and traditional forest events. Buddhism is a strong cohesive force in every aspect of life in Thailand, and its spiritual tenets are called upon to help protect and safeguard the forests.

In Thailand, the government emphasizes efforts to promote people's participation in community forest management through collaboration with the government. This collaboration focuses on conserving, restoring, and maintaining natural resources while sustainably continue utilizing those resources. The management of community forests focuses on promoting and supporting communities to be the center of development, while the government provides education and academic support, facilities, funding, seedling, training, and other resources necessary to implementation.

The Royal Forest Department aims to establish 10 million rai (1.6 million ha) of community forests in 15,000 villages in accordance with the 20-Year National Strategic Plan (2018-2037). As of 30 June, 2024, 11,193 community forest projects have been implemented in 12,801 villages encompassing approximately 1 million ha (6.10% of the economy's total forest area) (Royal Forest Department, 2024). The Community Forest Act 2019 has resulted in a noteworthy expansion of forest areas in Thailand due to the proliferation of community forest projects (Table 3). Moreover, the 2019 Community Forest Act's enforceable legislation and regulations address and support a balancing of forest economics as well as community conservation of forest resources.

Table 3: Number and area of community forests established under Community Forest Act 2019

Region	Number of villages	Number of projects	Area (ha)	(%)
North	4,688	4,242	682,223.73	68.46

Northeast	6,115	4,990	195,373.75	19.61
Central	1,184	1,157	85,794.39	8.61
South	814	804	33,114.88	3.32
Total	12,801	11,193	996,506.75	100.00

Source: Community Forest Management Office, Royal Forest Department (2024)

The Community Forest Act B.E. 2562 (2019) authorized local participation and decision-making in forest management, including conservation issues and the pursuit of the sustainable utilization of forest resources. Participation in the management process, supportive community forest regulations, perception and understanding of the salient issues, and benefit sharing have an impact on the social, economic, and environmental benefits of ecosystem services (Thammanu et al., 2021). This suggests that community forest management can improve forest health, while developing the livelihoods of those who rely on the forest's resources.

Section 50 of Thailand's community forest law emphasizes and encourages the collection of forest products for use (Thai government, 2019). In conformity with relevant law, a community forest can be divided into areas for conservation (60%-100% of the land area) and/or utilization (not to exceed 40%). (Thammanu et al., 2024).This can incentivize widespread involvement in community forest rehabilitation and management, as the abundance of forest resources can generate income resulting in protection and development of forest resources to ensure its continued viability for future generations.

Components of community forest management which are being implemented to rehabilitate degraded forests in Thailand can be summarized as follows:

3.1 Surveys and alignment

Community forest projects in Thailand fall under the mandates and authority of the Community Forest Act B.E. 2562 (2019). Surveys and alignment of community forest boundaries is a top priority to protect forest areas. Uncertain land boundaries contribute to deforestation as people are unaware of what is government land and what is not. Boundary disputes and other conflicts arise out of the necessity to verify rights because of overlapping government land boundaries. This is a longstanding problem that has caused a conflict between the government and the people that has hindered meaningful progress. Geographic Information System (GIS) technology and ground surveys are to be used to map the boundaries of each community forest project. Boundaries are to be confirmed by community residents as well as the government and published to address and avoid land boundary conflicts. Therefore, community forest projects can decrease land disputes and conflicts among community residents and between people and the government.

3.2 Community forest management planning

After a community forest is registered as such by the Royal Forest Department, communities are required to develop a 5-year management plan with these 5 components:

a) conservation related to activities such as forest patrols, forest fire prevention and control, building check dams and public relations;

b) plantation and rehabilitation;

c) community forest development;

d) control and regulations, and

e) utilization (forest product harvesting and accessing forest resources).

There are presently 200 community forest management projects. The Royal Forest Department has provided each with 70,000 THB (approximately US $1,750) to implement their plans.

3.3 Plantation and weed control

Planting trees is crucial to rehabilitating community forests, which encompass approximately 1 million ha (6.10% of the economy's total forest area). Suitable tree species are selected based on community needs and forest types. Generally, native tree and plant species will be selected to grow in different ecological forests to provide resources that fill one of one of these needs: 1) fuelwood and timber 2) medicinal use 3) food, and 4) environmental impact. Quality seedlings, academic advice and funding for planting and maintenance are provided by the government to the communities. Forest plantation includes weed control and fire protection. Thus, it is ensured that community forests are rehabilitated by collaborating in this manner; communities and the government can rehabilitate community forests and increase the overall forest area in Thailand.

3.4 Forest Patrols

Forest patrols are a powerful tool against deforestation and vital to protecting forest resources. Communities establish groups to patrol for fires, encroachment, illegal logging, over-exploitation or other problematic conditions. Generally, communities collaborate with the Royal Forest Department, local police, military personnel, and the local government in creating and conducting these patrols.

3.5 Forest fire prevention and control

Forest fire prevention and control is also an important mission in Thailand. Forest fires are significantly problematic throughout the economy. The Royal Forest Department aims to decrease hotspots to less than 20% of the previous three-year average. Each summer season, community forest communities establish forest fire management working teams. Determining the appropriate timing, size and routes of firebreak lines, selecting suitable tree species to plant in drought areas to increase soil moisture, or by employing specific techniques to extinguish fires using minimal water all come from traditional knowledge, experience and local wisdom that are applied to manage fires (Thammanu et al., 2021). Combined with preventative and control strategies, these efforts support forest rehabilitation efforts.

3.6 Building check dams

Thailand's dry season features 5-6 months of drought which exacerbates the impact of fires. Building check dams supports species diversity, safeguards NTFP supplies and, therefore, has a positive impact on ecosystem services. In Thailand, check dams are mostly built in the northern region deciduous forests. They not only help to safeguard against forest fires, but they also increase moisture that is helpful to regeneration and the growing of new trees. Consequently, building check dams is likely to have a positive impact on forest rehabilitation.

3.7 Forest culture and tradition

Resourcing forest culture and tradition for strategic management plays a vital role in community forests, particularly in their restoration. Various cultural and traditional activities are integrated to protect forest resources such as 'Tod Pa Bah', 'Suep Chata Pa' and 'Buod Pa'. Thammanu et al. (2021) explained that 'Tod Pa Bah' is a Buddhist robe-offering ceremony. It is an opportunity to make merit and donate funds for conservation effort; 'Suep Chata Pa' is a ritual with a purpose to boost the spirit and the morale of the people and prolong the life of the forest. 'Buod Pa' is a tree ordination ceremony seen as a deterrent to illegal deforestation.

4. Lessons Learnt From This Project/Programme

Upon review of degraded forest rehabilitation efforts in Thailand, the following observations can be made:

The primary lesson is that the community forest practices informed by these projects can be used to plan forest management strategically so as to continue to provide assistance to people in meeting their basic, social and economic needs and to ensure the sustainability of the environmental benefits provided by the forest ecosystem. Problem caused by uncertain land boundaries still exist. Uncertain land boundaries contribute to deforestation as people are unaware of what is government land and what is not government land. Boundary disputes and other conflicts arise out of the necessity to verify rights because of overlapping government land boundaries. This is a longstanding problem that has caused a conflict between the government and the people that has hindered meaningful progress.

Secondly, community forest management in Thailand continues to lack the requisite funding, knowledge, skills, and technologies that are required to successfully implement rehabilitative strategies. In addition, all policies, plans and management efforts need to be reviewed and monitored for effectiveness and to inform subsequent improvements.

Finally, all sectors should collaborate in the implementation of rehabilitation efforts. Deforestation and degraded forests have a gravely adverse impact on the social, economic, and environmental benefits of ecosystem services. Forest restoration efforts need to promote both increasing the tree population and forest ecosystem biodiversity. Moreover, sustainable forest management can only be realized by balancing the interests of utilization of forest resources by the present generation while conserving those same resources for future generations.

5. Positive Change and the Way Forward

The One Map project was established in 2015 to provide some certainty in forest land management. It would provide management information to address problems faced by forest lands in Thailand. The One Map database would show up-to-date forest areas in a geographic information system accessible by every agency to help manage their forest resources in pursuit of their own missions. The government expects that this project will facilitate planning and management of forest resources more accurately and clearly (Royal Forest Department, 2023). However, the implementation of the One Map project is not complete, and the database is as of yet unavailable, as is the assistance it would provide in addressing problems via community forest management. Thus, the government should provide the One Map to assist land management efficiency in Thailand as soon as possible.

Government provided financial support and equipment to community forests would be beneficial. Since the advent of community forests in Thailand, it has been demonstrated that people residing near forests have the potential to protect that forest's resources. In addition, training is required to provide the necessary knowledge and skills to extinguish fires, create and maintain seedling nurseries, build fire breaks and check dams, harvest NTFPs and enhance and clarify perception and understanding of community forest laws in pursuit of sustainable forest management.

Governments cannot solve the problems of deforestation and degradation acting alone. Collaboration is pivotal to successful forest management. It is vital that all domestic sectors cooperate, and economies work together on funding, knowledge, expertise and technology transfer. Such alliances should be pursued, supported and encouraged to achieve a rehabilitation of the forests and sustainable forest management in Asia-Pacific region.

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Assessing Forest Rehabilitation and Solutions: A Case Study of Dong Nai Biosphere Reserve and Kon Chu Rang Natural Reserve in Vietnam

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Abstract: Forest rehabilitation is a multifaceted process influenced by both biological and non-biological factors. Understanding the direct and indirect impacts of these factors on forest dynamics is crucial for effective restoration solutions. Research efforts that delve into the intricate relationships between these influences are essential. By comprehending the interplay of biological and non-biological drivers, we can develop more informed and sustainable forest restoration strategies. Despite Vietnam's high national forest coverage rate (accounting for 42.02% in 2022), forest quality has declined, biodiversity is low, and the ecological function of forests is no longer preserved intact. To address this, research conducted at the Dak Nong Biosphere Reserve (DNBR) and Kon Chu Rang Natural Reserve (KCR) comprehensively assessed natural forest rehabilitation using two main criteria groups: i) structural and biodiversity criteria and ii) Functional Criteria. The assessment primarily emphasizes quantitative elements, often weighted and adapted from the international forest restoration assessment scale. For the first time, the Delphi method and KAMET principles were applied to refine this comprehensive assessment framework for natural forest restoration in the Kon Ha Nung region, with strong consensus among expert stakeholders. A comprehensive approach is essential in which a landscape-based approach is a key method for sustainable management.

Keywords: Forest rehabilitation, structural and biodiversity criteria, Delphi method, KAMET principles, Dak Nong Biosphere Reserve, Kon Chu Rang Natural Reserve.

1. Introduction

The term "Land Use and Land Cover Change" is used to describe alterations in the manner in which land is used and managed, including deforestation and forest degradation. These changes contribute significantly to 17–25% of annual anthropogenic greenhouse gas emissions, which play a crucial role in global warming. Notwithstanding a reduction in deforestation and forest degradation, these issues persist, particularly in developing economies. It is imperative to comprehend the underlying causes of deforestation and forest degradation in order to develop efficacious policies that simultaneously advance climate change mitigation and biodiversity conservation (Kissinger et al., 2012). The primary reasons for this phenomenon are the pressures resulting from population growth and economic development, which lead to an

increased demand for land for agricultural, construction, and timber production to support livelihoods. Furthermore, other factors related to forest degradation concentrate on examining three natural elements that impact forest decline at the source: fire, storms, and topography. Nevertheless, the authors also recognize that other factors are equally significant but only impact smaller scales (Price, M.F. & Butt, N., 2000).

The term "deforestation" is well-established and has been in use for several years. As defined by Hosonuma et al. (2012), deforestation refers to the removal of trees and the conversion of forested areas into non-forest land, including uses such as agriculture and mining. It is noteworthy that Lund (2014) assembled over 250 definitions of deforestation, classifying them according to alterations in land cover, land use, or both. His comprehensive study ultimately defines deforestation as "the act or process of changing forest land to non-forest land."

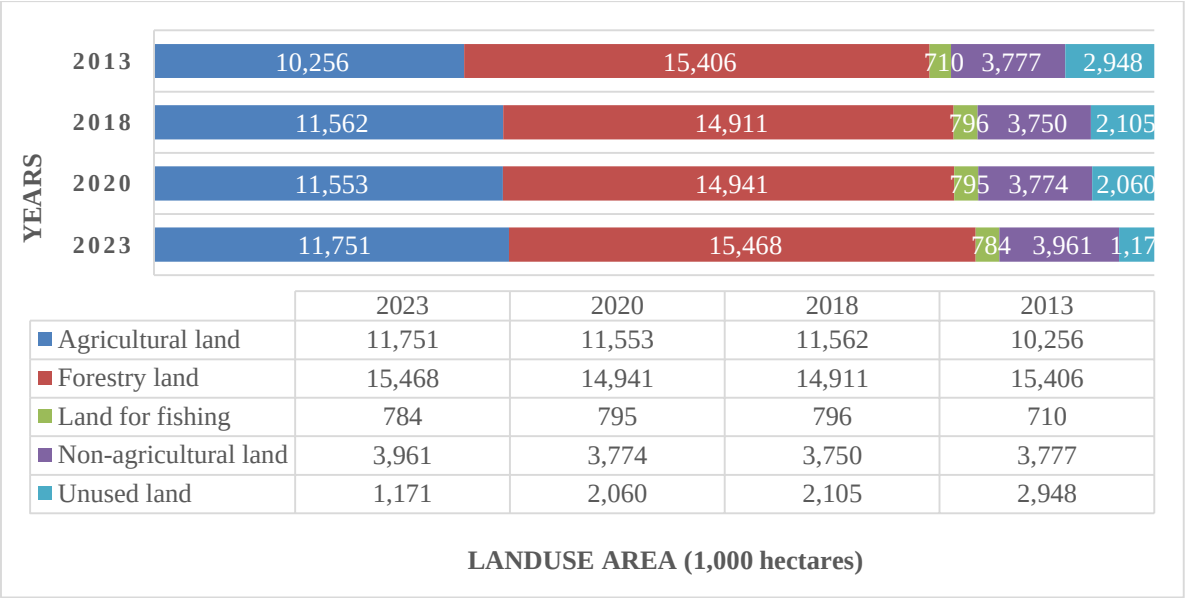
The definition of forest degradation is more complex due to the multifaceted nature of the phenomenon. It encompasses a multitude of dimensions related to states and processes that are not readily observable or quantifiable. In recent years, scholars have proposed new definitions of forest degradation. These definitions consider a range of indicators, including reduced tree density, which affects forest quality; decreased carbon stocks; and shifts in forest vegetation types, such as the transition from evergreen forests to bamboo-dominated areas. It is of the utmost importance to gain an understanding of both deforestation and forest degradation in order to ensure effective forest management and conservation.

The term "forest rehabilitation" is used to describe deliberate activities that are undertaken to reverse the effects of forest degradation. In the context of Vietnam, the initiative targets forestland with varying degrees of degradation, including not only formerly forested areas but also grasslands, brushlands, scrublands, and barren lands. The term "forest rehabilitation" has been discussed conceptually and is associated with other terms like "rehabilitation," "reclamation," "reforestation," and "afforestation." For instance, Lamb & Gilmour (2003) propose three categories of actions to address forest degradation: (i) reclamation, (ii) rehabilitation, and (iii) rehabilitation, with less emphasis on achieving the exact biodiversity level of the original forest.

2. Forest Deforestation and Degradation, and Rehabilitation in Vietnam

2.1 Deforestation and forest degradation

In the period from 2013 to 2023, land-use changes in Vietnam followed global trends. Agricultural and non-agricultural land areas expanded, while unused land significantly decreased (Fig. 01). Specifically, agricultural land increased by 1.631 million hectares, non-agricultural land by 0.184 million hectares, and unused land decreased by 1.778 million hectares. Notably, recent land-use shifts involved converting forestry land to agricultural production, transforming agrarian areas into urban zones and industrial sites, replacing mangroves with aquaculture, and afforesting barren land and hills (Guo, Xuan, et al. 2022).



	2023	2020	2018	2013
Agricultural land	11,751	11,553	11,562	10,256
Forestry land	15,468	14,941	14,911	15,406
Land for fishing	784	795	796	710
Non-agricultural land	3,961	3,774	3,750	3,777
Unused land	1,171	2,060	2,105	2,948

Figure 1: Land use changes between 2013 – 2023 in Vietnam

Since the 1990s, the forest area in Vietnam has consistently increased mostly in the form of plantations (for production and protection, classified accordingly). It expanded from 9.2 million hectares in 1992 to approximately 13.3 million hectares in 2010 and around 14.6 million hectares in 2019, with nearly 10.3 million hectares classified as natural forests (MARD 2011, 2020) (Fig. 02). Although the forest cover is 42.02%, forest quality has declined, diversity is low, and the ecological function of the forest is no longer preserved intact[68]. As of 2010, over two-thirds of Vietnam's natural forests are considered poor or regenerating, while rich and closed-canopy forests constitute only 5 percent of the total forest area (MARD, 2011). Additionally, between 2015 and 2020, Vietnam experienced deforestation at a rate of 1.59 thousand hectares per year, and the total area of humid primary forest decreased by 11%[69]. These figures highlight the ongoing challenges of deforestation and forest degradation in Vietnam.

1. [68] https://www.vietnam.vn/en/viet-nam-trong-va-khoi-phuc-rung-de-giam-tac-dong-cua-bien-doi-khi-hau

2. [69] https://www.globalforestwatch.org/dashboards/ economy/VNM/?category=forest-change&location=WyJjb3VudHJ5IiwiVk5NIl0%3D

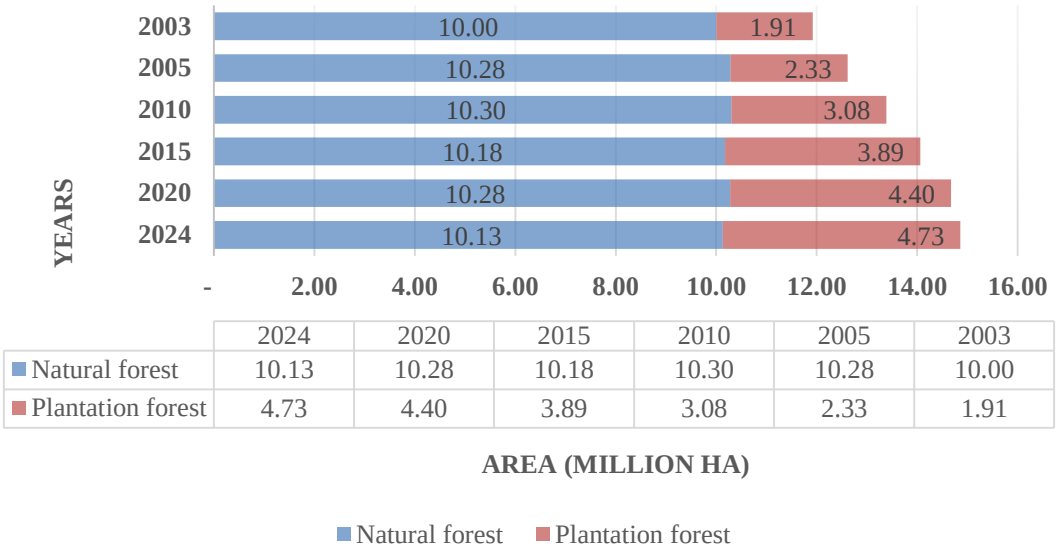


Figure 2: Forest types in Vietnam between 2003 and 2024[70].

The results of Vietnamese studies have identified direct causes contributing to deforestation and forest degradation in recent years. These include forest land conversion for other purposes such as coffee plantations (from 50,000 hectares to 645,400 hectares) and extensive sea and brackish water aquaculture (covering 730,000 hectares). Infrastructure development, including hydroelectric dams, economic projects, and general infrastructure, further contributed to deforestation. Unsustainable logging practices, driven by population growth and market demand, exacerbated the issue (Stéphane et al. 2021). Forest fires led to the loss of approximately 34,000 hectares of tree cover, with Quang Ninh province experiencing the highest annual fire-related loss. Additionally, natural disasters and weak forest protection policies exacerbate the loss of natural forests. Investment in natural forest rehabilitation remains low, and effective monitoring programs are lacking (Nguyen Huy Dung 2020). According to statistics, the primary cause of forest degradation has shifted over time, with poor-quality forest land being converted to commercial plantations in recent years. These findings underscore the importance of targeted conservation efforts and sustainable forest management practices in addressing the challenges facing Vietnam's forests.

2.2 Forest rehabilitation

Forests play a crucial role in Vietnam's socio-economic fabric, providing essential ecosystem services, supporting local livelihoods, and contributing to climate change mitigation. Recognizing their significance, the Vietnamese government has implemented various policies and strategies to promote sustainable forest management. The pivotal legal document for the forest sector is the 2017 Forestry Law[71], which establishes a comprehensive framework for managing social relations within forestry. This law covers aspects such as forest management,

3. [70] http://kiemlam.org.vn/Desktop.aspx/List/So-lieu-dien-bien-rung-hang-nam/

4. [71] https://english.luatvietnam.vn/law-no-16-2017-qh14-dated-november-15-2017-of-the-national-assembly-on-forestry-118853-doc1.html

protection, development, product processing, and trade. Its primary objectives are to modernize the sector, ensure sustainability, and enhance the well-being of local communities. Notably, the 2014 temporary logging ban (Decision 2242/2014/QD-TTG) closed all natural forests for logging, while also strengthening mechanisms for managing forest use conversion projects, including hydropower development and rubber plantations. The focus was on environmental services provision. Efforts such as the Payment for Forest Environmental Services (PFES) and the national REDD+ program have effectively reduced deforestation. These initiatives serve as crucial sources of financing for forest owners and local communities, enhancing biodiversity conservation.

With efforts on rehabilitation to prevent forest violations between 2005 and 2019, violations decreased by 62.8% compared to the 2006 baseline, both in terms of absolute cases and the extent of damage. Vietnam's commitment to balancing economic development with environmental sustainability was officially stated by Prime Minister Phạm Minh Chính. The economy aims to focus more on the development of green and renewable energy while fulfilling international commitments. It recognizes that economic progress must harmonize with nature, avoiding any trade-offs that compromise the environment

According to the Vietnam Forestry Development Strategy 2021-2030, with a vision extending to 2050, Vietnam aims to establish a modern forestry sector capable of competing in diverse high-value-added products and services within the global supply chain. Achieving this vision requires active involvement from local communities in both production activities and forest resource protection. This participatory approach aims to reduce poverty, enhance resilience to climate change, and promote sustainable forest management. Over the past two decades, approximately 2 million hectares of natural forests have undergone rehabilitation through national forest rehabilitation programs[72]. However, more than 73% of these natural forests are categorized as degraded and poor, with low forest biodiversity and stocks. Rehabilitation approaches included enrichment planting, assisted natural regeneration, introduction of native species into production and protection forests, and additional soil and water conservation measures.

In Vietnam, forest rehabilitation measures are relatively systematic and well-defined, guided by technical regulations and scientific foundations. These comprehensive technical and socio-economic solutions address specific forest types. Proposed native tree species for rehabilitation are also documented. However, some recent studies have focused primarily on vegetation cover characteristics, overlooking the significant influence of site factors (topography, soil conditions, microclimate) on the selection of silvicultural techniques for forest rehabilitation. Additionally, there is a lack of extensive research that systematically validates the accurate and effective application of silvicultural methods to specific forest types through experimental models. Although some trial models have been implemented, the lengthy growth cycles of forestry

5. [72] MARD Forest status statistic data (2019).

species limit the project duration, leaving room for subsequent evaluations after project completion.

3. Case Study in Dong Nai Biosphere Reserve and Kon Ka Kinh Reserve

In this section, two projects will be described including i) Research in Dong Nai Biosphere Reserve (Tran Lam Dong, 2018): This study evaluates the succession of forest ecosystem rehabilitation and proposes conservation solutions within the Dong Nai Biosphere Reserve. The project has developed criteria for assessing the degree of forest rehabilitation based mainly on forest structure, biodiversity index, and alignment with the standpoint of living in harmony with nature. and ii) Rehabilitation Solutions in Kon Ha Nung Biosphere Reserve (Tran Thi Thanh Huong, 2022): Focusing on Gia Lai Province, this research project adopts a landscape-based approach to natural forest rehabilitation. It emphasizes collaboration among the government, local communities, and private enterprises. The overarching objective is to achieve effective and sustainable landscape restoration while enhancing livelihoods. By actively involving community members, the project aims to improve forest management and promote targeted rehabilitation efforts. The perspective of the landscape approach in forest restoration, involving various stakeholders (private sector, government, civil society, and communities), has been recognized and established through legal frameworks for enforcement in Vietnam. Notably, the 2017 Forestry Law, Decree 118/CP, and Decision 297/QD-TTg play a crucial role in this context.

3.1 Research Sites

The Dong Nai Biosphere Reserve (DNBR) was established in 2011, covering a total area of nearly one million hectares across five provinces in Vietnam. The core area of DNBR comprises two special-use forests with a combined area of 173,073 hectares: Cat Tien National Park and the Nature-Culture Conservation Area (Đồng Nai). Beyond its extensive size, DNBR holds significant conservation values at both national and international levels. Notably, it is the sole remaining habitat in Vietnam for the unique Dipterocarpaceae rainforest ecosystem, native to Asia. Cat Tien National Park has also been one of the world's last refuges for the critically endangered *Javan rhinoceros* (Rhinoceros) (Dong Nai Government, 2010)[73].

The Kon Chu Rang Nature Reserve (KCR), located in Kon Ha Nung Biosphere Reserve recognized by UNESCO at the 33rd session, encompasses an area of 719 km², with a designated conservation zone of approximately 159 km². This zone includes the Strict Protection Zone (~8.75 km³) and the Ecological Rehabilitation Zone (~7.15 km³) (Fig. 03). notably, nearly 70% of the study area is comprised of rich forests, with a total forest volume exceeding 200 m³, representing the highest proportion of mature forests within the Kon Ha Nung plateau. The reserve's forest ecosystem serves as an exemplary model of the evergreen broad-leaved forest typology found in the Central Highlands of Vietnam[74].

6. [73] https://cattiennationalpark.com.vn/

7. [74] https://konchurang.vn/

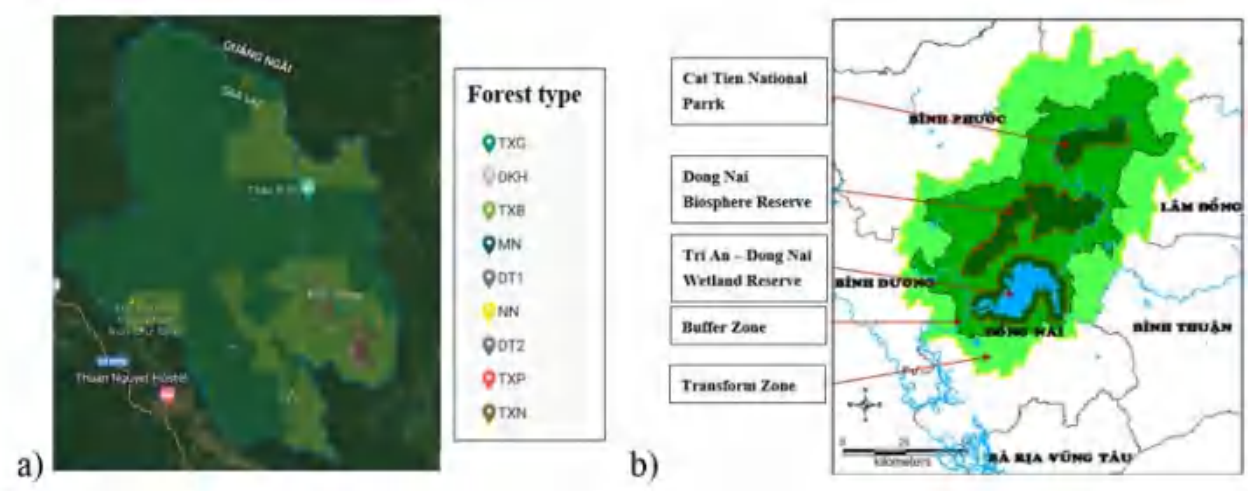


Figure 3: Location of the KCR (a) and the DNBR (b)

3.2 Methods

The project information and applied methods are illustrated in Table 01.

Table 1: The project's information and methods

	Dong Nai Biosphere Reserve	Kon Chu Rang Nature Reserve
Objects	Evergreen broadleaf, deciduous forest	Evergreen broadleaf
Location	Dong Nai, Binh Phuoc, Binh Duong, Lam Dong, and Binh Thuan Province.	Gia Lai province
Time	2015 - 2018	2022 - 2025
1. Forest status and successional stages of forest	- Field survey (258 plots, 1.000 m^2). - LANDSAT imagery from 1967 – 2018. - The log-log diagram of forest structure: H = 100*DBH - NMDS methods (Bruelheide et al., 2011).	- Field survey (68 sample plots, size from 1.000-10.000 m^2). - LANDSAT imagery from 2013 – 2023.
2. Criteria for assessing the degree of forest rehabilitation	- Interview forest owners, technical staff, and experts. - Interview local people and communities. - Global approaches by McDonald et al. 2016. The main criterion includes forest structure, and biodiversity (Annex 1-3).	- Interview forest owners, technical staff, and experts. - Interview local people and communities. - Delphi methods and KAMET rules.
3. Forest rehabilitation solutions	Solutions for improvement of forest rehabilitation based on the following main contents:	- The steps to provide solutions are the same as those provided in DNBR.

	i) Identifying characteristic features of forest ecosystems, ii) Determining the successional stages of forest conditions, iii) Assessing forest rehabilitation levels based on predefined criteria and factors impacting forest regeneration, and iv) Proposing technical solutions based on the findings, with the participation of local authorities, forest management boards, local communities, forest owners, local people, and private enterprises.	- Model for forest rehabilitation (two experimental models).

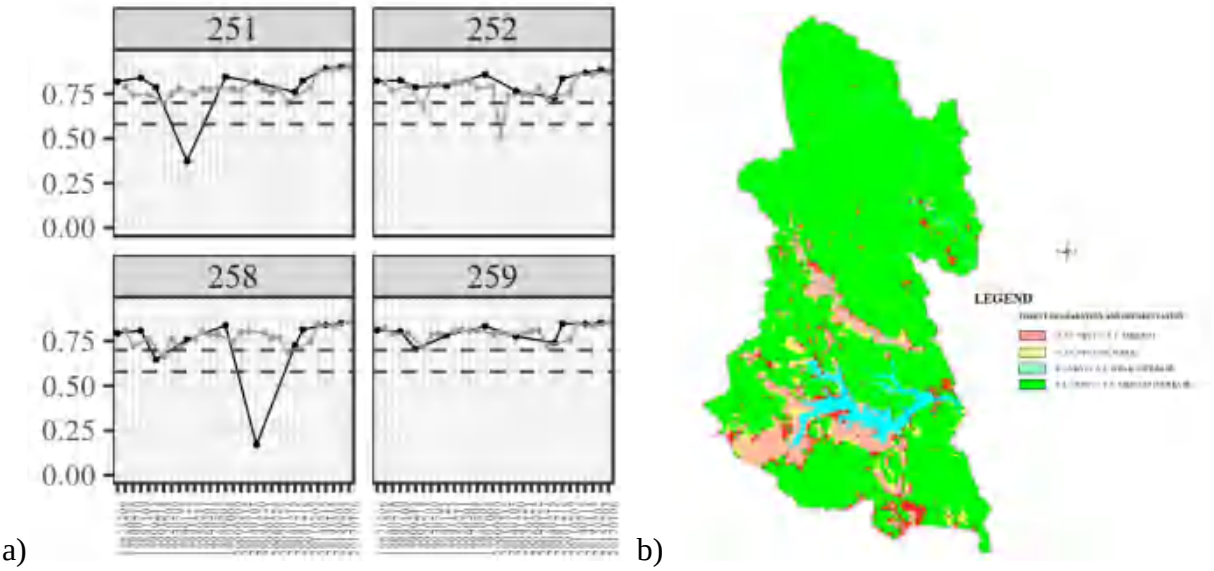
H: tree height; DBH: diameter at breast height; NMDS: Non-Metric Multidimensional Scaling.

3.3 Results

3.3.1 Forest status, successional stages of forest and main reasons for deforestation and forest degradation

a. Forest status and successional stages of forest

In the study in KCR, sample plots were carefully selected that corresponded to the NDVI (Normalized Difference Vegetation Index) range and effectively represented different successional stages. The NDVI trend from 2013 to 2023 exhibited an upward trajectory, indicating successful forest rehabilitation in the research areas (secondary forest after shifting cultivation and secondary forest after logging cultivation) and stable forests (Primary Forest). Consequently, using NDVI as a reliable indirect indicator provides valuable insights into forest successional stages. Tran Lam Dong (2018) compared three methods for determining forest successional stages: NDVI, H = 100*DBH, and NMDS methods. Interestingly, these methods showed reasonably high similarity in stage determination. The NDVI-based classification results align well with field-collected data on successional stages. The classification map for successional stages, forest status, and the planning forest map provides valuable data to assist managers of both forest boards at the macro level. The results depicting NDVI changes over time and the level of forest degradation are illustrated in Fig. 04.



a) b)

Figure 4: NDVI changes by time for DNBR (a) and map of forest deforestation and degradation for KCR (b).

b. Main reasons for deforestation and forest degradation

- Policies and Institutional Frameworks: Despite favorable features for forest conservation and development, the policies and laws (Annex 5) in the research area still have gaps. Community forest management models are underutilized, and management mechanisms lack robustness. Communities often don't actively engage in forest protection, and residents face challenges related to land use rights. Additionally, transparency in share transfer remains unclear.

- Timber Exploitation: Survey results along forest buffer zones and production forests (where timber exploitation permits have long been suspended) indicate that illegal logging is still occurring (Fig. 05). The different impacts on forests can be attributed to a variety of factors, but institutional influences on forest protection are evident. While special-use forests in the study areas showed minimal signs of illegal logging, they remain relatively common in protected and production forests.

Figure 5: Illegal logging in research sites (Tran Lam Dong, 2018)

- Non-Timber Forest Product Exploitation and Other Impacts: Activities related to non-timber forest products, such as firewood collection, hunting, and honey harvesting, are often carried out by indigenous peoples and certain ethnic minority groups. This is because these ethnic minorities do not typically engage in agricultural practices or livestock rearing within their households. The species targeted for exploitation are usually valuable timber species or other rare non-timber forest products that have a high market value. During the exploitation process, not only the targeted trees or individuals are affected, but often other species within the ecosystem are affected as well.

- Encroachment on Forest Land for Shifting Cultivation: Shifting cultivation primarily arises from the scarcity of arable land available to local communities. Factors such as increasing family size, inefficient production practices, urgent family needs, low education levels, and limited capital contribute to this shortage. Additionally, extreme weather conditions (storms, droughts, and water shortages) lead to crop failure and food insecurity, prompting the ongoing search for alternative land for cultivation.

- Negative Impacts on Indigenous Tree Plantations: The destruction of native trees within planted forests can result from several factors. These include a heavy reliance on intercropped trees without alternative income sources, a lack of technical knowledge in tree care, and an insufficient integration of effective cultivation models within native tree plantations.

- Indirect Causes Contributing to Forest Resource Decline: Population growth and resource pressure result in increased pressure on forest resources. Environmental pollution negatively impacts forest health, while altered climate conditions affect forest ecosystems. Public awareness plays a crucial role in sustainable resource management. Additionally, using natural forest resources for food, pets, and ornamental plants affects availability. Lax enforcement of forest protection laws and insufficient financial support for preserving biodiversity also contribute to the problem.

3.3.2 Criteria for assessing the degree of forest rehabilitation

Following data analysis, the criterion was established with two primary components: i) Assessing forest rehabilitation levels, including forest structure and biodiversity, and ii) Evaluating how forests contribute to human well-being (Table 2). Details are provided in Annexes 1-4.

Table 2: The criterion contributes to assessing the level of forest rehabilitation

Groups	Criterion
Group 1: Determination of the forest rehabilitation level	1. Forest structure: - Tree density with DBH ≥ 10 cm/ha (Index 1.1.1) - Vine density (Index 1.1.2). - Tree DBH (Index 1.1.3). 2. Forest biodiversity: - Number of tree species with DBH ≥ 10cm/1.000 m^2 (Index 1.2.1). - Simpson index (Index 1.2.2). - Shannon index (Index 1.2.3).
Group 2: Forests ensure harmony in terms of humans	1. Forests ensure the function of providing the basic needs of the community: 2. Forests ensure protection for humans: 3. Forests meet the cultural, religious, tourism, and recreational needs of the community. 4. People/communities have the right to manage and own forests and land. 5. Local people have access to other services that help improve their livelihoods.

A forest is considered fully recovered when all criteria (Group 1) receive a score of 4 or 5 points, and its capacity to meet human social needs is assessed in detail (as indicated in Annex 4).

3.3.3 Management, Restoration, and Conservation Solutions

a. Solutions for natural forests

The solutions proposed must be based on a comprehensive understanding of the factors influencing forest rehabilitation. Specifically, three groups of measures (detailed in Circulars 29/2018 and Bao Huy 2021) have been utilized, including:

Group 1: Protection of Forest, and Promotion of natural forest regeneration without/with supplementary planting.

Group 2: Monospecific or mixed-species economic tree plantations, and Forest planting strategies to enhance biodiversity for tourism and landscape purposes.

Group 3: Balanced Solutions including Forest enhancement, and Integrated Agroforestry development.

Additionally, continuous forest protection is essential to mitigate impacts such as logging, hunting, and regular patrols to prevent forest fires. Hunting of wildlife species can reduce seed dispersal in the forest area. Figure 06 indicates the framework for decision activities for forest rehabilitation.

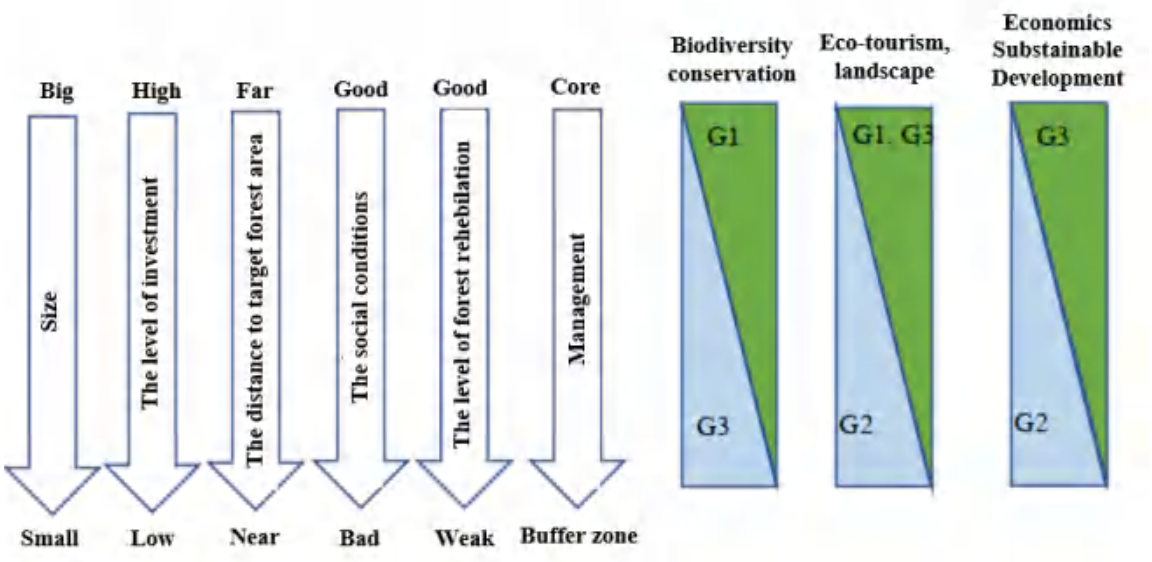


Figure 6: The framework to decision activities for forest rehabilitation

b. Sustainable Management of Indigenous Tree Plantations

Strengthening support from agricultural and forestry extension officers is crucial for knowledge transfer related to sustainable cultivation techniques.

c. Management and Conservation Measures for High-value Natural Forests in Buffer Zones

Prioritize protection through patrols and monitoring for small, high-value conservation forests. For larger areas, immediate measures involve strengthening supervision by forest officers. Long-term solutions include improving the socio-economic livelihoods of communities living near forests and enhancing community-based forest management.

d. Solutions in Economic, Cultural, Social, and Institutional Contexts:

Several policies and institutional frameworks have proven effective in forest management and protection and should continue to be applied:

- Payment for Forest Environmental Services (PFES) policies.
- Community-based forest protection agreements.
- Development of agroforestry models.

Leveraging local knowledge for sustainable forest and land resource use is essential.

- Implementing community-based forest management models helps minimize conflicts between community interests and forest owners in permissible areas.
- Creating income opportunities for locals through activities like forest protection, restoration, and management contracts.

- Supporting livestock and crop models to provide food security for ethnic minority communities and reduce pressure on forest resources.
- Organizing training workshops on technical skills, business knowledge, market access, and various forms of agricultural entrepreneurship (community-based tourism, agro-tourism, experiential tourism) suitable for minority youth in their local context.
- Facilitating business development to generate employment opportunities, especially for young laborers from ethnic minority households.

3.4 Suggestions

To implement research findings across various regions in Vietnam for evaluating the suitability of indicators and the effectiveness of models, several steps are essential:

Fixed Sample Plots for Long-term Monitoring:

- Establishing a system of fixed sample plots allows continuous, long-term monitoring. This approach ensures robust results by tracking and assessing research outcomes over time.
- Investment from diverse sources (including non-governmental organizations, biosphere reserve management boards, and national parks) is crucial for sustained monitoring efforts.

Addressing Policy Challenges:

- Research should identify existing policy gaps hindering economic development and sustainable forest management.
- Propose strategic policy directions for economic development in different regions, considering socio-economic livelihoods and community-based forest management.

Collaboration with Stakeholders:

- Engage relevant stakeholders to leverage and replicate successful socio-economic characteristics that promote harmony between forests and human activities.

4. Conclusion

The experience of Vietnam with deforestation and forest degradation is of particular relevance, especially within the context of developing economies where tropical forests play a dominant role. These ecosystems provide essential ecological services, support biodiversity, and contribute to local livelihoods. However, the complex interplay of socio-economic factors, policy decisions, and environmental dynamics influences the trajectory of forest cover change. While poverty reduction, forest conservation, governance improvement, and population control are of paramount importance, a comprehensive approach is essential. No single solution can effectively address deforestation and degradation thus policymakers must address multiple issues simultaneously. Despite efforts, these processes persist in diverse ways, varying across regions and changing over time. Understanding the approximate drivers is crucial for sustainable forest management. Long-term monitoring, policy evaluation, community engagement, and knowledge transfer are key imperatives.

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Annex 1. Groups of forest rehabilitation

Tree density **(point)**	Vine density **(point)**	Tree DBH **(point)**	Biodiversity index **(point)**	Groups of forest rehabilitation
<4	<4	<4	<4	Forests have not yet fully recovered in terms of both diversity and structure (L1).
<4	<4	<4	≥ 4	Forests recovered in terms of diversity but not yet in terms of structure (L2).

<4	<4	≥ 4	≥ 4	Forests recovered in terms of diversity and parts in terms of structure (L3).
<4	≥ 4	≥ 4	≥ 4	Forests recovered in terms of diversity and parts in terms of structure (L3).
≥ 4	≥ 4	≥ 4	≥ 4	Forests recovered in terms of diversity and structure (L4).

Annex 2. Evaluation of forest structure

Criteria	Evaluation (points)			
	2	**3**	**4**	**5**
Evergreen broadleaf forest				
Index 1.1.1: Tree density with DBH ≥ 10 cm/ha	< 410	410-525	525-670	≥ 670
Index 1.1.2: Vine density with DBH ≥ 0.5 cm (stems/ha)	≥ 330	≥ 330	< 330	< 330
Index 1.1.3: Mean DBH (cm)	< 18	18-20	20-22	≥ 22
Deciduous forest				
Index 1.1.1: Tree density with DBH ≥ 10 cm/ha	< 325	325-380	380-480	≥ 480
Index 1.1.2: Vine density with DBH ≥ 0.5 cm (stems/ha)	≥ 185	≥ 185	< 185	< 185
Index 1.1.3: Mean DBH (cm)	< 16	16-20	20-30	≥ 30

Annex 3. Evaluation for forest biodiversity

Criteria	Evaluation (points)			
	2	**3**	**4**	**5**
Evergreen broadleaf forest				
Index 1.2.1: Number of tree with DBH ≥ 10 cm/1000 m^2	<18	18-22	22-27	≥27
Index 1.2.2: Simpson's index[75]	< 0.89	0,89-0,91	0,91-0,93	≥ 0,93
Index 1.2.3: Shannon's index[76]	< 2.51	2,51-2,77	2,77-2,97	≥ 2,97
Deciduous forest				
Index 1.2.1: Number of tree with DBH ≥ 10 cm/1000 m^2	<10	10-13	13-15	≥15

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Index 1.2.2: Simpson's index	<0.78	0,78-0,82	0,82-0,85	≥ 0,85
Index 1.2.3: Shannon's index	1.87	1,87-2,06	2,06-2,30	≥ 2,30

Annex 4. Forests ensure harmony in terms of humans.

Criterion	The forest is not yet harmonious	The forest is harmonious
1. Forests ensure the function of providing the basic needs of the community		
Protecting and providing water for daily life and production.	**>25%** not satisfied with	**≥ 75 %** satisfied with
The function of providing NFTPs for the community.	**>25%** not satisfied with	**≥ 75 %** satisfied with
2. Forests ensure protection for humans		
Maintaining and regulating water resources.	**>25%** not agreed with	**≥ 75 %** agreed with
Soil protection function does not cause erosion or landslides.	**>25%** not agreed with	**≥ 75 %** agreed with
3. Forests meet the cultural, religious, tourism, and recreational needs of the community	**>25%** not agreed with	**≥ 75 %** agreed with
4. Right to manage and own forests and land		
Communities are assigned land and forest use rights/forest protection contracts.	No contracts	Have contracts
Local people are allowed to participate in forest protection contracts.	< 50% total number of local people	**≥ 50 %** total number of local people
Local people are given the right to use forestry land.	> 25% no rights	**≥ 75 %** have rights
5. Local people have access to other services that help improve their livelihoods		
Access to other services improves community livelihoods (training, sharing knowledge, etc.).	No	Yes
Education.	No	Yes
Access to medical support and health care in the community.	No	Yes

Annex 5. Five groups of policies and Laws related to forest rehabilitation.

Group 1. Land Allocation and Forest Transfer Policies: Decision 304/2001/QĐ-TTg, Decision 33/2007/QĐ-TTg, Decision 1342/2009/QĐ-TTg, Land Law 2013, and Law on Forest 2017. These policies focus on sustainable forest management and require forest owners to develop management plans. They prevent illegal logging, reduce deforestation risks, and empower local communities. Participants gain awareness of forest importance and their role in environmental conservation. Financial resources from forest protection agreements contribute to sustainable poverty reduction and enhance forest quality.

Group 2. Relocation Policies from Core Areas: The primary goal is to protect core forest ecosystems by reducing human impact. Families living in these critical zones are relocated to resettlement areas or new rural locations. This eases pressure on forest ecosystems and enhances the resilience of forest species.

Group 3. Forest Restoration and Protection Policies: Decision 661/1998/QĐ-TTg, Program 327, Program 661, Decision 07 and 24 /2012/QĐ-TTg. These policies emphasize sustainable practices, community engagement, and ecological resilience. They promote forest restoration, agroforestry, natural regeneration, and overall environmental goals.

Group 4. Payment for Forest Environmental Services (PFES): Launch in 2010, PFES provides direct financial incentives to forest owners and communities engaged in protection. Compensation is given for environmental services like carbon sequestration and biodiversity conservation.

Group 5. Livelihood Development Policies: Program 135, Decision 1722/2016/QĐ-TTg. They aim to reduce rural poverty sustainably and offer technical support, financial literacy training, vocational opportunities, and market access.

Annex 6. Silviculture for the forest rehabilitation level.

The forest rehabilitation level	Methods Approach
L1	- Index 1.1.1 ≤ 3 points: removing low valuable vine and keeping high valuable vine. - Index 1.1.1 > 3 points: promote natural regeneration - All indexes ≤ 3 points: promote natural regeneration combined with planting local forest tree species. - Forests must always be protected from logging, and hunting and regularly patrolled to prevent forest fires. - Enrichment planting for forest enhancement.
L2	- Index 1.1.1 ≤ 3 points: removing low valuable vine and keeping high valuable vine. - Index 1.1.1 > 3 points: promote natural regeneration - Forests must always be protected from logging, and hunting and regularly patrolled to prevent forest fires.
L3	- Index 1.1.1 ≤ 3 points: removing low valuable vine and keeping high valuable vine. - Forests must always be protected from logging, and hunting and regularly patrolled to prevent forest fires.
L4	- Forests must always be protected from logging, and hunting and regularly patrolled to prevent forest fires.